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Research Article

Association between admission diagnoses and intensive care unit mortality: A retrospective cohort study

Mehmet Akif Yilmaz [a,*], Mehmet Zubeyir Guney [a], Hasan Emre Kivanc [a], Nuray Uzun [a], Lale İbrahimbeyli [a], Huseyin Catalkaya [a], Nazim Dogan [a]

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ABSTRACT

Background: Mortality in the intensive care unit (ICU) is primarily driven by the severity of acute organ dysfunction; however, the prognostic contribution of admission clinical diagnoses beyond severity scores remains incompletely defined. This study aimed to evaluate the association between admission diagnoses and ICU mortality after adjustment for organ dysfunction severity.

Methods: This retrospective cohort study included adult patients admitted to a tertiary ICU between January 2024 and December 2025. Patients with missing baseline data or ICU length of stay <24 hours were excluded. Demographic characteristics, comorbidities, admission diagnoses, and disease severity scores were recorded. ICU mortality was the primary outcome. Multivariable logistic regression analysis was performed using the Sequential Organ Failure Assessment (SOFA) score as the primary severity adjustment variable.

Results: A total of 1,248 patients were included; 763 (61.1%) died during the ICU stay. In the SOFA-adjusted multivariable model, age (adjusted odds ratio [aOR] 1.02; 95% CI 1.02–1.03), SOFA score (aOR 1.33 per point; 95% CI 1.25–1.41), post–cardiac arrest status (aOR 6.21; 95% CI 4.17–9.23), sepsis (aOR 1.73; 95% CI 1.15–2.59), and active malignancy (aOR 1.69; 95% CI 1.17–2.44) were independently associated with ICU mortality. Neuromuscular disease showed a trend toward increased mortality but did not reach statistical significance.

Conclusion: Beyond organ dysfunction severity, selected admission diagnoses—particularly post–cardiac arrest status, sepsis, and active malignancy—provide independent prognostic information for ICU mortality. Incorporating diagnosis-based risk stratification alongside severity scores may improve early prognostic assessment in critically ill patients.

Trial Registration: The study was registered at ClinicalTrials.gov (ID: NCT07369206).

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1. Introduction

Intensive care units (ICUs) provide care for critically ill patients with life-threatening acute conditions and remain associated with substantial short-term mortality worldwide [1]. Mortality in critically ill patients is widely recognized as a multifactorial outcome influenced by demographic characteristics, underlying comorbidities, and the severity of acute physiological derangements at the time of ICU admission [2,3]. To support risk stratification and outcome prediction, severity-of-illness scoring systems such as APACHE II, SAPS, and the Sequential Organ Failure Assessment (SOFA) score have been extensively developed and validated [4–6]. Among these

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tools, the SOFA score has gained particular importance because it quantifies the burden of acute organ dysfunction and demonstrates a strong association with ICU mortality across diverse critical illness syndromes [6,7].

However, severity-of-illness scores are primarily driven by physiological and organ dysfunction parameters and may not fully capture the prognostic impact of the clinical diagnoses and syndromic conditions present at ICU admission [2,3]. In real-world ICU practice, patients are rarely admitted with a single isolated diagnosis; instead, overlapping clinical syndromes such as sepsis or septic shock, acute respiratory failure, acute respiratory distress syndrome (ARDS), post–cardiac arrest syndrome, and multiple organ dysfunction syndrome frequently coexist [6,8-10]. Previous investigations of ICU mortality have predominantly focused on specific disease subgroups or treatment-related variables, including sepsis, ARDS, trauma, or cardiac arrest, rather than systematically evaluating admission diagnoses in heterogeneous ICU populations [3,8,9]. As a result, the independent and combined prognostic contribution of admission clinical diagnoses beyond established severity scores remains incompletely defined [2,3].

The objective of this study was to evaluate the association between admission clinical diagnoses and ICU mortality in adult patients admitted to a tertiary mixed ICU while adjusting for acute organ dysfunction severity using the SOFA score [6]. By integrating diagnosis-based variables with severity adjustment, we aimed to determine whether selected admission diagnoses provide additional prognostic information beyond conventional risk stratification tools [2,3].

The primary hypothesis of this study was that selected admission clinical diagnoses contribute independently to ICU mortality beyond the severity of acute organ dysfunction as measured by the SOFA score. In particular, we hypothesized that post–cardiac arrest syndrome, sepsis, and active malignancy would remain significant predictors of ICU mortality after multivariable adjustment [6,9].

2. Materials and Methods

2.1. Study design, setting, and ethical approval

This single-center retrospective cohort study was conducted at a tertiary-care university hospital between January 1, 2024 and December 31, 2025. Institutional Ethics Committee approval was obtained (approval number: B.30.2.ATA.0.01.00/934). The study was registered at ClinicalTrials.gov (NCT07369206). The registration was completed to enhance transparency in the context of a retrospective design; the study represents a noninterventional observational analysis. The study was performed in accordance with the principles of the Declaration of Helsinki. Due to the retrospective nature of the study, informed consent was not obtained from participants.

2.2. Participants: Inclusion and exclusion criteria

The inclusion criteria comprised adult patients aged ≥18 years who were admitted to the ICU within the specified study period. In cases where a patient had multiple ICU admissions during the study timeframe, only the first ICU admission was included in the analysis to preserve the assumption of independence between observations.

Exclusion criteria included ICU stays of less than 24 hours and cases with missing essential data that precluded assessment of the primary outcome. The core dataset consisted of demographic characteristics (age and sex), ICU discharge status (survival or mortality), clinical diagnoses present at admission, and clinical records enabling the calculation of disease severity scores, including APACHE II, SAPS, and SOFA.

2.3. Data sources and data collection

Data were retrospectively retrieved from the hospital information management system and ICU clinical records. To ensure standardization, all variables were recorded based on data obtained within the first 24 hours following ICU admission. In our unit, all patients are clinically evaluated by the same attending faculty member during both daytime and nighttime periods, including twice-daily ward rounds. Admission diagnoses are verified through these clinical evaluations in conjunction with medical records. This standardized approach was implemented to minimize inter-observer variability in diagnostic classification.

2.4. Variables and operational definitions

2.4.1. Demographic variables

Age (years) and sex were recorded for all patients.

2.4.2. ICU admission characteristics

Type of ICU admission

The type of ICU admission was classified as medical, emergency surgical, or elective surgical, in accordance with widely accepted approaches based on the presence and urgency of a surgical intervention prior to ICU admission [11,12].

- Medical admission: Patients admitted to the ICU primarily for medical reasons, without a requirement for a planned or performed surgical intervention prior to or at the time of ICU admission. Typical indications included sepsis, septic shock, ARDS or non-ARDS acute respiratory failure, post–cardiac arrest syndrome, and similar conditions.
- Emergency surgical admission: Patients admitted to the ICU in an unplanned manner following an emergency surgical procedure, generally performed within 24 hours of decision-making.
- Elective surgical admission: Patients admitted to the ICU for postoperative monitoring and/or treatment following an elective surgical procedure that had been planned at least 24 hours in advance.

Source of ICU admission

The source of ICU admission was categorized according to the hospital unit from which the patient was physically transferred to the ICU, as emergency department, hospital ward, or operating room. This classification was adapted from previously published ICU admission studies [13].

- Emergency department: Patients who presented to the hospital through the emergency department and were directly admitted to the ICU due to an ICU indication.
- Hospital ward: Patients who were hospitalized in a clinical ward and subsequently transferred to the ICU following clinical deterioration necessitating intensive care.
- Operating room: Patients admitted to the ICU directly from the operating room (or via the post-anesthesia care unit) following a surgical procedure.

Requirement for Invasive Mechanical Ventilation at Admission

The requirement for invasive mechanical ventilation (IMV) at admission was defined as admission to the ICU while already intubated and receiving invasive mechanical ventilation. This variable was recorded as a binary outcome (yes/no).

2.4.3. Severity scores

The APACHE II, SAPS, and SOFA scores were calculated using the worst clinical and laboratory values recorded during the first 24 hours following ICU admission.

2.4.4. Comorbidities

Comorbidities were defined as chronic diseases present prior to ICU admission and were recorded as binary variables (yes/no). The following comorbid conditions were assessed: hypertension, diabetes mellitus, chronic obstructive pulmonary disease (COPD), chronic kidney disease (stage ≥3), congestive heart failure, and a history of cerebrovascular events.

2.4.5. Clinical diagnoses at admission

The following clinical diagnoses were recorded as binary variables (yes/no), provided that they were present at the time of ICU admission and documented in the clinical records:

- Sepsis: Patients with a documented diagnosis of sepsis in the clinical records.
- Septic shock: Patients with a documented diagnosis of septic shock in the clinical records.
- ARDS: Patients with a documented diagnosis of acute respiratory distress syndrome (ARDS) in the clinical records.
- In our ICU, diagnoses of sepsis and septic shock are routinely established according to the Sepsis-3 definitions in daily clinical practice. Because this study had a retrospective design, the investigators did not perform an independent retrospective reassessment of Sepsis-3 criteria. Instead, sepsis and septic shock diagnoses were recorded exactly as documented in the clinical records by the attending ICU physicians during routine patient care.
- Non-ARDS acute respiratory failure: Patients admitted with acute hypoxemic and/or hypercapnic respiratory failure who did not meet the diagnostic criteria for ARDS, including conditions such as cardiogenic pulmonary edema, pneumonia, acute exacerbation of COPD, pleural effusion, and similar causes.
- MODS: Patients with a documented diagnosis of multiple organ dysfunction syndrome involving more than one organ system.
- PCAS: Patients with return of spontaneous circulation after cardiac arrest and a documented diagnosis of post–cardiac arrest syndrome.
  In our ICU, post–cardiac arrest syndrome (PCAS) is clinically defined in patients who achieve return of spontaneous circulation following cardiac arrest and subsequently require intensive care management due to neurological, cardiovascular, or systemic complications related to global ischemia–reperfusion injury. Because of the retrospective design of this study, additional variables such as the type of cardiac arrest (in-hospital or out-of-hospital), duration of arrest, or the use of targeted temperature management were not systematically analyzed. PCAS diagnoses were recorded as documented in the clinical records by the treating ICU physicians during routine clinical practice.
- Catastrophic neurological condition: Patients with a clinical diagnosis consistent with severe impairment of consciousness and/or life-threatening intracranial pathology due to primary neurological injury, including intracerebral hemorrhage, subarachnoid hemorrhage, large territorial infarction, or malignant cerebral edema.
- Multiple trauma: Patients with severe or multiple traumatic injuries requiring ICU admission, such as major thoracic trauma or trauma associated with long-bone fractures.
- Pulmonary embolism: Patients with a documented diagnosis of pulmonary embolism in the clinical records.
- Active malignancy: Patients with documentation of active malignancy at the time of ICU admission; cases with a history of malignancy in remission or under post-curative follow-up were excluded from this category.
- Neuromuscular disease: Patients with a documented diagnosis of a neuromuscular disease in the clinical records.
- Morbid obesity: Defined as a body mass index (BMI) ≥40 kg/m^2 and recorded as present when documented in the clinical records.

2.5. Source of diagnoses

Because this study was conducted using a retrospective design, no retrospective diagnostic adjudication was performed by the investigators. Clinical diagnoses present at admission were established as part of routine ICU practice by the attending faculty member and recorded during patient follow-up, including twice-daily ward rounds. The investigators coded diagnoses as binary variables (present/absent) exactly as documented in the clinical records.

2.6. Outcome measures

The primary outcome was defined as mortality occurring during the ICU stay (ICU mortality).

Secondary outcomes were ICU length of stay and ICU discharge disposition.

ICU discharge disposition was categorized into three groups:

- Death: Death occurring during the ICU stay.
- Transfer to hospital ward: Transfer from the ICU to hospital wards after resolution of the need for intensive care.
- Transfer to an external center: Transfer from the ICU to another institution after clinical stabilization due to patient/family preference or administrative/logistical reasons.

2.7. Statistical analysis

All statistical analyses were performed using data obtained during the ICU stay. Distributional characteristics of continuous variables were assessed using visual methods (histograms and Q–Q plots) and appropriate tests of normality. Continuous variables with a normal distribution are presented as mean ± standard deviation, whereas non-normally distributed variables are presented as median (interquartile range, IQR). Categorical variables are reported as counts and percentages.

Comparisons between survivors and non-survivors were performed using Student's t-test or the Mann–Whitney U test for continuous variables, depending on distribution. For categorical variables, the chi-square test or Fisher's exact test was used, as appropriate. For variables with more than two categories (e.g., type of ICU admission and source of ICU admission), the p value was reported to reflect the overall comparison across categories.

To identify variables associated with ICU mortality, univariable logistic regression analyses were initially conducted. Variables with $p<0.10$ in univariable analyses and/or those considered clinically relevant were selected as candidates for multivariable analyses.

Multivariable logistic regression was performed to evaluate independent predictors of ICU mortality. During model development, demographic variables, comorbidities, clinical diagnoses at admission, and severity-of-illness scores were considered. Because of potential multicollinearity among severity scores, APACHE II, SAPS, and SOFA were not entered into the model simultaneously. Based on clinical rationale, the SOFA score—reflecting the burden of acute organ dysfunction—was selected as the primary severity indicator, and the main multivariable model was constructed accordingly. Alternative models including other severity scores were examined as secondary analyses.

Results from logistic regression models are reported as adjusted odds ratios (ORs) with 95% confidence intervals (CIs). Model fit and collinearity among covariates were assessed using appropriate diagnostic methods. A two-sided p value <0.05 was considered statistically significant.

3. Results

Between January 2024 and December 2025, a total of 1,334 adult patients admitted to the ICU were assessed for eligibility. Of these, 12 patients were excluded due to missing essential baseline data, 27 patients were excluded because their ICU stay was shorter than 24 hours, and 47 patients were excluded due to readmission to the ICU during the study period. Consequently, 1,248 patients were included in the final analysis. Among the included patients, 485 were discharged from the ICU alive (either transferred to a hospital ward or transferred to an external center), whereas 763 patients died during the ICU stay (Fig. 1).

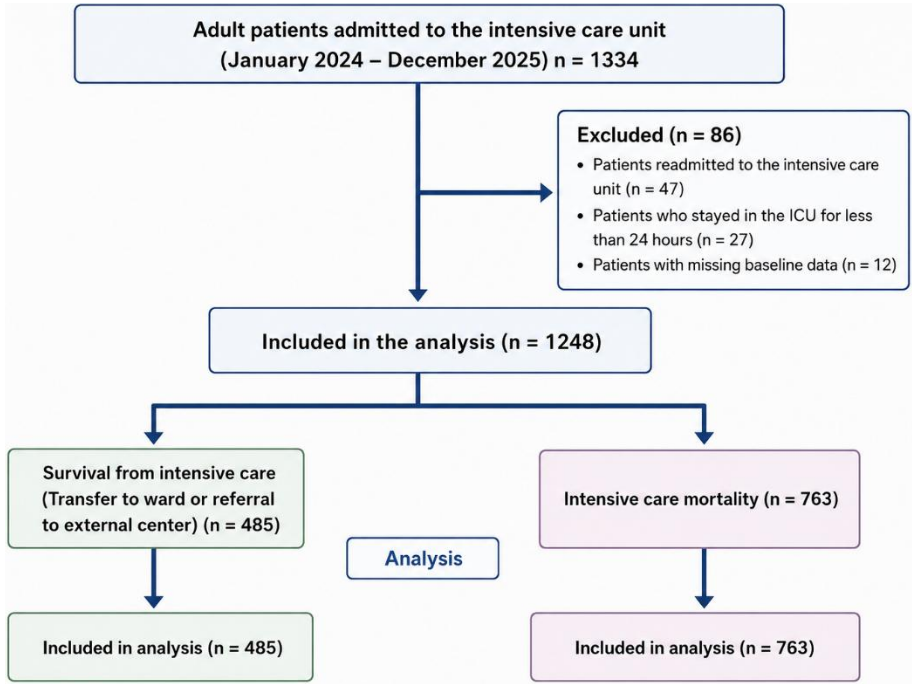

Fig. 1. Flow diagram of the research.

Among the 1,248 patients included in the study, the mean age was 66.9 ± 16.3 years. Of these patients, 771 (61.8%) were male and 477 (38.2%) were female. The majority of ICU admissions were for medical reasons, with 91.7% (n = 1,144) classified as medical admissions, whereas 5.7% (n = 71) and 2.6% (n = 33) were classified as emergency surgical and elective surgical admissions, respectively. Regarding the source of ICU admission, 56.3% (n = 703) of patients were admitted from the emergency department, 38.5% (n = 480) from hospital wards, and 5.2% (n = 65) from the operating room. Hypertension was the most prevalent comorbidity, present in 50.0% (n = 624) of patients. Other common comorbidities included diabetes mellitus in 30.6% (n = 382), chronic obstructive pulmonary disease in 21.4% (n = 267), congestive heart failure in 19.0% (n = 237), a history of cerebrovascular events in 17.8% (n = 222), and chronic kidney disease (stage ≥3) in 11.7% (n = 146). Nearly half of the patients required invasive mechanical ventilation at admission, with 49.8% (n = 621) admitted while intubated. The mean severity-of-illness scores were 25.0 ± 8.8 for APACHE II, 54.4 ± 18.5 for SAPS, and 6.8 ± 3.3 for SOFA. The mean ICU length of stay was 9.3 ± 14.2 days (Table 1).

Table 1. Demographic and clinical characteristics of the study population (n = 1,248).

Variable	Value
Number of patients	1,248
Age, years	66.9 ± 16.3
Sex	
Male	771 (61.8%)
Female	477 (38.2%)
Type of ICU admission	
Medical	1,144 (91.7%)
Emergency surgical	71 (5.7%)
Elective surgical	33 (2.6%)
Source of ICU admission	
Emergency department	703 (56.3%)
Hospital ward	480 (38.5%)
Operating room	65 (5.2%)
Comorbidities	
Hypertension	624 (50.0%)
Diabetes mellitus	382 (30.6%)
COPD	267 (21.4%)
Chronic kidney disease	146 (11.7%)
Congestive heart failure	237 (19.0%)
History of cerebrovascular events	222 (17.8%)
Requirement for invasive mechanical ventilation at admission	621 (49.8%)
APACHE II score	25.0 ± 8.8
SAPS score	54.4 ± 18.5
SOFA score	6.8 ± 3.3
ICU length of stay, days	9.3 ± 14.2

Note: Continuous variables are presented as mean ± standard deviation, and categorical variables are presented as n (%).
Abbreviations: ICU, intensive care unit; APACHE II, Acute Physiology and Chronic Health Evaluation II; SAPS, Simplified Acute Physiology Score; SOFA, Sequential Organ Failure Assessment; COPD, chronic obstructive pulmonary disease. Chronic kidney disease was defined as stage ≥3.

Non-survivors were significantly older than survivors [median (IQR): 72.0 (61.0–80.0) vs. 65.0 (53.0–76.0); p<0.001]. Severity-of-illness scores were markedly higher in the non-survivor group; APACHE II, SAPS, and SOFA scores were 28.0 (22.0–33.0), 61.0 (48.0–72.0), and 8.0 (5.0–10.0), respectively, among non-survivors, compared with 20.0 (16.0–25.0), 44.0 (33.0–55.0), and 5.0 (3.0–7.0) among survivors (all comparisons p<0.001). There was no significant difference in ICU length of stay between groups [median (IQR): 5.0 (2.0–12.0) vs. 4.0 (2.0–8.0); p=0.237]. The distribution of male sex was similar between survivors and non-survivors (p=0.799). With respect to comorbidities, hypertension, diabetes mellitus, congestive heart failure, and a history of cerebrovascular events were significantly more common among non-survivors (p=0.002, p=0.001, p=0.003, and p<0.001, respectively), whereas the prevalence of chronic obstructive pulmonary disease and chronic kidney disease (stage ≥3) did not differ significantly between groups (p=1.000 and p=0.339, respectively). The proportion of patients requiring invasive mechanical ventilation at admission was higher among non-survivors than survivors (53.2% vs. 44.3%; p=0.003). The distribution of both type of ICU admission and source of ICU admission also differed significantly between groups (both p<0.001). While the proportion of medical admissions was higher among non-survivors, elective surgical admissions and admissions from the operating room were more frequent among survivors (Table 2).

Table 2. Comparison of survivors and non-survivors.

Variable	Survivors (n = 485)	Non-survivors (n = 763)	p value
Age, years	65.0 (53.0–76.0)	72.0 (61.0–80.0)	<0.001
APACHE II score	20.0 (16.0–25.0)	28.0 (22.0–33.0)	<0.001
SAPS score	44.0 (33.0–55.0)	61.0 (48.0–72.0)	<0.001
SOFA score	5.0 (3.0–7.0)	8.0 (5.0–10.0)	<0.001
ICU length of stay, days	4.0 (2.0–8.0)	5.0 (2.0–12.0)	0.237
Male sex	297 (61.2%)	474 (62.1%)	0.799
Hypertension	215 (44.3%)	409 (53.6%)	0.002
Diabetes mellitus	122 (25.2%)	260 (34.1%)	0.001
COPD	104 (21.4%)	163 (21.4%)	1.000
Chronic kidney disease (stage ≥3)	51 (10.5%)	95 (12.5%)	0.339
Congestive heart failure	72 (14.8%)	165 (21.6%)	0.003
History of cerebrovascular events	62 (12.8%)	160 (21.0%)	<0.001
Requirement for invasive mechanical ventilation at admission	215 (44.3%)	406 (53.2%)	0.003
Type of ICU admission			<0.001
Medical	420 (86.6%)	724 (94.9%)	
Emergency surgical	38 (7.8%)	33 (4.3%)	
Elective surgical	27 (5.6%)	6 (0.8%)	
Source of ICU admission			<0.001
Emergency department	327 (67.4%)	376 (49.3%)	
Hospital ward	108 (22.3%)	372 (48.8%)	
Operating room	50 (10.3%)	15 (2.0%)	

Note: Continuous variables are presented as median (interquartile range, IQR) because they were not normally distributed and were compared using the Mann–Whitney U test. Categorical variables are presented as n (%) and were compared using the chi-square test. For variables with more than two categories (type of ICU admission and source of ICU admission), the p value represents the overall comparison across categories. A p value <0.05 was considered statistically significant.

Abbreviations: ICU, intensive care unit; APACHE II, Acute Physiology and Chronic Health Evaluation II; COPD, Chronic obstructive pulmonary disease; SAPS, Simplified Acute Physiology Score; SOFA, Sequential Organ Failure Assessment.

When the association between clinical diagnoses at admission and ICU mortality was evaluated, the presence of sepsis and septic shock was significantly more frequent among non-survivors than survivors. Sepsis was observed in 31.1% of non-survivors compared with 13.8% of survivors (p<0.001). Similarly, septic shock was present in 10.9% of non-survivors versus 3.3% of survivors (p<0.001). There was no significant difference between groups in the prevalence of ARDS (p=0.231), whereas non-ARDS acute respiratory failure was more common among non-survivors (63.4% vs. 56.3%; p=0.014). The prevalence of MODS and PCAS was markedly higher in non-survivors than survivors (12.3% vs. 3.5% and 41.0% vs. 8.5%, respectively; both p<0.001). Catastrophic neurological condition was also more frequent in the non-survivor group (27.9% vs. 21.6%; p=0.016). In contrast, multiple trauma was more common among survivors than non-survivors (8.0% vs. 3.7%; p=0.001). Pulmonary embolism was also more frequent among survivors (11.8% vs. 7.5%; p=0.014). Additionally, the presence of active malignancy and neuromuscular disease was significantly higher in non-survivors compared with survivors (21.1% vs. 12.8%; p<0.001 and 6.4% vs. 2.5%; p=0.003, respectively). No significant difference was observed for morbid obesity (p=0.239) (Table 3).

Variables associated with ICU mortality were evaluated using univariable logistic regression analysis. Increasing age was associated with a higher likelihood of mortality (OR 1.03; 95% CI 1.02–1.03; p<0.001). Among comorbidities, hypertension (OR 1.45; 95% CI 1.15–1.82; p=0.001), diabetes mellitus (OR 1.54; 95% CI 1.19–1.98; p<0.001), chronic kidney disease (OR 1.87; 95% CI 1.27–2.74; p=0.002), congestive heart failure (OR 1.62; 95% CI 1.20–2.20; p=0.002), and a history of cerebrovascular events (OR 1.81; 95% CI 1.32–2.49; p<0.001) were significantly associated with mortality, whereas the presence of chronic obstructive pulmonary disease was not (OR 1.00; p=0.973). The requirement for invasive mechanical ventilation at admission (admission while intubated) was significantly associated with increased mortality (OR 1.43; 95% CI 1.14–1.80; p=0.002). Severity-of-illness scores showed a strong association with mortality; increases in APACHE II (OR 1.12; 95% CI 1.10–1.14; p<0.001), SAPS (OR 1.06; 95% CI 1.05–1.06; p<0.001), and SOFA (OR 1.38; 95% CI 1.31–1.45; p<0.001) scores were each associated with higher odds of mortality on a per-point basis. When clinical diagnoses at admission were examined, sepsis (OR 2.81; 95% CI 2.08–3.79; p<0.001), septic shock (OR 3.58; 95% CI 2.07–6.19; p<0.001), non-ARDS acute respiratory failure (OR 1.35; 95% CI 1.07–1.70; p=0.012), multiple organ dysfunction syndrome (MODS) (OR 3.87; 95% CI 2.28–6.57; p<0.001), post–cardiac arrest syndrome (PCAS) (OR 7.53; 95% CI 5.30–10.70; p<0.001), catastrophic neurological condition (OR 1.40; 95% CI 1.07–1.83; p=0.013), active malignancy (OR 1.82; 95% CI 1.33–2.51; p<0.001), and neuromas-

cular disease (OR 2.71; 95% CI 1.42–5.14; p=0.002) were significantly associated with increased mortality. In contrast, multiple trauma (OR 0.44; 95% CI 0.26–0.72; p=0.001) and pulmonary embolism (OR 0.61; 95% CI 0.41–0.89; p=0.011) were associated with lower odds of mortality. ARDS (p=0.171) and morbid obesity (p=0.159) were not significantly associated with ICU mortality (Table 4).

Table 3. Association between clinical diagnoses at admission and ICU mortality.

Clinical diagnosis	Total (n = 1,248)	Survivors (n = 485)	Non-survivors (n = 763)	p value
Sepsis	304 (24.4%)	67 (13.8%)	237 (31.1%)	<0.001
Septic shock	99 (7.9%)	16 (3.3%)	83 (10.9%)	<0.001
ARDS	30 (2.4%)	8 (1.6%)	22 (2.9%)	0.231
Non-ARDS acute respiratory failure	757 (60.7%)	273 (56.3%)	484 (63.4%)	0.014
MODS	111 (8.9%)	17 (3.5%)	94 (12.3%)	<0.001
PCAS	354 (28.4%)	41 (8.5%)	313 (41.0%)	<0.001
Catastrophic neurological condition	318 (25.5%)	105 (21.6%)	213 (27.9%)	0.016
Multiple trauma	67 (5.4%)	39 (8.0%)	28 (3.7%)	0.001
Pulmonary embolism	114 (9.1%)	57 (11.8%)	57 (7.5%)	0.014
Active malignancy	223 (17.9%)	62 (12.8%)	161 (21.1%)	<0.001
Neuromuscular disease	61 (4.9%)	12 (2.5%)	49 (6.4%)	0.003
Morbid obesity	16 (1.3%)	9 (1.9%)	7 (0.9%)	0.239

Note: Data are presented as n (%). Comparisons between survivors and non-survivors were performed using the chi-square test. A p value <0.05 was considered statistically significant.

Abbreviations: ARDS, acute respiratory distress syndrome; MODS, multiple organ dysfunction syndrome; PCAS, post–cardiac arrest syndrome; ICU, intensive care unit.

Table 4. Univariable logistic regression analysis for ICU mortality.

Variable	OR	95% CI	p value
Age, years	1.03	1.02–1.03	<0.001
Hypertension	1.45	1.15–1.82	0.001
Diabetes mellitus	1.54	1.19–1.98	<0.001
COPD	1.00	0.75–1.31	0.973
Chronic kidney disease (stage ≥3)	1.87	1.27–2.74	0.002
Congestive heart failure	1.62	1.20–2.20	0.002
History of cerebrovascular events	1.81	1.32–2.49	<0.001
Requirement for invasive mechanical ventilation at admission	1.43	1.14–1.80	0.002
APACHE II score (per point)	1.12	1.10–1.14	<0.001
SAPS score (per point)	1.06	1.05–1.06	<0.001
SOFA score (per point)	1.38	1.31–1.45	<0.001
Sepsis	2.81	2.08–3.79	<0.001
Septic shock	3.58	2.07–6.19	<0.001
ARDS	1.77	0.78–4.01	0.171
Non-ARDS acute respiratory failure	1.35	1.07–1.70	0.012
MODS	3.87	2.28–6.57	<0.001
PCAS	7.53	5.30–10.70	<0.001
Catastrophic neurological condition	1.40	1.07–1.83	0.013
Multiple trauma	0.44	0.26–0.72	0.001
Pulmonary embolism	0.61	0.41–0.89	0.011
Active malignancy	1.82	1.33–2.51	<0.001
Neuromuscular disease	2.71	1.42–5.14	0.002
Morbid obesity	0.49	0.18–1.32	0.159

Note: Results are presented as odds ratios (ORs) with 95% confidence intervals (CIs). A p value <0.05 was considered statistically significant. For APACHE II, SAPS, and SOFA scores, ORs represent the effect per one-point increase. An OR >1 indicates an increased likelihood of ICU mortality, whereas an OR <1 indicates a decreased likelihood.

Abbreviations: ICU, intensive care unit; OR, odds ratio; CI, confidence interval; APACHE II, Acute Physiology and Chronic Health Evaluation II; COPD, Chronic obstructive pulmonary disease; SAPS, Simplified Acute Physiology Score; SOFA, Sequential Organ Failure Assessment; ARDS, acute respiratory distress syndrome; MODS, multiple organ dysfunction syndrome; PCAS, post–cardiac arrest syndrome.

Independent predictors of ICU mortality were evaluated using a multivariable logistic regression model that included the SOFA score as the severity-of-illness indicator. In this model, age (adjusted OR 1.02; 95% CI 1.02–1.03; p<0.001) and the SOFA score (per point; adjusted OR 1.33; 95% CI 1.25–1.41; p<0.001) were independently associated with mortality. The presence of post–cardiac arrest syndrome (PCAS) was associated with a marked increase in the odds of mortality (adjusted OR 6.21; 95% CI 4.17–9.23; p<0.001). Sepsis at admission (adjusted OR 1.73; 95% CI 1.15–2.59; p=0.008) and active malignancy (adjusted OR 1.69; 95% CI 1.17–2.44; p=0.005) remained independently associated with ICU mortality after adjustment for the SOFA score. Although neuromuscular disease showed a trend toward higher mortality, this association did not reach statistical significance (adjusted OR 2.01; 95% CI 0.90–4.50; p=0.089) (Table 5).

Table 5. Multivariable logistic regression analysis for ICU mortality (primary SOFA-based model).

Variable	Adjusted OR	95% CI	p value
Age, years	1.02	1.02–1.03	<0.001
SOFA score (per point)	1.33	1.25–1.41	<0.001
PCAS	6.21	4.17–9.23	<0.001
Sepsis	1.73	1.15–2.59	0.008
Active malignancy	1.69	1.17–2.44	0.005
Neuromuscular disease	2.01	0.90–4.50	0.089

Note: Results are presented as adjusted odds ratios (ORs) with 95% confidence intervals (CIs). The SOFA score was used as the severity-of-illness indicator in the model, and the OR for SOFA represents the effect per one-point increase. A p value <0.05 was considered statistically significant.

Abbreviations: ICU, intensive care unit; OR, odds ratio; CI, confidence interval; SOFA, Sequential Organ Failure Assessment; PCAS, post–cardiac arrest syndrome.

4. Discussion

In this retrospective cohort study, the independent predictors of ICU mortality were evaluated using a SOFA-based multivariable model, in which age, SOFA score, post–cardiac arrest syndrome (PCAS), sepsis, and active malignancy were found to be independently associated with mortality. These findings suggest that ICU mortality is shaped not only by "acute physiological derangement" but also by the additional prognostic burden imposed by certain clinical conditions present at admission [14].

The strong and independent association between the SOFA score and mortality is consistent with the ability of SOFA to quantitatively reflect the burden of organ dysfunction and its widespread acceptance as a predictor of ICU outcomes [7]. Moreover, the use of SOFA for clinical operationalization within the sepsis spectrum—such as the definition of organ dysfunction by an increase in SOFA score in Sepsis-3—provides a conceptual framework supporting its prognostic relevance [15]. Previous studies have reported that SOFA demonstrates comparable or, in certain contexts, superior discriminative performance relative to APACHE II, and that dynamic or serial SOFA assessments may further enhance prognostic accuracy [7,16].

The independent association between age and mortality may be explained by reduced physiological reserve and diminished tolerance to the stress of critical illness in older patients [14]. This finding aligns with the prevailing view that age in ICU outcome assessment represents not only a surrogate for comorbidity burden but also a determinant influencing the response to acute pathological processes [7].

The persistence of PCAS as one of the strongest predictors in the multivariable model is consistent with the well-recognized high mortality risk associated with post–cardiac arrest syndrome, which encompasses hypoxic-ischemic brain injury, myocardial dysfunction, and a systemic ischemia–reperfusion response [9,17]. In hospitalized cardiac arrest populations, survival to discharge has been reported in the range of approximately 50–60% in most studies, underscoring the generally poor outcomes observed in patients with PCAS [18,19]. Furthermore, prior investigations have shown that SOFA scores are associated with prognosis in PCAS and that their combined use with biomarkers may improve prognostic performance [20].

The finding that sepsis remained independently associated with mortality after adjustment for the SOFA score suggests that sepsis represents not merely a "static" reflection of existing organ dysfunction but rather a "dynamic" clinical syndrome that predisposes to ongoing organ failure and subsequent complications [15].

The independent association between active malignancy and mortality is consistent with the notion that malignancy-related immunosuppression, increased susceptibility to infection, and potential limitations in therapeutic intensity may aggravate the course of critical illness [21]. Systematic reviews demonstrating worse ICU outcomes among oncology patients—particularly in the presence of sepsis or septic shock—provide further support for this observation [22].

Although neuromuscular disease showed a trend toward increased mortality, this association did not reach statistical significance, which may be related to limitations in sample size and diagnostic heterogeneity within this subgroup [7].

In secondary analyses, the observation that APACHE II, SAPS, and SOFA scores were higher among non-survivors is consistent with the existing literature supporting the utility of ICU severity scores for mortality discrimination [16,23]. However, the use of a single severity

score (SOFA) in the multivariable model reduces overlap among scoring systems and contributes to a more parsimonious and interpretable model [14].

In the univariable analysis, multiple trauma and pulmonary embolism were associated with odds ratios below unity, which may reflect the fact that these diagnoses can represent more “reversible” clinical conditions in certain centers, as well as differences in patient profiles such as age and physiological reserve [23,24]. In trauma populations, ICU outcomes have been shown to be closely related to age, comorbidity burden, and injury severity, with higher survival rates observed among younger and less comorbid patients [23,24]. In pulmonary embolism, ICU mortality has been reported to vary widely and to differ substantially according to risk profile (e.g., massive vs. submassive PE, vasopressor requirement), rendering the interpretation of univariable odds ratios inherently cautious [25]. Additionally, these findings may also reflect center-specific patient selection patterns and referral policies. In some tertiary care settings, trauma and pulmonary embolism patients admitted to the ICU may represent relatively stabilized cases transferred for monitoring or specialized management, which could contribute to lower observed mortality risks in univariable analyses.

The lack of a significant association between ARDS and mortality in this cohort may be attributable to its relatively low prevalence, limited statistical power, and the heterogeneity of ARDS definitions and management strategies [7]. Similarly, the absence of a significant association for morbid obesity may be explained by the frequently debated “obesity paradox” in critical care literature, as well as the limited number of affected cases, which constrains statistical power [7].

Overall, this study demonstrates that even after adjustment with the SOFA score in a heterogeneous ICU population, sepsis and active malignancy continue to contribute independently to mortality risk, highlighting the importance of a diagnosis-based approach in early risk stratification [22]. In addition, the high-risk profile of patients with PCAS underscores the need for systematic consideration of neurological prognosis and post–cardiac arrest syndrome components alongside organ dysfunction scores [9,18].

5. Clinical Implications

The findings of this study may have important implications for early risk stratification in critically ill patients. While severity-of-illness scores such as SOFA remain central tools for prognostic assessment in the ICU, our results suggest that certain admission clinical diagnoses provide additional prognostic information beyond organ dysfunction severity. In particular, the strong association of post–cardiac arrest syndrome, sepsis, and active malignancy with ICU mortality highlights the importance of integrating diagnosis-based clinical context into early prognostic evaluation. Recognizing these high-risk diagnostic categories at ICU admission may assist clinicians in identifying patients who require closer monitoring, early multidisciplinary management, and more individualized treatment strategies. Future studies may further explore how combining severity scores with diagnosis-based risk models could improve prognostic accuracy and clinical decision-making in critically ill populations.

Integration of diagnosis-based risk stratification into clinical practice may offer several practical advantages in ICU settings. For example, early recognition of high-risk diagnostic categories such as post–cardiac arrest syndrome, sepsis, and active malignancy may support triage decisions, assist in prioritizing ICU resources, and facilitate earlier multidisciplinary evaluation, including neurological prognostication and palliative care consultation when appropriate. From a systems perspective, incorporating diagnosis-based information alongside physiological severity scores may also improve resource planning in high-demand ICU environments.

In addition, the findings of this study may contribute to the future development of more comprehensive prognostic models. Current ICU risk prediction tools primarily rely on physiological variables and organ dysfunction scores. Our results suggest that selected admission diagnoses may provide complementary prognostic information. Future prospective studies integrating diagnosis-based variables with established severity scores may enable the development of hybrid risk prediction models with improved prognostic accuracy for heterogeneous ICU populations.

6. Study Limitations

This study has several limitations. First, the retrospective, single-center design may limit the generalizability of the findings. Due to the retrospective nature of the study, residual confounding cannot be completely excluded because of unrecorded or missing variables. Treatment-related factors potentially associated with ICU mortality (e.g., vasopressor doses, mechanical ventilation parameters, details of renal replacement therapy, or components of goal-directed sepsis management) were not included in the analyses, which may have precluded a comprehensive assessment of certain clinical effects. Another important limitation relates to the exclusion of several treatment-related variables that may influence ICU outcomes, including vasopressor use, mechanical ventilation parameters, renal replacement therapy, and components of goal-directed sepsis therapy. These variables were not included in the multivariable model primarily because the aim of the present study was to evaluate the prognostic contribution of admission clinical diagnoses independently of treatment-related interventions. Many of these variables represent downstream consequences of disease severity or therapeutic responses occurring after ICU admission and may therefore act as intermediate variables in the causal pathway between the underlying condition and mortality. Including such variables in the regression model could potentially lead to overadjustment or obscure the independent association between admission diagnoses and ICU mortality. Future prospective studies incorporating detailed treatment-related variables may provide additional insights into their interaction with diagnosis-based risk stratification.

Similarly, diagnoses of sepsis and septic shock were based on clinical documentation, and the source of infection and microbiological data were not analyzed in detail. The use of a single severity score (SOFA) as the severity-of-illness indicator was an intentional methodological choice; however, this approach may have prevented additional prognostic information provided by alternative scores such as APACHE II or SAPS from being reflected in the model. Nevertheless, selecting a parsimonious model to reduce collinearity among severity scores is a widely accepted approach that improves the interpretability of multivariable analyses. Finally, the limited sample size for certain clinical conditions, including neuromuscular disease, ARDS, and morbid obesity, may have reduced statistical power and hindered the detection of potential associations for these variables.

7. Conclusions

In this study, conducted in a heterogeneous ICU population, age, post–cardiac arrest syndrome (PCAS), sepsis, and active malignancy were independently associated with ICU mortality, even after adjustment using the SOFA score. These findings indicate that ICU mortality is determined not only by the severity of acute organ dysfunction but also by the additional prognostic burden of certain clinical diagnoses present at admission. In particular, the observation that mortality risk in patients with PCAS remained high independent of the SOFA score highlights the importance of early neurological assessment and prognosis-oriented clinical decision-making in this subgroup. The independent prognostic impact of sepsis and active malignancy further supports the need for early risk stratification and individualized treatment strategies in these patients.

Overall, consideration of specific clinical diagnoses at admission in addition to SOFA-based assessment may improve the prediction of mortality risk in ICU patients. This approach may serve as a basis for future prospective, multicenter studies and facilitate the development of more targeted risk models to guide patient management in the ICU.

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Conflict of Interest

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this manuscript.

Data Availability

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

AI Assistance

No AI-based tools were used in the preparation of this manuscript.

Ethics Approval and Consent to Participate

This single-center retrospective cohort study was conducted at Atatürk University Faculty of Medicine Hospital, a tertiary-care university hospital, between January 1, 2024 and December 31, 2025. Institutional Ethics Committee approval was obtained (approval number: B.30.2.ATA.0.01.00/934). The study was registered at ClinicalTrials.gov (NCT07369206). The registration was completed to enhance transparency in the context of a retrospective design; the study represents a non-interventional observational analysis. The study was performed in accordance with the principles of the Declaration of Helsinki. Due to the retrospective nature of the study, informed consent was not obtained from participants.

Author Contributions

***Mehmet Akif Yilmaz**: conceptualization, methodology, validation, formal analysis, investigation, resources, data curation, writing – original draft, writing – review & editing, visualization, supervision, project administration.*
***Mehmet Zubeyir Guney:** formal analysis, investigation, resources, data curation, writing – original draft, visualization.*
***Hasan Emre Kivanc:** conceptualization, methodology, software, validation.*
***Nuray Uzun:** writing – original draft, visualization.*
***Lale Ibrahimbeyli:** conceptualization, methodology, software, validation.*
***Hüseyin Catalkaya:** investigation, resources, data curation.*
***Nazim Dogan:** writing – original draft, writing – review & editing.*

References

1. Vincent J-L, Marshall JC, Ñamendys-Silva SA, François B, Martin-Loeches I, Lipman J, et al. Assessment of the worldwide burden of critical illness: The Intensive Care Over Nations (ICON) audit. *Lancet Respir Med*. **2014**;2(5):380–386.
2. Pellathy TP, Pinsky MR, Hravnak M. Intensive care unit scoring systems. *Crit Care Nurse*. **2021**;41(4):54–64.
3. Bouch DC, Thompson JP. Severity scoring systems in the critically ill. *Contin Educ Anaesth Crit Care Pain*. **2008**;8(5):181–185.
4. Knaus WA, Draper EA, Wagner DP, Zimmerman JE. APACHE II: A severity of disease classification system. *Crit Care Med*. **1985**;13(10):818–829.
5. Le Gall JR, Lemeshow S, Saulnier F. A new Simplified Acute Physiology Score (SAPS II) based on a European/North American multicenter study. *JAMA*. **1993**;270(24):2957–2963.
6. Vincent JL, Moreno R, Takala J, Willatts S, De Mendonça A, Bruining H, et al. The SOFA (Sepsis-related Organ Failure Assessment) score to describe organ dysfunction/failure. On behalf of the Working Group on Sepsis-Related Problems of the European Society of Intensive Care Medicine. *Intensive Care Med*. **1996**;22(7):707–710.
7. Shariq T, Rahman AS, Jamal Q, Siddiqui M, Khan U, Taufiq F. The SOFA score as a mortality predictor in ICU patients: Insights from a tertiary care hospital in Pakistan. *BMC Res Notes*. **2026**;19:12.
8. ARDS Definition Task Force. Acute respiratory distress syndrome: The Berlin definition. *JAMA*. **2012**;307(23):2526–2533.
9. Neumar RW, Nolan JP, Adrie C, Aibiki M, Berg RA, Böttiger BW, et al. Post-cardiac arrest syndrome: Epidemiology, pathophysiology, treatment, and prognostication. A consensus statement from the International Liaison Committee on Resuscitation. *Circulation*. **2008**;118(23):2452–2483.
10. Ramírez M. Multiple organ dysfunction syndrome. *Curr Probl Pediatr Adolesc Health Care*. **2013**;43(10):273–277.
11. Vincent J-L, Rello J, Marshall J, Silva E, Anzueto A, Martin CD, et al. International study of the prevalence and outcomes of infection in intensive care units. *JAMA*. **2009**;302(21):2323–2329.

12. Divatia JV, Mehta Y, Govil D, Zirpe K, Amin PR, Ramakrishnan N, et al. Intensive care in India in 2018–2019: The Second Indian Intensive Care Case Mix and Practice Patterns Study. *Indian J Crit Care Med*. **2021**;25(10):1093–1107.
13. D'Arcy J, Doherty S, Fletcher L, Neto AS, Jones D. Intensive care unit admission from the emergency department in the setting of National Emergency Access Targets. *Crit Care Resusc*. **2023**;25(2):84–89.
14. Ranzani OT, Singer M, Salluh JIF, et al. Development and validation of the Sequential Organ Failure Assessment (SOFA)-2 score. *JAMA*. **2025**;334(23):2090–2103.
15. Singer M, Deutschman CS, Seymour CW, Shankar-Hari M, Annane D, Bauer M, et al. The third international consensus definitions for sepsis and septic shock (Sepsis-3). *JAMA*. **2016**;315(8):801–810.
16. Thakur R, Naga Rohith V, Arora JK. Mean SOFA score in comparison with APACHE II score in predicting mortality in surgical patients with sepsis. *Cureus*. **2023**;15(3):e36653.
17. Binks A, Nolan JP. Post-cardiac arrest syndrome. *Minerva Anestesiol*. **2010**;76(5):362–368.
18. Amacher SA, Bohren C, Blatter R, Becker C, Beck K, Mueller J, et al. Long-term survival after out-of-hospital cardiac arrest: A systematic review and meta-analysis. *JAMA Cardiol*. **2022**;7(6):633–643.
19. Fugate JE, Brinjikji W, Mandrekar JN, Cloft HJ, White RD, Wijdicks EFM, et al. Post-cardiac arrest mortality is declining: A study of the US National Inpatient Sample 2001 to 2009. *Circulation*. **2012**;126(5):546–550.
20. Kim S, Yang H, Rhee B, Song H, Kim H. Predicting survival outcomes in post-cardiac arrest syndrome: The impact of combined Sequential Organ Failure Assessment score and serum lactate measurement. *Med Sci Monit*. **2023**;29:e942119.
21. Chen C-L, Wang S-T, Cheng W-C, Wu B-R, Liao W-C, Hsu W-H. Outcomes and prognostic factors in critical patients with hematologic malignancies. *J Clin Med*. **2023**;12(3):958.
22. Edwards L, Nelmes E, Ardissino M, Lin Jia Qi H, Jhanji S, Antcliffe DB, et al. The evolution of mortality from sepsis in patients with cancer: A systematic review and meta-analysis. *J Intensive Care Soc*. **2026**;27(1):55–65.
23. Papadimitriou-Olivgeris M, Panteli E, Koutsileou K, Boulovana M, Zotou A, Marangos M, et al. Predictors of mortality of trauma patients admitted to the ICU: A retrospective observational study. *Braz J Anesthesiol*. **2021**;71(1):23–30.
24. Jennings M, Booker J, Addison A, Egglestone R, Dushianthan A. Predictors of mortality for blunt trauma patients in intensive care: A retrospective cohort study. *F1000Res*. **2024**;12:974.
25. Bahloul M, Chaari A, Kallel H, Abid L, Ben Hamida C, Dammak H, et al. Pulmonary embolism in intensive care unit: Predictive factors, clinical manifestations and outcome. *Ann Thorac Med*. **2010**;5(2):97–103.

Research Article

The effect of hemovac drain use on postoperative pain and patient satisfaction in primary aesthetic breast augmentation: A retrospective comparative study

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ABSTRACT

Background: This study aimed to evaluate the effect of hemovac drain use on postoperative pain and patient satisfaction in patients undergoing primary aesthetic breast augmentation.

Materials and Methods: This retrospective single-centre study included 53 patients who underwent bilateral primary aesthetic breast augmentation between January 2024 and May 2026. Patients were divided into non-drain (n=41) and hemovac drain (n=12) groups. Postoperative pain was assessed using the Numeric Rating Scale (NRS). Long-term outcomes were analysed using the Utrecht Questionnaire (UQ), adapted for breast augmentation patients, and overall satisfaction scores.

Results: The groups were comparable in terms of age, implant volume, body weight, and body mass index (all p>0.05). On postoperative day 1, right- and left-sided NRS scores were significantly higher in the hemovac drain group [right: 8.5 (8–9) vs 5 (4.5–7); left: 8 (8–9) vs 5 (5–7); both p<0.001]. However, no significant differences were observed between the groups regarding postoperative week 1 and month 1 NRS scores. UQ scores were similar between the groups at postoperative months 1 and 6 (p=0.225 and p=0.909, respectively). Although the overall satisfaction score was numerically higher in the non-drain group, the difference did not reach statistical significance [8 (7–9) vs 7 (7–8); p=0.087].

Conclusion: Patients with hemovac drains demonstrated higher early postoperative pain scores; however, this difference did not persist during subsequent follow-up evaluations. No significant differences were observed between the groups regarding long-term pain outcomes, UQ scores, or overall patient satisfaction. These findings support a selective rather than routine use of drains in primary aesthetic breast augmentation.

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1. Introduction

Breast augmentation is one of the most commonly performed aesthetic surgical procedures worldwide. Despite significant advancements in surgical techniques and implant technology, early postoperative pain management, prevention of seroma/hematoma formation, and optimisation of patient satisfaction remain among the primary clinical objectives [1].

Although the incidence of hematoma and seroma remains relatively low, ranging from 1–3% in most series, hematomas developing particularly within the first 24

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hours postoperatively may negatively affect infection risk, capsular contracture rates, and final cosmetic outcomes [2]. To prevent these complications, hemovac drains have been widely used to drain fluid from the implant pocket. However, the clinical benefit of routine drain use in primary breast augmentation remains controversial in the literature [3]. Systematic reviews have emphasised the limited availability of high-quality evidence on augmentation-specific procedures and reported no clear superiority of routine drain use, even in other areas of breast surgery [3].

The value of routine drain placement following primary aesthetic breast augmentation continues to be debated in contemporary practice. Supporters of drain use suggest that evacuation of postoperative fluid collections may help minimise hematoma and seroma formation while also allowing earlier recognition of bleeding-related complications (1,2). In contrast, concerns have been raised regarding patient discomfort, drain-related pain, infection risk, and the uncertain benefit of drains in otherwise uncomplicated augmentation procedures [1,4]. Despite numerous publications addressing this topic, augmentation-specific evidence remains limited and available studies have produced inconsistent conclusions, making it difficult to formulate universally accepted recommendations [1,4]. As a result, the role of routine drain use in primary breast augmentation surgery remains unresolved.

The Utrecht Questionnaire (UQ) was initially introduced in 2009 and later underwent validation studies in 2013. Previous research has primarily employed this instrument to evaluate patient-reported outcomes following rhinoplasty procedures [5]. To our knowledge, its application in aesthetic breast augmentation has not been previously reported. Therefore, in the present study, the questionnaire was modified for use in breast augmentation patients and incorporated into the postoperative assessment process. In addition, postoperative pain intensity was evaluated using the Numeric Rating Scale (NRS), a practical and widely accepted instrument for quantifying subjective pain severity [6]. Owing to its simplicity, reliability, and ease of administration, the NRS has become one of the most frequently utilised tools for pain assessment in both clinical practice and research settings [7].

This study aimed to compare postoperative pain levels using the NRS between patients undergoing primary aesthetic breast augmentation with and without intraoperative hemovac drain placement, and to analyse overall postoperative patient satisfaction, together with outcomes from the breast augmentation-adapted UQ.

2. Materials and Methods

This retrospective, single-centre clinical study reviewed the medical records of patients who underwent bilateral primary aesthetic breast augmentation at our institution between January 2024 and May 2026. This study was approved by the ethics committee of Samsun University Clinical Research Ethics Committee (Approval Number: 2026/8/32; Date: May 06, 2026). This study was conducted in accordance with the ethical principles of the Declaration of Helsinki and its 2013 revision.

2.1. Study design and patient selection

The study population consisted of female patients who underwent bilateral silicone breast implant placement for aesthetic purposes at our clinic. In our institution, hemovac drain placement represents one of the postoperative approaches routinely utilised following breast augmentation surgery. The decision to use a drain was based on intraoperative assessments performed according to standard clinical procedures and the surgeon's clinical judgment. Patient data were retrospectively obtained from medical records and the FONET hospital information management system (FONET Information Technologies inc., Türkiye). All patients meeting the study criteria within the specified study period were included, and no randomisation was performed.

2.2. Inclusion criteria

- Female patients aged between 18 and 65 years
- Undergoing primary breast augmentation surgery for aesthetic purposes
- Sufficient clinical documentation to allow evaluation of perioperative and follow-up outcomes
- Availability of complete NRS and Utrecht Questionnaire assessment records
- Compliance with the routine postoperative follow-up schedule established by the institution

2.3. Exclusion criteria

- Known coagulation abnormalities or significant systemic illness
- Current immunosuppressive treatment, chronic corticosteroid use, immunodeficiency, or active malignancy
- Absence of essential clinical information or inability to verify follow-up assessments
- Reoperation required because of postoperative complications such as hematoma
- Previous breast surgery or revision augmentation procedures
- Additional surgical interventions performed during the same operative session
- Chronic pain disorders or regular use of analgesic medication

2.4. Data collection and measurements

As part of the study, postoperative pain levels were assessed using the NRS, 0–10 at postoperative day 1, week 1, and month 1 follow-up visits. To evaluate long-term patient satisfaction, the UQ, adapted for breast augmentation patients, was administered at postoperative months 1 and 6. The NRS is a widely used instrument for postoperative pain assessment and provides a quantitative evaluation of subjective pain intensity. The World Health Organisation has also recommended it as one of the guiding tools for assessing analgesic treatment strategies [8]. Patients rate their pain intensity on a scale from 0 to 10, where 0 indicates "no pain" and 10 represents "unbearable/worst possible pain." All NRS and UQ assessments were routinely performed and documented

as part of our institution's standard postoperative follow-up protocol. The outcome data used in this study were retrospectively retrieved from patients' medical records and the hospital information management system. No additional patient contact was required for data collection [9].

UQ is a patient-reported outcome measure used to assess patient satisfaction regarding surgical outcomes. This questionnaire aims to evaluate individuals' subjective perceptions of surgical outcomes systematically and enable comparisons of patient satisfaction across different groups. Patients assess their satisfaction with surgical outcomes using a standardised question format. UQ has been predominantly used in rhinoplasty studies [6]. In the present study, the questionnaire was adapted and applied to patients undergoing breast augmentation surgery. An example of the UQ used in this study is presented in Fig. 1. Lower UQ indicate higher patient satisfaction and fewer breast-related complaints. Overall patient satisfaction was additionally assessed at the postoperative 6-month follow-up visit using a 10-point NRS, where 0 represented complete dissatisfaction, and 10 represented complete satisfaction with the surgical outcome.

The Utrecht Questionnaire for Outcome Assessment in Aesthetic Breast Augmentation

I give the following score to the way I like the appearance of my breast:

0	1	2	3	4	5	6	7	8	9	10
0 (Very ugly)										*10 (Very nice)*

Questions	**Not at all (1)**	**A little (2)**	**Moderate (3)**	**Much/often (4)**	**Very much (5)**
1. Are you concerned about the appearance of your breast?	[ ]	[ ]	[ ]	[ ]	[ ]
2. Does this concern bother you often?	[ ]	[ ]	[ ]	[ ]	[ ]
3. Does this concern affect your daily life (e.g., your work)?	[ ]	[ ]	[ ]	[ ]	[ ]
4. Does this concern affect your relationships with others?	[ ]	[ ]	[ ]	[ ]	[ ]
5. Do you feel stressed by the appearance of your breast?	[ ]	[ ]	[ ]	[ ]	[ ]

Fig. 1. The revised UQ for breast augmentation patients [10].

2.5. Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA). The normality of continuous variables was assessed using the Shapiro–Wilk test. Variables with normal distribution were analysed using parametric methods, whereas non-normally distributed variables were analysed using non-parametric methods. Continuous variables were expressed as mean ± standard deviation or median (interquartile range [IQR]), whereas categorical variables were presented as frequency and percentage [n (%)]. Group comparisons were performed using the independent-samples *t*-test or the Mann–Whitney *U* test, depending on the data distribution. Categorical variables were analysed using the Pearson chi-square test or Fisher's exact test when appropriate. A two-sided *p*-value of <0.05 was considered statistically significant.

3. Results

A total of 55 patients were initially included in the study, of whom 43 were assigned to the non-drain group and 12 to the hemovac drain group. During the early postoperative period, one patient from each group (3.7%) underwent reoperation due to suspected hematoma formation. Surgical exploration revealed no evidence of a massive hematoma, and the existing implants were preserved following irrigation of the implant pockets. However, these patients were excluded from the final analysis because postoperative pain assessments deviated from the standard follow-up protocol. Consequently, the study was completed with 53 patients: 41 in the non-drain group and 12 in the hemovac drain group. No statistically significant differences were observed between the groups regarding age, implant volume, body weight, or BMI ($p > 0.05$) (Table 1).

On postoperative day 1, right- and left-sided NRS pain scores were significantly higher in the hemovac drain group compared with the non-drain group (right side: 8.5 [8–9] vs 5 [4.5–7], $p < 0.001$; left side: 8 [8–9] vs. 5 [5–7], $p < 0.001$). However, no statistically significant differences were observed between the groups regarding right- and left-sided NRS pain scores at postoperative week 1 and month 1 (all $p > 0.05$). Although higher left-sided NRS pain scores were observed in the hemovac drain group at postoperative week 1, this difference did not reach statistical significance ($p = 0.053$) (Table 1).

Table 1. Baseline demographic characteristics and postoperative pain score comparisons between the drain and non-drain groups.

Variables	No-drain group	Drain group	p value
Age, years*	32.3 ± 6.9	34.6 ± 12.8	0.536
Implant volume, cc*	342.4 ± 29.6	345.8 ± 65.5	0.798
Body weight, kg*	75.9 ± 4.3	76.7 ± 4.4	0.571
Body mass index, kg/m^2*	21.8 ± 1.6	21.1 ± 1.5	0.207
Time point/side			
Postoperative day 1 NRS pain score (0–10) (right)**	5 (4.5–7)	8.5 (8–9)	<0.001
Postoperative day 1 NRS pain score (0–10) (left)**	5 (5–7)	8 (8–9)	<0.001
Postoperative week 1 NRS pain score (0–10) (right)**	2 (1–3)	2 (2–3)	0.782
Postoperative week 1 NRS pain score (0–10) (left)**	2 (1–3)	2 (2–3)	0.053
Postoperative month 1 NRS pain score (0–10) (right)**	0 (0–1)	1 (0–1)	0.279
Postoperative month 1 NRS pain score (0–10) (left)**	0 (0–1)	1 (0–1)	0.253

* median ± standard deviation; ** Median (interquartile range); ***Abbreviations: NRS:Numeric rating scale.

When comparing the total median UQ scores between the groups, the median score at postoperative month 1 was 1 (1–1.5) in the non-drain group and 1.2 (1.0–1.8) in the hemovac drain group (p = 0.225). Similarly, UQ scores at postoperative month 6 were comparable between the groups (1 [1–1] vs 1 [1–1.5], p = 0.909). These findings suggest that the use of hemovac drains did not provide an additional clinical benefit for long-term patient satisfaction or aesthetic outcomes (Table 2).

Analysis of overall patient satisfaction scores demonstrated numerically higher satisfaction levels in the non-drain group; however, the difference did not reach statistical significance (8 [7–9] vs 7 [7–8], p = 0.087) (Table 2).

Table 2. Comparison of Utrecht questionnaire mean scores and overall satisfaction between the drain and non-drain groups.

Variables	No-drain group	Drain group	p value
Median Utrecht questionnaire score at month 1 (1–5)	1 (1–1.5)	1.2 (1.0–1.8)	0.225
Median Utrecht questionnaire score at month 6 (1–5)	1 (1–1)	1 (1–1.5)	0.909
Overall satisfaction score (0–10)	8 (7–9)	7 (7–8)	0.087

Median (interquartile range). Abbreviations: UQ, Utrecht Questionnaire.
Lower UQ scores indicate higher patient satisfaction and fewer breast-related complaints.
Overall satisfaction was assessed at postoperative month 6 using a 10-point Numeric Rating Scale (0 = completely dissatisfied; 10 = completely satisfied).

According to the UQ results, no statistically significant differences were observed between the hemovac drain and non-drain groups regarding questionnaire parameters at postoperative months 1 and 6 (all $p > 0.05$). Although the p-values for Question 2 at postoperative month 1 and Question 1 at postoperative month 6 were close to the threshold of statistical significance, these findings did not reach statistical significance (p = 0.053 and p = 0.051, respectively).

Evaluation of the UQ results at postoperative month 6 demonstrated that the response "none" was reported in the non-drain group by 34 patients (82.9%) for Question 1, 36 patients (87.8%) for Question 2, 37 patients (90.2%) for Question 3, 32 patients (78.0%) for Question 4, and 34 patients (82.9%) for Question 5. In the hemovac drain group, the corresponding numbers were 9 (75.0%), 8 (66.7%), 10 (83.3%), 7 (58.3%), and 10 patients (83.3%), respectively. These findings indicate low complaint levels in both groups, as assessed by the UQ at postoperative month 6.

4. Discussion

In this study, we evaluated the effects of hemovac drain use on early postoperative pain, suspected complications, and patient satisfaction in patients undergoing primary aesthetic breast augmentation. The absence of significant differences between the groups regarding age, implant volume, body weight, and BMI suggests that postoperative outcomes were assessed in comparable patient populations. The most important finding of this study was that NRS pain scores on postoperative day 1 were significantly higher bilaterally in the hemovac drain group. In contrast, no significant differences were observed between the groups in pain scores at postoperative weeks 1 and 1 month. These findings indicate that pain associated with hemovac drain use becomes particularly apparent during the early postoperative period, while this difference gradually diminishes during subsequent follow-up.

Postoperative discomfort associated with drainage systems has previously been described in the breast surgery literature. Woo et al. reported that drain-related symptoms were among the most common sources of postoperative discomfort during recovery following implant-based breast reconstruction procedures [11]. The findings of the present study demonstrate a similar pattern, with significantly greater pain scores observed during the early postoperative period in patients managed with hemovac drains.

Several mechanisms may account for the increased pain observed in the drain group during the first postoperative day. The presence of a drain may create local tissue irritation at the insertion site, contribute to discomfort during upper body movement, and increase awareness of a foreign body during the early healing process. These factors may collectively augment pain perception independent of the surgical procedure itself.

Previous studies have demonstrated that pain following breast augmentation is particularly prominent during the early postoperative period and gradually decreases over time [12]. It should also be noted that postoperative day 1 pain scores were relatively high in both groups. All patients received the same institutional postoperative analgesic regimen; therefore, differences in pain management are unlikely to explain the observed findings. Rather, the higher pain scores observed in the drain group may be attributable to additional mechanical irritation and discomfort associated with drain placement during the early postoperative period. A recent study published in 2025 also reported that patients undergoing breast augmentation with drainage experienced greater pain during the first three postoperative days compared with patients without drainage. In contrast, pain levels significantly decreased during subsequent follow-up [2]. Our findings are consistent with these previous reports.

From a complication standpoint, the necessity of routine drain use in primary breast augmentation remains controversial. Scomacao et al. stated that currently available evidence is insufficient to establish definitive recommendations and emphasised the need for more standardised studies [13]. Similarly, Torresetti et al. and Montemurro et al. highlighted the lack of strong evidence supporting routine use of drains [4]. In our study, one patient in each group underwent reoperation because of suspected hematoma formation; however, no massive hematoma was identified during surgical exploration.

To date, no previous study has evaluated the use of the UQ following breast augmentation surgery. UQ was originally developed to assess aesthetic outcomes and patient perceptions following rhinoplasty [12]. This brief and practical patient-reported outcome measure was adapted in our study to assess patient satisfaction and symptom perception after breast augmentation surgery. In this respect, our study demonstrates a novel aspect. However, the lack of specific validation of the UQ for breast augmentation surgery represents an important methodological limitation. Although the UQ was adapted for use in breast augmentation patients in the present study, it should be noted that the questionnaire was originally developed and validated for rhinoplasty outcomes. Therefore, the psychometric properties, validity, and reliability of this adaptation have not yet been formally established in the breast augmentation population. Future prospective studies are needed to validate this modified version and determine its suitability for assessing patient-reported outcomes following aesthetic breast augmentation.

Although overall satisfaction scores were numerically higher in the non-drain group, this difference did not reach statistical significance. Similarly, no significant differences were observed between the groups regarding UQ scores at postoperative months 1 and 6. Previous studies have reported that scars at the drain insertion site may cause aesthetic concerns in certain patients [14]. However, our findings suggest that drain use does not have a significant impact on long-term patient satisfaction.

Overall, the present results indicate that routine drain placement offers limited advantages with respect to long-term pain outcomes and patient-reported satisfaction. Clinical decisions regarding drain use may therefore be guided by operative findings, anticipated bleeding risk, and surgeon judgment on a case-by-case basis. Therefore, rather than routine use, decisions regarding hemovac drain placement may be more appropriately individualised based on intraoperative bleeding, the extent of tissue dissection, the surgeon's assessment of complication risk, and patient-specific risk factors.

Several considerations should be taken into account when interpreting the present results. The study was based on retrospectively collected data from a single institution, which may limit external applicability. In addition, the unequal distribution of patients between the groups and the relatively small number of individuals receiving drains may have reduced the ability to detect differences in uncommon outcomes. Furthermore, drain placement was determined according to intraoperative assessment and surgeon preference rather than random allocation. Although this approach reflects everyday clinical practice, a degree of selection bias cannot be completely excluded. Finally, while a standardized postoperative analgesic protocol was applied to all patients, individual differences in pain perception may have influenced the reported pain scores.

5. Conclusions

Although higher early postoperative pain scores were observed in patients undergoing primary aesthetic breast augmentation with hemovac drain placement, this difference did not persist at postoperative week 1 and month 1 follow-up evaluations. No significant differences were observed between the drain and non-drain groups regarding long-term patient-reported outcomes or overall patient satisfaction. The findings of this study suggest that drain use should be tailored to individual operative circumstances and patient characteristics instead of being adopted as a routine component of every primary augmentation procedure.

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Conflict of Interest
The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this manuscript.

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

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AI-based tools, including ChatGPT (OpenAI), were used solely for text refinement and to improve the readability of the manuscript. Grammarly was used for grammar and language checking. No AI-based tool contributed to the study design, data collection, data analysis, interpretation of the results, or scientific conclusions. All scientific content, interpretations, and conclusions remain the sole responsibility of the authors.

Ethics Approval and Consent to Participate
This study was approved by the ethics committee of Samsun University Clinical Research Ethics Committee (Approval Number: 2026/8/32; Date: May 06, 2026). Due to the retrospective design of the study, the requirement for informed consent was waived by the ethics committee. All procedures were conducted in accordance with the Declaration of Helsinki.

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References

1. Torresetti M, Zavalloni Y, Peltristo B, Di Benedetto G. A Shakespearean dilemma in breast augmentation: To use drains or not? A systematic review: Drains in breast augmentation. *Aesthetic Plast Surg*. **2022**;46(4):1553–1566.
2. Grieco MP, Iannelli P, Lovero S, Iuliano M, Aprea F. Use of drainage in breast augmentation surgery: Benefits and clinical evidence from our experience. *Plast Reconstr Regen Surg*. **2025**;4(1–2):12–18.
3. Khan SM, Smeulders MJC, van der Horst CM. Wound drainage after plastic and reconstructive surgery of the breast. *Cochrane Database Syst Rev*. **2015**;2015(10):CD007258.
4. Montemurro P, Gupta T. It is time to resolve the dilemma and move away from using drains in primary breast augmentation. *Aesthet Surg J Open Forum*. **2023**;5:ojad048.
5. Maldonado-Chapa F, Datema FR, van Zijl FVWJ, et al. Clinical benefits of the Utrecht Questionnaire for aesthetic outcome assessment in rhinoplasty: An update. *Facial Plast Surg*. **2023**;39(4):377–386.
6. Williamson A, Hoggart B. Pain: A review of three commonly used pain rating scales. *J Clin Nurs*. **2005**;14(7):798–804.
7. Karcioglu O, Topacoglu H, Dikme O, Dikme O. A systematic review of the pain scales in adults: Which to use? *Am J Emerg Med*. **2018**;36(4):707–714.
8. Breivik H, Borchgrevink PC, Allen SM, et al. Assessment of pain. *Br J Anaesth*. **2008**;101(1):17–24.
9. Sun M, Peng T, Sun Y, et al. Intraoperative use of low-dose dexmedetomidine for the prevention of emergence agitation following general anaesthesia in elderly patients: A randomized controlled trial. *Aging Clin Exp Res*. **2022**;34(3):611–618.
10. Rosa F, Lohuis PJFM, Almeida J, et al. The Portuguese version of "The Utrecht questionnaire for outcome assessment in aesthetic rhinoplasty": Validation and clinical application. *Braz J Otorhinolaryngol*. **2019**;85(2):170–175.
11. Woo KJ, Paik JM, Mun GH, et al. Analysis of factors influencing drain amount, time to drain removal, and seroma formation in patients undergoing immediate expander-implant breast reconstruction. *J Plast Surg Hand Surg*. **2018**;52(1):53–59.
12. Eryilmaz NC, Eryilmaz T. Pain levels following cosmetic breast surgery and an easy-to-use pain treatment algorithm for plastic surgeons. *Aesthetic Plast Surg*. **2024**;48(17):1–6.
13. Scomacao I, Cummins A, Roan E, Duraes EFR, Djohan R. The use of surgical site drains in breast reconstruction: A systematic review. *J Plast Reconstr Aesthet Surg*. **2020**;73(4):651–662.
14. Nishioka H, Yasunaga Y, Yanagisawa D, Yuzuriha S, Ito KI. Where do you insert a drain tube during breast reconstruction? *Surg Today*. **2020**;50(12):1626–1632.

Challenge Journal of PERIOPERATIVE MEDICINE

Research Article

The effect of regional anesthesia practices on intensive care unit admission rates in shoulder surgery: A single-center, 7-year retrospective analysis

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ABSTRACT

Background: Shoulder surgeries are performed on a heterogeneous patient population ranging from young to elderly individuals. Across this diverse spectrum, general anesthesia (GA) can increase the risk of perioperative systemic complications and intensive care unit (ICU) admission, whereas regional anesthesia (RA) techniques are known to mitigate these risks and reduce ICU requirements. The aim of the study is to evaluate the effect of transitioning from general anesthesia (GA) to a primary regional anesthesia (RA) model in clinical anesthesia practice on postoperative intensive care unit (ICU) admission rates in patients undergoing shoulder surgery.

Materials and Methods: In this single-center, retrospective study, electronic records of patients who underwent shoulder surgery (arthroscopic or open) at Samsun University Samsun Training and Research Hospital between May 2019 and May 2026 were retrospectively reviewed. Patients were divided into two main groups based on the clinical transition to regional anesthesia: before 2022 (GA Period) and after 2022 (RA Period). Postoperative ICU admission rates of the groups were compared as percentages.

Results: A total of 947 patients were included in the study. In the post-2022 period, when regional techniques were used as the primary method in routine anesthesia practice, postoperative ICU admission rates were found to be statistically significantly lower compared to the GA period (Group RA: 6.41% and Group GA: 15.24%, $p < 0.05$).

Conclusion: This study demonstrates a significant association between the primary regional anesthesia period and lower postoperative ICU admission rates in shoulder surgery. While this correlation points to a potential benefit for hospital resource optimization, further prospective multi-center studies are required to evaluate these retrospective data.

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1. Introduction

Shoulder surgery is performed across a wide age spectrum, ranging from traumatic injuries in the young active population to degenerative diseases in the elderly. The heterogeneous nature of this patient population requires anesthesia management to ensure perioperative safety for patients with comorbid systemic diseases while incorporating "fast-track" recovery protocols. Particularly in the high-risk patient group, the management of the surgical process is directly associated with the choice of anesthesia technique [1].

General anesthesia (GA), traditionally preferred in shoulder surgery, may lead to the need for intensive care

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unit (ICU) admission due to its systemic effects and the requirement for positive pressure ventilation. These admissions may be intended to manage postoperative complications in elderly patients with severe comorbidities, or they may become necessary due to factors such as hemodynamic instability, respiratory distress, or prolonged recovery developing during the surgical or anesthetic process. Consequently, ICU admissions have significant impacts on hospital resource utilization, increased costs, and patient morbidity [2].

In recent years, regional anesthesia (RA) techniques have expanded the opportunities for awake surgery as the primary anesthesia method in shoulder surgery. The preservation of spontaneous ventilation and minimal systemic drug load provided by RA can enhance perioperative physiological stability, thereby reducing planned or unexpected intensive care requirements in patients [3].

As of 2022, our clinic transitioned from routine general anesthesia practice for shoulder surgeries to a model where regional anesthesia techniques are utilized as the primary anaesthetic method. The aim of this study is to evaluate the impact of this change in anesthesia management on postoperative intensive care unit admission rates based on data from the last 7 years.

2. Materials and Methods

2.1. Study design and ethical approval

This single-center, retrospective cohort study was conducted by reviewing the data of patients who underwent open or arthroscopic shoulder surgery at Samsun University Samsun Training and Research Hospital between May 2019 and May 2026. The study protocol was approved by the local ethics committee (Approval Number: GOKAEK 2026/9/24; Date: May 20, 2026). Due to the retrospective nature of the study, the requirement for obtaining informed consent from the participants was waived by the ethics committee.

2.2. Patient population and grouping

Patients were divided into two groups based on the clinical protocol change implemented in anesthesia management in January 2022 (transition from general anesthesia to regional anesthesia):

- Group GA (General Anesthesia): Patients operated on between May 2019 and January 2022 who received routine general anesthesia.
- Group RA (Regional Anesthesia): Patients operated on between January 2022 and May 2026 for whom regional anesthesia techniques and an awake surgery protocol were applied as the primary method.

2.3. Data collection and primary outcome

Demographic data, such as age and sex, were retrospectively retrieved from the hospital's electronic record system. The primary outcome of this study was the rate of postoperative intensive care unit (ICU) admission. ICU admission was defined as the direct transfer of a patient from the operating theater or the postanesthesia care unit (PACU) to the tertiary ICU. To comprehend-sively reflect overall perioperative risk and hospital resource utilization, all postoperative transfers—encompassing both planned admissions for high-risk systemic comorbidities and unplanned/unexpected admissions driven by intraoperative courses—were captured under a single, all-inclusive primary outcome category. The standardized institutional indications for ICU admission included the requirement for mechanical or non-invasive ventilatory support, hemodynamic instability necessitating vasoactive drug infusions, or the necessity for close invasive physiological monitoring due to advanced systemic disease.

2.4. Anesthesia management

In Group GA, general anesthesia was induced and maintained following standard institutional protocols, accompanied by endotracheal intubation or a laryngeal mask airway. Patients in this group did not receive routine regional nerve blocks.

In Group RA, surgical procedures were performed under ultrasound-guided regional nerve blocks while maintaining spontaneous ventilation throughout the operation. Prior to the block administration, a standardized sedation and preemptive analgesia protocol consisting of intravenous midazolam (1 mg) and ketamine (0.25 mg/kg) was administered to all patients. The regional anesthesia regimen comprised an ultrasound-guided interscalene brachial plexus block (10 mL) combined with a superficial cervical plexus block (10 mL), and a supraclavicular brachial plexus block (10 mL). A local anesthetic mixture of 0.25% bupivacaine and 0.5% lidocaine was utilized for all regional interventions. Two cases in which a regional block was performed but converted to general anesthesia due to an insufficient block were excluded from the study.

2.5. Statistical analysis

Statistical analysis of the collected data was performed using the SPSS v22.0 software. Descriptive statistics were expressed as frequencies and/or percentages for categorical variables, and as means ± standard deviations (SD) for continuous variables. The Chi-square test was utilized to compare categorical variables, including demographic distributions and postoperative intensive care unit (ICU) admission rates between the groups. Furthermore, a multivariate binary logistic regression analysis was conducted to adjust for potential confounding factors (age and sex) and to determine the independent association of the anesthesia technique with postoperative ICU admission. Adjusted odds ratios (aOR) and their corresponding 95% confidence intervals (CI) were calculated from the regression model. A p-value < 0.05 was considered statistically significant.

3. Results

The demographic characteristics and clinical outcomes of the 947 patients comprising the study population are summarized in Table 1 as a comparison between the groups.

Table 1. Patient demographics and intensive care unit admission outcomes.

	Group GA (n=105)	Group RA (n=842)	p
Age (Years, Mean ± SD)	55.17±15.90	53.46±16.04	0.302
Sex (Male / Female)	49/56	384/458	0.918
ICU Admission [n (%)]	16(%15.24)	54(%6.41)	0.002

No istatistically significant difference was found between the groups regarding age and sex distribution. The mean age was 55.17 ± 15.90 years in Group GA and 53.46 ± 16.04 years in Group RA (p=0.302). The sex distribution (male/female) was found to be 49/56 in Group GA and 384/458 in Group RA (p=0.918).

When the postoperative ICU admission rates, which represent the primary outcome of the study, were examined, a statistically significant difference was present between the groups (p=0.002). Postoperative ICU admission was observed in 15.24% (n=16) of patients in Group GA, whereas this rate was 6.41% (n=54) in Group RA.

To evaluate the independent predictors of postoperative intensive care requirements, a multivariate binary logistic regression model was constructed (Table 2).

Table 2. Multivariate logistic regression analysis of risk factors for postoperative ICU admission.

Risk Factor	p	Adjusted Odds Ratio (aOR)	95% Confidence Interval (CI)
Anesthesia Technique (GA vs. RA)	0.005	2.504	1.344 – 4.667
Age (Per-year increase)	<0.001	1.073	1.048 – 1.099
Sex (Male vs. Female)	0.356	1.291	0.751 – 2.218

The analysis demonstrated that anesthesia methodology was an independent predictor of ICU admission. After adjusting for age and sex, general anesthesia was significantly associated with higher odds of ICU admission compared to regional anesthesia (aOR = 2.504, 95% CI: 1.344–4.667, p = 0.004). Advanced age was also identified as an independent risk factor (aOR = 1.073, 95% CI: 1.048–1.099, p < 0.001), whereas patient sex showed no statistically significant association with the outcome (aOR = 1.291, 95% CI: 0.751–2.218, p = 0.356).

4. Discussion

In this study, the effects of GA and RA methods on ICU admission rates were retrospectively examined in a patient population undergoing shoulder surgery at Samsun Training and Research Hospital. Our data suggest that the clinical transition to a primary RA model is associated with a lower rate of postoperative ICU admissions. This trend points to a potential advantage in perioperative care management and may offer important benefits regarding the efficient utilization of hospital resources.

Our finding that primary regional anesthesia is associated with a significantly lower rate of postoperative ICU admissions aligns with large-scale database studies in major orthopedic surgery [4]. Previous literature demonstrates that avoiding GA reduces overall perioperative morbidity, shortens hospital length of stay, and minimizes intensive care utilization [4,5]. Additionally, the use of peripheral nerve blocks is recommended within Enhanced Recovery After Surgery (ERAS) pathways for shoulder surgery to help support recovery and hospital resource management [6].

Although traditional approaches prioritize GA administration for airway control and surgical comfort in shoulder surgery, the systemic effects and positive pressure ventilation (PPV) requirement of this method bring along certain challenges in clinical management. As widely documented in the literature, the use of PPV and high-dose systemic agents prolongs the postoperative recovery period and predisposes patients to hemodynamic instability and respiratory complications, particularly in the vulnerable patient group with advanced age and cardiopulmonary comorbidities [7]. This situation can constitute the major reason for admitting patients to the ICU due to the need for close monitoring and/or mechanical ventilation support during the postoperative period.

Several physiological mechanisms may explain the lower ICU requirement in the RA cohort. First, the preservation of spontaneous ventilation and avoidance of endotracheal intubation can reduce the risk of postoperative respiratory complications, such as atelectasis and ventilator-associated lung injury, particularly in patients with underlying chronic obstructive pulmonary disease or obstructive sleep apnea [8,9]. Second, this observation could potentially be driven by a lower requirement for postoperative systemic opioids due to the prolonged analgesic efficacy of peripheral nerve blocks, although opioid consumption was not directly quantified in our cohort. Consequently, a subsequent reduction in potential opioid-induced adverse events—such as respiratory depression, profound sedation, or severe postoperative nausea and vomiting—might have minimized common clinical triggers for ICU admission [10,11].

Furthermore, regional anesthesia techniques effectively blunt the neuroendocrine stress response triggered by surgical trauma [12]. Compared to general anesthesia, which may cause intraoperative hypotension

due to systemic vasodilation, peripheral nerve blocks can provide more stable hemodynamic profiles [5]. Consequently, maintaining a more stable hemodynamic course with peripheral blocks might help minimize perioperative cardiovascular stress, potentially lowering the necessity for continuous physiological monitoring in an intensive care setting during the immediate postoperative window.

The RA techniques evaluated in our study allow patients to undergo shoulder surgery while awake, without receiving general anesthesia. Continuous preservation of spontaneous ventilation through peripheral nerve blocks and maintaining a minimal systemic drug load play a fundamental role in maintaining perioperative physiological homeostasis. The significantly lower ICU admission rates found in the RA group in our study can be evaluated as a direct reflection of these operative advantages into clinical practice.

In our cohort, the conversion rate from regional to general anesthesia was remarkably low at 0.24% (n=2). Both cases were managed under general anesthesia without intraoperative complications or subsequent postoperative ICU requirements. This low conversion rate indicates that the exclusion of these cases does not mathematically or clinically alter the primary outcomes of the study.

Our study has certain limitations. One of these limitations is that the two periods examined in our study were not equal in duration. However, to minimize potential biases that this situation might cause, intensive care admission rates (percentages) were used as the basis in our analyses instead of absolute numbers of patients. Second, due to insufficient records in the hospital's electronic system, patients' ASA physical status scores and detailed comorbidity data could not be accessed, which limited the full homogenization of the baseline risk profiles of the groups.

Another limitation is a prominent five-fold difference in monthly case volume was present between the two study periods (Group GA: 3.28 cases/month vs. Group RA: 16.19 cases/month), primarily driven by the global reduction in elective procedures during the COVID-19 pandemic [13,14]. Methodologically, this temporal disparity introduces a period-related selection bias. The restricted ICU bed capacity during the pandemic era may have led to a higher clinical threshold for postoperative ICU admissions, potentially selecting a relatively more stable patient profile for surgery during the GA period. Although this selection bias could have underestimated the true baseline ICU admission requirements in the general anesthesia cohort, the primary regional anesthesia period was still associated with a statistically lower rate of admissions. Nevertheless, this historical variation warrants a cautious interpretation, as standard, non-pandemic clinical settings might present different baseline risk distributions.

5. Conclusions

Our findings suggest that utilizing regional anesthesia methods as the primary approach in shoulder surgery is associated with lower postoperative ICU admission rates and more efficient hospital resource utilization. Within the framework of modern ERAS protocols, regional techniques appear to offer a valuable strategy for enhancing perioperative patient safety. However, given the single-center retrospective nature of this study, further prospective, multi-center randomized controlled trials are needed to confirm these findings and firmly establish these protocols as a routine clinical standard.

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Conflict of Interest

The author declares no potential conflicts of interest with respect to the research, authorship, and/or publication of this manuscript.

Data Availability

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

AI Assistance

No AI-based tools were used in the preparation of this manuscript.

Ethics Approval and Consent to Participate

This single-center, retrospective cohort study was conducted by reviewing the data of patients who underwent open or arthroscopic shoulder surgery at Samsun University Samsun Training and Research Hospital between May 2019 and May 2026. The study protocol was approved by the local ethics committee (Approval Number: GOKAEK 2026/9/24; Date: May 20, 2026). Due to the retrospective nature of the study, the requirement for obtaining informed consent from the participants was waived by the ethics committee.

Author Contributions

The author declares sole responsibility for all aspects of the study, including conceptualization, methodology, formal analysis, investigation, data curation, visualization, writing of the original draft, and writing, review, and editing of the manuscript.

References

1. Hausman MS Jr, Jewell ES, Engoren M. Regional versus general anesthesia in surgical patients with chronic obstructive pulmonary disease: Does avoiding general anesthesia reduce the risk of postoperative complications? *Anesth Analg*. **2015**;120(6):1405–1412.
2. Thevathasan T, Copeland CC, Long DR, Patrocínio MD, Friedrich S, Grabitz SD, Kasotakis G, Benjamin J, Ladha K, Sarge T, Eikermann M. The impact of postoperative intensive care unit admission on postoperative hospital length of stay and costs: A prespecified propensity-matched cohort study. *Anesth Analg*. **2019**;129(3):753–761.
3. Herrick MD, Liu H, Davis M, Bell JE, Sites BD. Regional anesthesia decreases complications and resource utilization in shoulder arthroplasty patients. *Acta Anaesthesiol Scand*. **2018**;62(4):540–547.
4. Chen FR, Quan T, Pan S, Manzi JE, Recarey M, Agarwal AR, Nicholson A, Zimmer ZR, Gulotta L, Dines JS. Anesthesia type and

postoperative outcomes for patients receiving arthroscopic rotator cuff repairs. *HSS J*. **2022**;18(4):519–526.

5. Ding DY, Mahure SA, Mollon B, Shamah SD, Zuckerman JD, Kwon YW. Comparison of general versus isolated regional anesthesia in total shoulder arthroplasty: A retrospective propensity-matched cohort analysis. *J Orthop*. **2017**;14(4):417–424.
6. Shinwari H, Mouyer Z, Butt A, Shinwari HT, Gill SS, Kamath AG, Sugand K. Enhanced recovery after surgery in shoulder arthroplasty: A systematic review of perioperative outcomes. *J Shoulder Elbow Surg*. **2026**;published online February 19.
7. Luca E, Schipa C, Cambise C, Sollazzi L, Aceto P. Implication of age-related changes on anesthesia management. *Saudi J Anaesth*. **2023**;17(4):474–481.
8. Karcz M, Papadakos PJ. Respiratory complications in the postanesthesia care unit: A review of pathophysiological mechanisms. *Can J Respir Ther*. **2013**;49(4):21–29.
9. Memtsoudis SG, Stundner O, Rasul R, Sun X, Chiu YL, Fleischut P, Danninger T, Mazumdar M. Sleep apnea and total joint arthroplasty under various types of anesthesia: A population-based study of perioperative outcomes. *Reg Anesth Pain Med*. **2013**;38(4):274–281.
10. Yiu CH, Gnjidic D, Patanwala A, Fong I, Begley D, Khor KE, Rimington J, Bugeja B, Penm J. Opioid-related adverse drug events in surgical patients: Risk factors and association with clinical outcomes. *Expert Opin Drug Saf*. **2022**;21(9):1211–1223.
11. Abdallah FW, Halpern SH, Aoyama K, Brull R. Will the real benefits of single-shot interscalene block please stand up? A systematic review and meta-analysis. *Anesth Analg*. **2015**;120(5):1114–1129.
12. Desborough JP. The stress response to trauma and surgery. *Br J Anaesth*. **2000**;85(1):109–117.
13. Khan AZ, Best MJ, Fedorka CJ, Belniak RM, Haas DA, Zhang X, et al. Impact of the COVID-19 pandemic on shoulder arthroplasty: Surgical trends and postoperative care pathway analysis. *J Shoulder Elbow Surg*. **2022**;31(12):2457–2464.
14. Birsel O, Eren İ, Demirhan M. How the COVID-19 pandemic affected shoulder and elbow practice in Turkey? *JSES Int*. **2020**;4(4):705–708.e2.

Research Article

Ultrasound-guided bilateral superficial cervical plexus block after neck-lift and temporal-lift surgery: Retrospective observational pilot study

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ABSTRACT

Background: Postoperative analgesia after aesthetic neck surgery is poorly characterised, with limited published data on regional analgesic techniques. We report our initial experience with ultrasound-guided bilateral superficial cervical plexus block (SCPB) for neck-lift and temporal-lift procedures.

Methods: In this single-centre retrospective observational case-controlled series, six consecutive patients receiving bilateral SCPB (20 mL of 0.25% bupivacaine at the end of surgery) were compared with 21 contemporaneous controls receiving standard analgesia. All received IV paracetamol and tenoxicam, with on-demand tramadol as rescue. Pain was assessed using the Numeric Rating Scale (NRS, 0–10) at 0, 1, 6, 12, and 24 h, with total analgesic use during hospital stay and satisfaction (1–5 Likert scale) as secondary outcomes. Data are median (IQR); Mann–Whitney U and Fisher exact tests were used.

Results: Groups were balanced for age, sex, BMI, ASA status, and operative duration. NRS scores were lower with SCPB at every time point: 0 vs 3 in PACU and at 1 h (P = 0.0002), 0 vs 2 at 6 h (P = 0.0003), 0 vs 2 at 12 h (P = 0.005), and 0 vs 1 at 24 h (P = 0.016). SCPB patients required fewer total paracetamol vials during their hospital stay (median 2.5 vs 7.0; P = 0.0003) and fewer tenoxicam ampoules (2.0 vs 6.0; P = 0.003). Satisfaction was higher with SCPB (median 5 vs 3; P = 0.0005). No block-related complication occurred.

Conclusion: US-guided bilateral SCPB was associated with lower pain scores, reduced supplemental analgesic use, and higher satisfaction after aesthetic neck surgery. These hypothesis-generating findings should be confirmed in an adequately powered randomised trial.

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1. Introduction

Aesthetic neck surgery including neck lift (rhytidectomy) and temporal-lift procedures involves extensive subcutaneous undermining, platysmal manipulation, and long incision lines. Together these features generate moderate-to-severe early postoperative pain, which, if undertreated, predisposes the patient to haematoma formation as well as to postoperative nausea and vomiting (PONV) and to a poorer overall experience [1–5].

Despite the frequency of these operations, published data specifically addressing analgesia after aesthetic neck surgery are limited. The usual approach is a multimodal regimen combining intravenous paracetamol, non-steroidal anti-inflammatory drugs (NSAIDs), and opioids. However, this strategy has notable drawbacks in

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this setting: opioids may cause sedation and PONV, while NSAID-related platelet dysfunction contributes to the risk of postoperative haematoma [1,2,5,6].

Throughout this manuscript, the standardised term 'superficial cervical plexus block' (SCPB) is used to refer to the technique; earlier literature may also describe this as bilateral SCPB (BSCPB). The superficial cervical plexus arises from the anterior rami of the spinal nerves. Its four terminal branches — the lesser occipital, great auricular, transverse cervical, and supraclavicular nerves — emerge posterior to the sternocleidomastoid muscle (SCM) at the level of Erb's point [7,8]. While these branches course within the superficial cervical fascia to supply the skin of the anterolateral neck, parotid and mastoid regions, upper anterior chest wall, and the skin overlying the clavicle and shoulder [9,10], our technique specifically targeted the intermuscular plane between the SCM and the anterior scalene muscle. This anatomical approach covers virtually the entire operative field of a neck or temporal lift, making our modified SCPB an anatomically rational target for regional analgesia in these procedures.

The analgesic efficacy of bilateral SCPB has been well established in thyroid surgery. The 2023 updated systematic review and meta-analysis by Wilson and colleagues, which pooled 31 randomised trials including 2,273 patients, found that SCPB significantly reduced postoperative opioid consumption, lowered NRS pain scores throughout the first 24 h, and shortened analgesic-free time after thyroidectomy [1]. A separate 2023 meta-analysis of 12 trials (866 patients) also reported a significant reduction in PONV, consistent with the earlier work of Mayhew et al. [2], subsequent randomised data [11], and the systematic review by Betancourt and Sanabria [4]. Beyond thyroidectomy, cervical plexus block has been shown to provide effective perioperative pain control across a range of other head-and-neck operations [12] as well as in anterior cervical-spine surgery [13].

To our knowledge, no published study has evaluated the role of SCPB in aesthetic neck surgery. We therefore report a retrospective series comparing SCPB with standard analgesia in patients undergoing neck lift and temporal lift procedures, with the primary aim of generating preliminary data to inform the design of a future adequately powered prospective trial. We hypothesised that bilateral SCPB would reduce postoperative NRS pain scores and supplemental analgesic consumption compared with standard multimodal analgesia alone.

2. Materials and Methods

This single-centre retrospective observational case-controlled series was conducted in accordance with the principles of the Declaration of Helsinki. The protocol was approved by the İstinye University Human Research Ethics Committee (Approval Number: 2026/252; Date: May 25, 2026) and individual written informed consent was waived in view of the retrospective study design.

2.1. Study design and participants

We screened all adult patients (18–70 years) who underwent elective neck lift, temporal lift, or combined neck-lift plus temporal-lift surgery at our institution between December 2025 and May 2026. Patients with ASA physical status I or II and without any of the following exclusion criteria were eligible: known allergy to local anaesthetics, active infection at the proposed injection site, uncorrected coagulopathy, current anticoagulant or antiplatelet therapy, severe hepatic or renal impairment, chronic opioid use, or previous cervical radiotherapy. Previous cervical radiotherapy was listed as an exclusion criterion because radiation-induced fibrosis and potential neuropathic injury to cervical structures may alter the expected spread of local anaesthetic, create pre-existing neurological symptoms that confound pain assessment, and complicate the interpretation of any postoperative neurological changes attributed to the block. Six consecutive patients in whom the attending anaesthesiologist elected to perform a US-guided bilateral SCPB constituted the SCPB group; the 21 eligible patients managed without a block during the same period formed the control group.

2.2. Anaesthetic management and block technique

General anaesthesia was administered according to the standard institutional protocol. Once the surgical procedure was complete and while the patient was still anaesthetised, a US-guided bilateral SCPB was performed in patients allocated to the block group. The phrenic nerve (C3-C5) courses deep to the investing cervical fascia, directly along the anterior surface of the anterior scalene muscle. In our study, the technique involved injecting the local anesthetic solution into the intermuscular plane between the sternocleidomastoid (SCM) and anterior scalene muscles. A B. Braun Stimuplex® Ultra 360® echogenic needle was advanced in-plane in a posterior-to-anterior direction, and 10 mL of local anaesthetic was deposited within the superficial cervical fascial plane on each side (total volume 20 mL), targeting the plane where the terminal branches of the superficial cervical plexus emerge. The injectate was prepared by diluting 10 mL of hyperbaric 0.5% bupivacaine with 10 mL of 0.9% saline, yielding a final concentration of approximately 0.25% bupivacaine. Patients were then emerged from anaesthesia in the usual fashion. No block was performed in the control group.

2.3. Postoperative analgesia

In both groups, postoperative analgesia followed a uniform multimodal regimen: an initial routine dose of intravenous paracetamol 1 g, tenoxicam 20 mg, and tramadol 100 mg was administered in the PACU, and subsequent doses (paracetamol up to every 8 h, tenoxicam up to every 12 h) were given only when the patient reported pain or discomfort and were withheld otherwise. Tramadol hydrochloride 100 mg IV was reserved as on-demand rescue analgesia and was administered by the ward nurse only at the patient's explicit request for severe breakthrough pain.

2.4. Outcome measures

The primary outcome was postoperative pain intensity, assessed using the Numeric Rating Scale (NRS; 0 = no pain, 10 = worst imaginable pain) in the PACU (0 h) and at 1, 6, 12, and 24 h postoperatively. Secondary outcomes were the total number of paracetamol vials and tenoxicam ampoules administered from PACU admission through discharge (including the initial routine PACU dose, reflecting the complete analgesic burden during the hospital stay); the number of additional tramadol ampoules administered on demand; the total tramadol consumption (mg); the time from PACU arrival to the first request for rescue tramadol (min); patient satisfaction at 24 h on a five-point Likert scale (1 = very dissatisfied to 5 = very satisfied); duration of hospital stay (hours); PONV; and haematoma.

2.5. Statistical analysis

In view of the small sample sizes, which preclude reliable normality testing, non-parametric methods were used throughout. Continuous variables are summarised as median and interquartile range (IQR) and were compared between groups using the Mann–Whitney U test. Categorical variables were compared using the Fisher exact test. Effect size for the Mann–Whitney comparisons was estimated using $r = Z / \sqrt{N}$, with $r \geq 0.50$ considered large. Two-sided $P < 0.05$ was considered significant. No a priori sample-size calculation was performed, in keeping with the exploratory nature of the study; the observed effect sizes will inform the design of a confirmatory randomised trial. All analyses were performed using IBM SPSS Statistics version 25 (IBM Corp., Armonk, NY, USA).

3. Results

Twenty-seven patients were included: 6 in the SCPB group and 21 in the control group. Baseline demographic and procedural data are shown in Table 1. All 27 patients underwent the combined neck-lift plus temporal-lift procedure. The two groups were comparable for age (P = 0.502), sex distribution (P = 0.204), body mass index (P = 0.097), ASA physical status, and operative duration (P = 0.392). All patients were ASA physical status I or II.

NRS scores at every postoperative time point were significantly lower in the SCPB group (Table 2). Within the SCPB group, the median NRS was 0 in the PACU and at 1, 6, 12, and 24 h. In the control group the median NRS ranged from 3 in the PACU and at 1 h to 1 at 24 h. Effect sizes were large at the early time points — r = 0.707 at PACU and 1 h (P = 0.0002) and r = 0.673 at 6 h (P = 0.0003) — and remained moderate-to-large at 12 h (r = 0.528; P = 0.005) and 24 h (r = 0.449; P = 0.016).

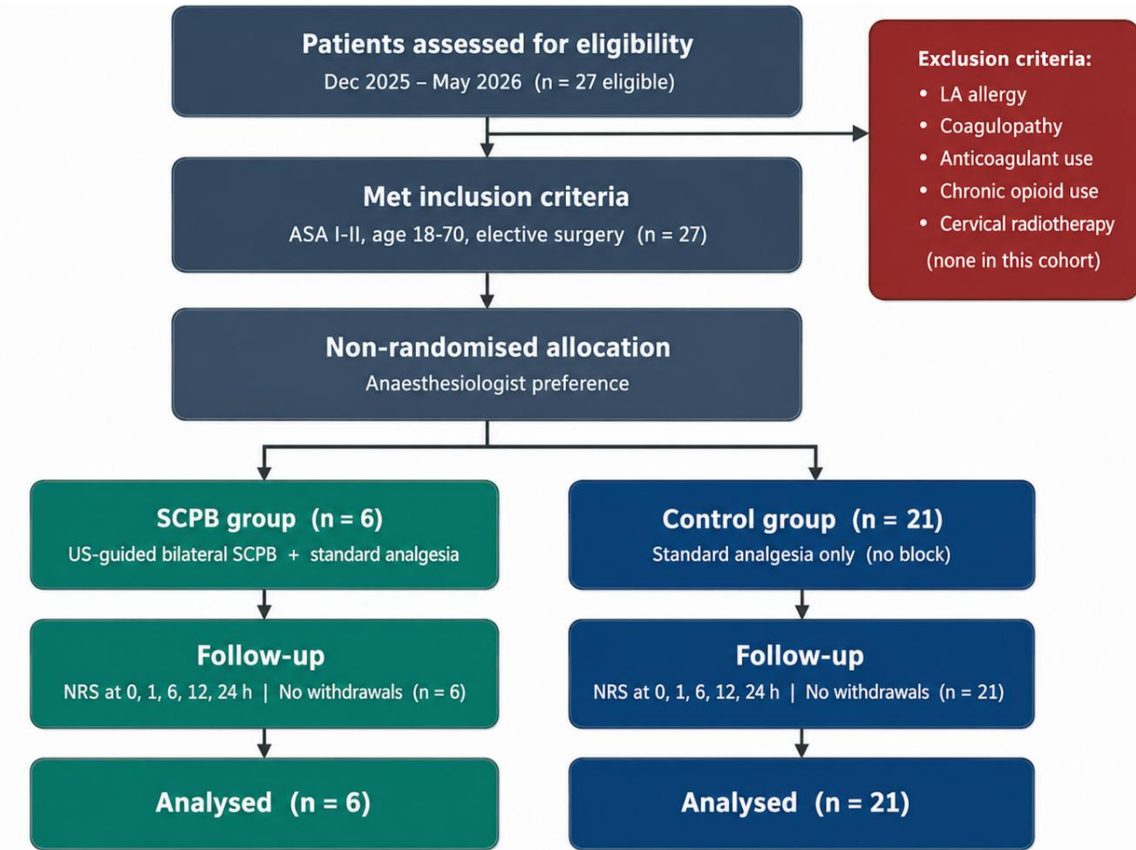

Fig. 1. STROBE-compliant patient flow diagram illustrating eligibility assessment, exclusion criteria, group allocation, follow-up, and analysis.

Table 1. Baseline characteristics.

Variable	SCBP group (n=6) median (IQR) or n (%)	Control group (n=21) median (IQR) or n (%)	P value
Age, years	54.5 (49.8–57.8)	57.0 (52.0–61.0)	0.502
Female sex, n (%)	4 (66.7)	19 (90.5)	0.204
BMI, kg/m^2, median (IQR)	25.0 (24.0–26.0)	27.0 (25.0–28.0)	0.097
ASA status I / II, n	1 / 5	0 / 21	0.222
Surgery duration, min	360 (338–360)	360 (345–420)	0.392

Data are median (IQR) or n (%). Mann–Whitney U test for continuous variables;
Fisher exact test for categorical variables. BMI, body mass index; SCPB, superficial cervical plexus block.

Table 2. Postoperative NRS pain scores.

Time point	SCBP group (n=6) median (IQR)	Control group (n=21) median (IQR)	P value
PACU (0 h)	0 (0–0)	3 (2–4)	0.0002*
1 h	0 (0–0)	3 (2–4)	0.0002*
6 h	0 (0–0)	2 (1–3)	0.0003*
12 h	0 (0–0.75)	2 (1–2)	0.005*
24 h	0 (0–0.75)	1 (1–2)	0.016*

Data are median (IQR). Mann–Whitney U test.
*P < 0.05. PACU, post-anaesthesia care unit; SCPB, superficial cervical plexus block;
NRS, Numeric Rating Scale.

3.1. Analgesic consumption and secondary outcomes

Postoperative analgesic use and secondary outcomes are summarised in Table 3. Patients in the SCPB group required significantly fewer total paracetamol vials (median 2.5 vs 7.0; P = 0.0003; r = 0.690) and tenoxicam ampoules (median 2.0 vs 6.0; P = 0.003; r = 0.561) over the course of the hospital stay. The number of additional tramadol ampoules did not differ significantly (P = 0.124), although total tramadol consumption tended to be lower with SCPB (median 50 mg vs 200 mg; P = 0.071). Only 2 of 6 SCPB patients (33.3%) requested rescue tramadol, versus 13 of 21 controls (61.9%; P = 0.355). Among those who requested tramadol, SCPB patients made their first request at a median of 780 min after PACU arrival versus 60 min in controls; this comparison is descriptive only, based on two SCPB patients.

Patient satisfaction was higher in the SCPB group (median 5 vs 3; P = 0.0005; r = 0.640). Hospital stay was similar between groups (median 48 h; P = 0.360). PONV was absent in all SCPB patients compared with 9 controls (42.9%; P = 0.071). Two haematomas occurred in the control group and none in the SCPB group (P = 1.000). No block-related complication — including phrenic nerve palsy, Horner syndrome, vascular puncture, or local-anaesthetic systemic toxicity — was observed in any of the six SCPB patients.

4. Discussion

In this retrospective observational case-controlled series, patients receiving ultrasound-guided bilateral SCPB demonstrated significantly lower NRS pain scores at all five postoperative time points, reduced total non-opioid analgesic consumption over the hospital stay, and higher patient satisfaction scores compared with controls receiving standard multimodal analgesia alone. No block-related complications were observed. These findings provide the first available preliminary data on SCPB in aesthetic neck and temporal-lift surgery.

To our knowledge, no prior study has evaluated SCPB in this aesthetic surgical context, and the present series therefore provides the first available data on which to base the design of a prospective randomised trial.

Within the SCPB group, the median NRS remained at zero throughout the 24-hour observation period, in contrast to persistent mild-to-moderate pain in the controls. This observation should be interpreted with caution given the small sample size, and may in part reflect a floor effect of the NRS at the lower end of the scale. The median NRS of zero should be interpreted alongside the analgesic consumption data: the proactive administration of non-opioid analgesics upon the earliest signs of mild discomfort likely prevented pain-score escalation throughout the observation period. This pattern parallels findings from thyroid surgery, where SCPB has repeatedly been shown to reduce NRS pain scores, lower opioid requirements, and shorten time to discharge during the first 24 h [1,2,4]. The physiological rationale is direct: the cervicofacial dissection and platysmal manipulation performed during a neck or temporal lift involve skin and subcutaneous structures innervated almost entirely by the C2–C4 terminal branches of the superficial cervical plexus [9,10], which are precisely the targets of the SCPB technique used here.

Table 3. Analgesic consumption and postoperative outcomes.

Outcome	SCBP group (n=6) median (IQR) or n (%)	Control group (n=21) median (IQR) or n (%)	P value
Total paracetamol vials (hospital stay)	2.5 (2.0–3.0)	7.0 (5.0–8.0)	0.0003*
Total tenoxicam ampoules (hospital stay)	2.0 (0.3–3.0)	6.0 (5.0–6.0)	0.003*
Additional tramadol, ampoules	0 (0–1.5)	1 (0–4)	0.124
Total tramadol consumption, mg	50 (0–250)	200 (100–500)	0.071
Patients requesting rescue tramadol, n (%)	2 (33.3)	13 (61.9)	0.355
Time to first rescue tramadol, min	780 (600–960)†	60 (60–60)	—
Hospital stay, h	48 (30–66)	48 (48–72)	0.360
Patient satisfaction (1–5), median (IQR)	5 (5–5)	3 (2–3)	0.0005*
PONV, n (%)	0 (0)	9 (42.9)	0.071
Haematoma, n (%)	0 (0)	2 (9.5)	1.000

Data are median (IQR) or n (%). Mann–Whitney U test for continuous variables; Fisher exact test for categorical variables. Paracetamol and tenoxicam totals reflect all doses administered from PACU admission through discharge (median hospital stay 48 h), including the initial routine PACU dose. †Calculated only for the two SCPB patients who requested rescue tramadol. *P < 0.05. SCPB, superficial cervical plexus block; PONV, postoperative nausea and vomiting.

The significantly lower total consumption of paracetamol and tenoxicam in the SCPB group over the hospital stay lends further support to a real analgesic effect. The non-significant trends toward lower total tramadol use and lower PONV (both P = 0.071) are notable: opioid-sparing matters particularly in aesthetic neck surgery because opioid-induced nausea and vomiting may contribute to postoperative hypertension and agitation, recognised triggers of expanding haematoma [3,5]. Meta-analytic data in thyroid surgery indicate that SCPB reduces both opioid consumption and PONV [1]; our observations are directionally consistent with that hypothesis.

Although the earlier meta-analysis by Mayhew et al. [2] did not find a significant effect on PONV, the more recent update by Wilson et al. [1], which included 31 trials and 2,273 patients, demonstrated a statistically significant reduction (P = 0.02), aligning the meta-analytic evidence with the directional trend observed in our cohort.

Regarding the volume of local anaesthetic used: we administered 10 mL per side (total 20 mL of 0.25% bupivacaine, corresponding to a total bupivacaine dose of 50 mg, well within established safety margins). There is no universally accepted consensus on the optimal volume for SCPB; published studies have used volumes ranging from 5 to 20 mL per side [1,2,6]. In the absence of standardised dosing guidance for this technique in the aesthetic surgery context, a volume of 10 mL per side was selected as the minimum dose considered clinically sufficient to achieve reliable spread along the posterior SCM border while minimising the risks of inadvertent deep injection, local anaesthetic systemic toxicity, and phrenic nerve involvement. Whether smaller volumes would provide equivalent analgesia warrants evaluation in future prospective studies.

The anatomical relationship between the superficial cervical plexus block and the phrenic nerve warrants specific consideration. The phrenic nerve (C3-C5) courses deep to the investing cervical fascia, directly along the anterior surface of the anterior scalene muscle. In our study, the technique involved injecting the local anesthetic solution into the intermuscular plane between the sternocleidomastoid (SCM) and anterior scalene muscles. When performed under real-time ultrasound guidance—ensuring the injectate is precisely deposited superficial to the deep investing fascia—the risk of inadvertent phrenic nerve involvement remains minimal. In published series of bilateral SCPB for thyroid surgery involving thousands of patients, clinically significant phrenic nerve palsy has not been reported as a complication of this technique [1,2]. Consistent with this evidence, no phrenic nerve palsy, Horner syndrome, or other neurological complication was observed in any of the six SCPB patients in the present series.

The high patient satisfaction with SCPB (median 5 vs 3; P = 0.0005; r = 0.640, large effect) is multifactorial: in elective aesthetic surgery, satisfaction encompasses freedom from pain, freedom from PONV, comfort during emergence, and the overall perioperative experience.

The findings regarding PONV and haematoma should be interpreted with particular caution. This study was not designed or powered to detect differences in these outcomes, and the apparent differences observed should be regarded as descriptive and purely exploratory. No conclusions about the effect of SCPB on PONV or haematoma can be drawn from this data.

Several important limitations must be explicitly acknowledged. The most fundamental limitation is the non-randomised allocation of the intervention: patients were assigned to the SCPB group according to the individual attending anaesthesiologist's preference rather than by formal randomisation, which introduces a substantial and unquantifiable risk of selection bias and confounding. Patients who received the block may have differed systematically from controls in ways not captured by the recorded variables. The retrospective single-cen-

tre design precludes causal inference, the total sample size is small (n = 27), the SCPB group is very small (n = 6), and the group sizes are markedly unequal. No adjustment for potential confounders was performed. Analgesic consumption was extracted from routine clinical records rather than prospectively collected, which may have introduced ascertainment bias. The possibility that the proactive administration of scheduled non-opioid analgesics influenced pain scores, maintaining a floor NRS of zero in the SCPB group, cannot be excluded. Given these limitations, all statistically significant findings should be regarded as hypothesis-generating rather than confirmatory, and the reported effect sizes are provided solely to inform sample-size calculations for a future adequately powered randomised trial.

Notwithstanding these limitations, the consistency of the observed differences across five sequential NRS time points and two analgesic-consumption endpoints, together with the complete absence of block-related adverse events in all six patients, provides preliminary support for further evaluation of US-guided bilateral SCPB in aesthetic neck surgery.

5. Conclusions

In this small retrospective observational series, US-guided bilateral superficial cervical plexus block was associated with significantly lower postoperative pain scores, lower supplemental analgesic requirements during the hospital stay, and higher patient satisfaction compared with standard analgesia alone after neck-lift and temporal-lift surgery, with no block-related complications. These preliminary findings demonstrate the feasibility of SCPB in aesthetic neck surgery and provide the effect-size estimates needed to design an adequately powered prospective randomised trial.

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Conflict of Interest

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this manuscript.

Data Availability

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

AI Assistance

During the preparation of this manuscript, ChatGPT (OpenAI) was used exclusively for language editing and stylistic refinement. The authors take full responsibility for the content, interpretation, and conclusions of the published article.

Ethics Approval and Consent to Participate

This single-centre retrospective observational case-controlled series was conducted in accordance with the principles of the Declaration of Helsinki. The protocol was approved by the İstinye University Human Research Ethics Committee (Approval Number: 2026/252; Date: May 25, 2026) and individual written informed consent was waived in view of the retrospective study design.

Author Contributions

Suleyman Ozkahraman: *conceptualization, methodology, project administration, supervision, resources, formal analysis, visualization, writing – original draft, writing – review & editing.*
Uson Mamasaliev: *conceptualization, methodology, project administration, supervision, validation, resources, writing – review & editing.*
Bora Bilal: *writing – original draft, writing – review & editing.*

References

1. Wilson L, Malhotra R, Mayhew D, Banerjee A. The analgesic effects of bilateral superficial cervical plexus block in thyroid surgery: A systematic review and meta-analysis. *Indian J Anaesth*. **2023**;67(7):579–589.
2. Mayhew D, Sahgal N, Khirwadkar R, Hunter JM, Banerjee A. Analgesic efficacy of bilateral superficial cervical plexus block for thyroid surgery: Meta-analysis and systematic review. *Br J Anaesth*. **2018**;120(2):241–251.
3. Gupta V, Winocour J, Shi H, Shack RB, Grotting JC, Higdon KK. Preoperative risk factors and complication rates in facelift: Analysis of 11,300 patients. *Aesthet Surg J*. **2016**;36(1):1–13.
4. Betancourt C, Sanabria A. Post-thyroidectomy bilateral cervical plexus block relieves pain: A systematic review. *Eur Arch Otorhinolaryngol*. **2024**;281(7):3765–3778.
5. Kleinberger AJ, Spiegel JH. What is the best method for minimizing the risk of hematoma formation after rhytidectomy? *Laryngoscope*. **2015**;125(3):534–536.
6. Gürkan Y, Taş Z, Toker K, Solak M. Ultrasound guided bilateral cervical plexus block reduces postoperative opioid consumption following thyroid surgery. *J Clin Monit Comput*. **2015**;29(5):579–584.
7. Ahiskalioglu A, Yayik AM, Oral Ahiskalioglu E, et al. Ultrasound-guided bilateral superficial cervical block and preemptive single-dose oral tizanidine for post-thyroidectomy pain: A randomized-controlled double-blind study. *J Anesth*. **2018**;32(2):219–226.
8. Peksöz U, Öner F, Ahıskalıoğlu A. Superficial cervical plexus block for retroauricular mass excision in a patient with high risk of general anaesthesia: A case report. *Turk J Anaesthesiol Reanim*. **2022**;50(2):148–150.
9. Pandit JJ, Dutta D, Morris JF. Spread of injectate with superficial cervical plexus block in humans: An anatomical study. *Br J Anaesth*. **2003**;91(5):733–735.
10. Kim JS, Ko JS, Bang S, Kim H, Lee SY. Cervical plexus block. *Korean J Anesthesiol*. **2018**;71(4):274–288.
11. Karakış A, Tapar H, Özsoy Z, Suren M, Dogru S, Karaman T, et al. Perioperative analgesic efficacy of bilateral superficial cervical plexus block in patients undergoing thyroidectomy: A randomized controlled trial. *Braz J Anesthesiol*. **2019**;69(5):455–460.
12. Patel H, Shah N, Syed A, Shah P, Macwan S. Evaluating the analgesic efficacy of superficial cervical plexus block for head and neck surgeries: A comparative randomized control study. *Cureus*. **2023**;15(5):e39303.
13. Kamel AAF, Fahmy AM, Fathi HM, Elmesallamy W, Khalifa OYA. Regional analgesia using ultrasound-guided intermediate cervical plexus block versus cervical erector spinae block for anterior cervical spine surgery: A randomized trial. *BMC Anesthesiol*. **2024**;24:153.

Challenge Journal of PERIOPERATIVE MEDICINE

Case Report

Treatment of postpartum posterior reversible encephalopathy syndrome (PRES) with peripheral block

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ABSTRACT

Posterior reversible encephalopathy syndrome (PRES) is associated with high blood pressure and various neurological symptoms. The most common neurological symptom is headache. It is usually diffuse and progressive at onset. If left untreated, symptoms progressively worsen over days to weeks. The excruciating headache associated with this syndrome may also trigger or worsen hypertension, thereby placing patients into a vicious cycle that complicates management. Preeclampsia is one of the reported causes of PRES. In developed countries, 16% of maternal deaths are attributed to hypertensive disorders. There is no specific, established antihypertensive regimen for the treatment of acute hypertension in patients with PRES. The use of intravenous antihypertensives may necessitate admission to the intensive care unit until a stable blood pressure target is achieved. Early recognition and treatment of PRES can help reduce the frequency of complications and improve patient outcomes.

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1. Introduction

Posterior reversible encephalopathy syndrome (PRES) encompasses a series of neuroradiological symptoms first described by Hinchey et al. in 1996 [1]. The most common symptoms include headache, encephalopathy, visual disturbances, altered consciousness, and focal neurological deficits. The characteristic radiological finding of the disease is edema in the occipitoparietal region. Predisposing factors include preeclampsia, eclampsia, hemolysis, elevated liver enzymes, and low platelets (HELLP) syndrome, the postpartum period, and the use of cytotoxic drugs [2]. In the management of PRES, in addition to careful treatment of hypertension, identifying, treating, and managing the underlying etiology is crucial [3].

Preeclampsia is end-organ damage that can be accompanied by proteinuria as a result of newly onset hypertension, affecting 3-8% of pregnant women [2]. It typically occurs at or after the 20th week of pregnancy, with delivery being the definitive treatment [4]. Severe cases of PRES can be life-threatening and may require aggressive supportive care at the intensive care unit level.

Supraorbital nerve block (SONB) is a regional technique used in the treatment of acute and chronic headaches. In this block, the targeted nerve is the supraor-

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bital nerve, which branches from the ophthalmic nerve, a division of the trigeminal nerve [5].

Greater occipital nerve block (GONB) is an increasingly popular approach for posterior headaches. The greater occipital nerve originates from the C2 and C3 spinal nerves and provides a significant portion of the scalp's innervation [6].

We planned to present our patient who was diagnosed with preeclampsia at the 24th week of pregnancy and admitted to the emergency department 21 days postpartum with complaints of headache, nausea, and vomiting, and was treated in the intensive care unit using regional techniques.

2. Case Presentation

Written informed consent was obtained for the case report. A 35-year-old pregnant patient with a history of hypertension was under regular follow-up and was diagnosed with preeclampsia at the 24th week of gestation. At the 37th week, she underwent a cesarean section under spinal anesthesia and delivered a healthy baby. The patient was discharged home after stabilization of her blood pressure.

On the 20th day post-discharge, she presented to the emergency department with complaints of dizziness, nausea, vomiting, and severe headache. On examination, her Glasgow Coma Scale (GCS) score was 15, and her blood pressure was measured at 180/95 mmHg. Laboratory tests revealed elevated liver enzymes (ALT, AST) without other pathological findings. Magnetic resonance imaging (MRI) showed edema in the anterior parieto-occipital region (Fig 1). With a normal neurological examination, the patient was diagnosed with PRES syndrome and was admitted to the intensive care unit for monitoring and treatment.

The patient was started on an infusion of nitroglycerin at 0.25 mcg/kg/min and nimodipine at 10 mcg/kg/h, along with non-steroidal anti-inflammatory drugs (NSAIDs) and tramadol. On the second day of intensive care admission, despite antihypertensive therapy, blood pressure remained uncontrolled. The patient experienced a stabbing, pulsatile, and diffuse headache localized to the occipital region, along with elevated liver enzymes. To avoid NSAIDs, a SONB and GONB were planned. Informed written consent was obtained from the patient for the procedure and for the use of clinical data for scientific publication.

After obtaining informed consent, the patient was placed in a seated position. Using ultrasound guidance, the superior orbital notch was identified bilaterally just above the globes, and 1.5 mL of 0.5% bupivacaine was injected to complete the SONB. For the GONB, the patient was repositioned posteriorly, and after identifying the semispinalis capitis muscle via ultrasound, 2 mL of 0.5% bupivacaine was injected between the obliquus capitis superior muscles. Following the procedure, the patient was repositioned with the bed elevated to 60 degrees. Approximately 25-30 minutes after the procedure, the patient experienced a reduction in headache intensity, followed by a gradual decrease in blood pressure. Effective analgesia was achieved. The procedures were repeated 12 hours later, leading to the discontinuation of antihypertensive treatment.

After 24 hours of monitoring, the patient's headache symptoms had regressed, blood pressure had stabilized, and liver enzyme levels showed a downward trend. Consequently, she was transferred to the general ward for further follow-up.

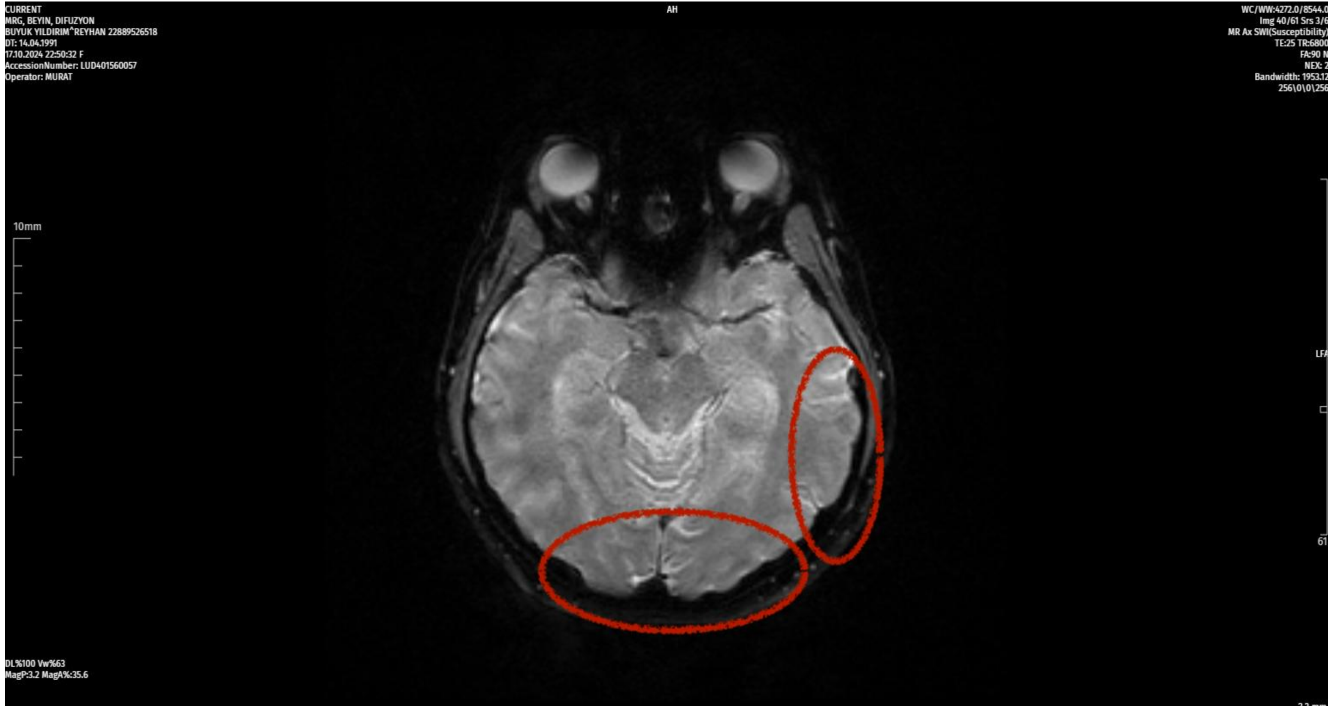

Fig. 1. Magnetic resonance imaging (MRI) showed edema in the anterior parieto-occipital region.

3. Discussion

Pregnancy-related complications pose significant health challenges. Studies have shown that pain experienced during this period plays a significant role in the development of chronic pain later in life as a form of learned pain [7].

Preeclampsia is one of the most feared complications of pregnancy. Patients with preeclampsia are discharged with specific recommendations. When postpartum patients present to the hospital, their medical history should be carefully reviewed, considering complications encountered during pregnancy and potentially related symptoms.

In cases of severe headache, after ruling out cranial emergencies, the patient's history should be assessed alongside headache characteristics such as distribution, exacerbation with movement, and duration to guide the preliminary diagnosis and treatment plan.

In our patient, a history of cesarean delivery under spinal anesthesia 20 days earlier and an alert mental state initially suggested a post-dural puncture headache. However, the fact that the headache did not improve with positional changes (standing up or lying down) led us to reconsider this diagnosis.

PRES is a clinical and radiographic diagnosis, making a thorough history and physical examination essential. In our case, the diagnosis of PRES syndrome was established based on the presence of preeclampsia, a known predisposing factor, and the characteristic MRI findings.

In their study, Triplett and colleagues recommend managing hypertension and providing symptomatic treatment in the management of the disease [8]. There is no specific, established antihypertensive regimen for the treatment of acute hypertension in patients with PRES. In our case, since the patient's hypertension could not be controlled with pharmacological agents and was thought to be pain-related, regional techniques were considered and applied for pain management. As a result, both pain relief and blood pressure stabilization were achieved.

Low-dose local anesthetics were used to effectively control the headache. The method we used in the treatment of PRES syndrome extends beyond the conventional indications for regional blocks. These techniques are generally employed in chronic pain management, and their use in symptomatic treatment remains limited.

In patients where NSAID use is contraindicated and opioid use is a concern, regional techniques should be considered for pain management. This approach is not only effective and rapid-acting but also enhances patient comfort, making it a promising alternative for selected cases.

4. Conclusions

With the increasing use of ultrasonography, we believe that regional techniques should not be overlooked in the management of refractory pain. They offer a viable and safe alternative, especially in cases where conventional pharmacologic treatments are inadequate or contraindicated. Their broader application in acute symptomatic scenarios like PRES may open new avenues for multidisciplinary pain management.

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Conflict of Interest

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this manuscript.

Data Availability

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

AI Assistance

No AI-based tools were used in the preparation of this manuscript.

Ethics Approval and Consent to Participate

Informed consent form was obtained from the patient.

Author Contributions

Osman Celik: *conceptualization, data curation, formal analysis, validation, visualization, writing – original draft, writing – review & editing.*
Gunes Eskidemir: *conceptualization, data curation, writing – original draft, writing – review & editing.*
Ceren Karaduman: *investigation, methodology, project administration, resources, software, supervision, validation, visualization.*
Ayse Vahapoglu: *writing – original draft, writing – review & editing.*

References

1. Miniksar ÖH, Yücel A, Aydoğan MS, Kaya F, Toğal T. Preeklampsiye sekonder posterior reversible ensefalopati sendromu (PRES): Olgu sunumu. *Aegean J Med Sci*. **2019**;2(3):140–143.
2. Adorno M, Maher-Griffiths C, Grush Abadie HR. HELLP syndrome. *Crit Care Nurs Clin North Am*. **2022**;34(3):277–288.
3. Zelaya JE, Al-Khoury L. Posterior reversible encephalopathy syndrome. [Updated 2026 Jan 31]. In: *StatPearls [Internet]*. Treasure Island (FL): StatPearls Publishing; **2026**.
4. Ma'ayeh M, Costantine MM. Prevention of preeclampsia. *Semin Fetal Neonatal Med*. **2020**;25(5):101123.
5. Napier A, De Jesus O, Taylor A. Supraorbital nerve block. [Updated 2023 Aug 23]. In: *StatPearls [Internet]*. Treasure Island (FL): StatPearls Publishing; **2026**.
6. Mckenzie D, Hinson MR. Occipital nerve block. [Updated 2025 Jul 30]. In: *StatPearls [Internet]*. Treasure Island (FL): StatPearls Publishing; **2026**.
7. Marhofer D, Jaksch W, Aigmüller T, Jochberger S, Urlesberger B, Pils K, et al. Schmerztherapie in der Schwangerschaft: Eine expertInnenbasierte interdisziplinäre Konsensus-Empfehlung [Pain management during pregnancy: An expert-based interdisciplinary consensus recommendation]. *Schmerz*. **2021**;35(6):382–390.
8. Triplett JD, Kutlubaev MA, Kermode AG, Hardy T. Posterior reversible encephalopathy syndrome (PRES): Diagnosis and management. *Pract Neurol*. **2022**;22(3):183–189.

Case Report

Refractory intraoperative hypotension: A case report to keep in mind

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ABSTRACT

Refractory intraoperative hypotension can be triggered by a complex interplay of perioperative factors, including anesthetic-induced vasodilation, patient positioning, surgical blood loss, autonomic dysfunction, and the prolonged effects of the patient's daily medications (such as long-acting irbesartan, amlodipine, and concomitant beta-blocker therapy). While the optimal approach to perioperative renin–angiotensin system inhibitor use remains uncertain, these combined agents can severely impair cardiovascular compensatory mechanisms and blunt vasopressor responsiveness under general anesthesia. A 66-year-old male with hypertension and diabetes underwent posterior spinal instrumentation under general anesthesia. Following induction and prone positioning, severe refractory hypotension developed despite aggressive fluid resuscitation guided by Pleth Variability Index, vasopressors, and inotropic support. Progressive lactic acidosis led to surgical termination at the 150th minute. Postoperative cardiac evaluations were normal. Further history revealed the patient had taken a long-acting triple combined antihypertensive regimen (irbesartan/amlodipine/hydrochlorothiazide) the night before surgery. Norepinephrine support was required for 36 hours postoperatively, followed by a full recovery. While diabetic cardiac autonomic neuropathy and prone positioning create a vulnerable baseline for hemodynamic instability, long-acting triple combination antihypertensive therapy acts as the definitive driver for severe, refractory vasoplegic shock. Concomitant use of renin-angiotensin system inhibitors, calcium channel blockers, and thiazide diuretics can severely impair compensatory vasoconstriction and blunt vasopressor responsiveness under general anesthesia. Perioperative antihypertensive management must be strictly individualized according to drug half-life, combination characteristics, and patient comorbidities.

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1. Introduction

We aimed to discuss the possible causes of refractory hypotension encountered during posterior instrumentation surgery, which persisted despite adequate volume replacement, inotropic and vasopressor support, ultimately leading to the termination of the procedure.

2. Case Presentation

Informed consent was obtained from the patient. A 66-year-old, 80 kg male patient with a history of hypertension for 18 years and diabetes mellitus for 12 years (ASA III) was scheduled for posterior spinal instrumentation. Informed consent was obtained from the patient in order to publish this case. Preoperative evaluation, in-

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cluding systemic examination, imaging, and laboratory findings, was unremarkable.

Preoperative blood pressure was 165/85 mmHg with a resting tachycardia (114 bpm). Due to these findings, cardiology consultation was requested, and oral bisoprolol (5 mg/day) was added to his regimen [metformin (1000 mg/day), acetylsalicylic acid (100 mg/day), and irbesartan/amlodipine/hydrochlorothiazide (150/10/12.5 mg)]. Echocardiography revealed a normal ejection fraction (EF 60%) and normal valvular functions.

Following routine monitoring and induction (propofol, fentanyl, rocuronium), the patient was intubated. Invasive arterial pressure and Pleth Variability Index (PVI) monitoring were established. Anesthesia was maintained with sevoflurane (0.8–1.0 MAC) in oxygen/air mixture and remifentanil infusion (0.05–0.20 mcg/kg/min) was titrated according to the hemodynamic response.

The patient was positioned prone using thoracic and abdominal supports. Airway pressures remained stable, and the abdomen was free of compression. Immediately post-positioning, profound refractory hypotension developed. Despite fluid resuscitation and ephedrine boluses, the collapse was non-reactive, requiring sequential norepinephrine and adrenaline infusions (Table 1). PVI (12–14%), oxygenation, and ECG remained stable.

Table 1. Patient's hemodynamic status and interventions performed.

Time point	Blood pressure (mmHg)	Heart rate (beats/min)	Intervention	Clinical response	Estimated blood loss (mL)	Fluid and blood replacement
Pre-induction	165/94	62	—	—	—	Crystalloid infusion
Post-induction	125/69	68	—	—	—	Crystalloid infusion
After prone positioning	80/42	78	500 mL colloid bolus	Normotension achieved within 15 min	—	Crystalloid infusion
5 min after colloid administration	52/35	61	Ephedrine 5 mg ×2; norepinephrine infusion initiated	No significant response	—	Crystalloid bolus and fluid challenge continued
Intraoperative 1st hour	92/52	70	Norepinephrine infusion 0.2 mcg/kg/min	Systolic blood pressure maintained between 90–100 mmHg	500	2400 mL crystalloid + 500 mL colloid
Intraoperative 90th min	62/36	75	Norepinephrine 0.3 mcg/kg/min + dopamine 20 mcg/kg/min	Systolic blood pressure increased to 90 mmHg; surgical team informed	750	1 unit erythrocyte suspension (ES); total crystalloid infusion 3500 mL
Intraoperative 120th min	65/38	78	Adrenaline infusion added to vasopressor and inotropic therapy	Systolic blood pressure reached 100 mmHg; surgical team warned about possible termination	1500	2 units ES administered; total crystalloid infusion 5500 mL
Intraoperative 150th min	82/48	73	Norepinephrine 0.5 mcg/kg/min + adrenaline 0.5 mcg/kg/min + dopamine 20 mcg/kg/min	Surgery terminated	2100	Total 7100 mL crystalloid + 500 mL colloid + 2 units ES replacement

Due to refractory hypotension unattributable to hypovolemia, cardiac, or pulmonary causes, surgery was terminated at the 150th minute. Intraoperative troponin, D-dimer, and fibrinogen were sampled. The patient was transferred intubated to the intensive care unit (ICU) (blood gas data in Table 2).

Table 2. Arterial blood gas and laboratory parameters during the perioperative period.

Time point	pH	$PaCO_2$ (mmHg)	PaO_2 (mmHg)	Hemoglobin (g/dL)	Hematocrit (%)	Lactate (mmol/L)	Potassium (mmol/L)	Sodium (mmol/L)	HCO_3^- (mmol/L)	Base deficit (mmol/L)
Operating room 15th min	7.38	32.2	97	14.1	42.3	0.5	4.0	136	21.4	-3.9
Operating room 60th min	7.30	31.3	95	13.3	39.9	2.5	3.2	139	20.6	-5.3
Operating room 120th min	7.28	28.0	88	10.2	30.6	5.2	3.5	144	17.4	-8.5
Postoperative 0th hour	7.19	35.9	93	10.5	31.5	8.4	3.8	144	13.8	-13.3
Postoperative 1st hour	7.12	39.0	112	10.3	31.9	12.3	4.0	142	9.5	-16.2
Postoperative 6th hour	7.27	38.0	108	10.6	31.8	10.1	4.1	140	15.7	-11.4
Postoperative 12th hour	7.38	32.3	96	11.1	33.3	4.5	3.6	139	19.8	-6.3
Postoperative 24th hour	7.40	32.0	91	10.4	31.2	2.2	3.5	140	20.7	-4.5
Postoperative 48th hour	7.38	34.0	94	10.5	31.5	0.8	3.6	139	21.0	-4.8
Postoperative 72nd hour	7.39	35.0	98	10.4	31.2	0.6	3.5	139	21.3	-4.5

Postoperatively, ECG, chest X-ray, complete blood count, biochemistry, intraoperative and postoperative troponin levels were all within normal limits. Echocardiography again showed normal valvular functions and EF 60%.

Severe hypotension persisted for six hours, requiring maximum vasoactive support. Further questioning of the family revealed the patient had taken his triple antihypertensive combination the night prior to surgery. Spontaneous eye opening occurred at postoperative hour 7. Following extubation at hour 18 under low-dose norepinephrine (0.2 mcg/kg/min), vasoactive support was discontinued by hour 36, allowing a stable transfer to the ward at hour 72.

3. Discussion

Intraoperative refractory hypotension is a potentially life-threatening condition associated with increased perioperative morbidity and mortality. Multiple perioperative factors including advanced age, diabetes mellitus, antihypertensive medications, anesthetic agents, patient positioning, blood loss, cardiac autonomic neuropathy (CAN) and vasoplegic mechanisms may contribute to impaired hemodynamic stability during general anesthesia [1].

In our case, hypovolemia was ruled out as the primary cause of refractory hypotension, which emerged following anesthesia induction and remained unresponsive to volume replacement. This assessment was further supported by PVI values ranging between 12% and 14%; as demonstrated by Çelikalp et al. [2] PVI-guided monitoring serves as a valuable tool for assessing fluid responsiveness and excluding significant hypovolemia during spinal surgery.

Pulmonary causes were excluded as oxygenation/ventilation and respiratory parameters remained stable. While the inability to perform intraoperative echocardiography due to the prone position was a limitation in our case, cardiac causes for the refractory hypotension were ruled out by normal preoperative echocardiography and the absence of ECG findings, which was subsequently confirmed by normal intraoperative troponin values and normal postoperative echocardiographic findings. Although the lack of BIS monitoring is a limitation, our routine practice of titrating both sevoflurane and remifentanil maintained a conservative anesthetic depth, rendering deep anesthesia an unlikely cause for the refractory hypotension. The study by Ryu et al. [3] showed that although sevoflurane may cause hypotension up to 1 MAC, it is generally not severe enough to become clinically intolerable. Cardiac autonomic neuropathy is a serious complication of diabetes mellitus, characterized by the impairment of cardiovascular autonomic control, with a literature-reported incidence ranging from 7.7% to 90% [4].

By compromising heart rate, cardiac output, and vascular function, this condition disrupts hemodynamic stability, rendering the response to both vasopressor and inotropic agents highly unpredictable due to postganglionic norepinephrine depletion and denervation supersensitivity [5]. Here, the coexistence of a 12-year history of diabetes mellitus and preoperative resting tachycardia (114 bpm) served as a strong clinical indicator for CAN. Although preoperative bisoprolol therapy masked this presentation by lowering the heart rate to 62 bpm immediately prior to anesthesia induction, which initially led us to attribute the absence of intraoperative reflex tachycardia to beta-blockade, CAN should remain a critical consideration in the differential diagnosis of refractory hypotension. Previous studies have demonstrated that diabetes mellitus, particularly when accompanied by CAN, increases susceptibility to post-induction hypotension due to impaired cardiovascular autonomic control and altered compensatory vasoconstrictive responses, typically manifesting within the first 15–20 minutes after induction [1]. Similarly, our patient developed relative hypotension following induction, demonstrated by a 24% decrease in blood pressure. Considering the increasing prevalence of diabetes, a routine, cost-effective CAN screening involving the evaluation of effort capacity, resting tachycardia, and bedside orthostatic hypotension may be highly valuable, although it should be noted that subclinical diabetic autonomic dysfunction can easily be overlooked preoperatively [6].

Prone positioning during spine surgery contributes to transient hypotension by inducing hemodynamic instability through a combination of positionally induced mechanical load and blunted autonomic reflexes. Specifically, abdominal and thoracic compression restricts venous return, elevates intrathoracic pressure, and impairs right ventricular filling, ultimately reducing preload, stroke volume, and cardiac index [7,8]. Although volume replacement was administered to counteract the potential hypotensive effects of prone positioning, the patient remained unresponsive, a failure that may be explained by CAN preventing the compensatory response. Consequently, we consider it unlikely that prone positioning alone could explain this presentation. Despite aggressive management with volume replacement, vasopressors, and inotropic therapies, the patient's refractory hypotension persisted for a catastrophic duration, and ultimately, the surgery had to be terminated early.

Crucially, we hypothesize that the prolonged pharmacological effect of the triple combination therapy administered the night before surgery was the primary driver that converted this suspected baseline vulnerability into an irreversible state, thereby contributing to the refractory vasoplegic shock. A possible contributing factor to refractory hypotension may have been the prolonged effects of the antihypertensive combination therapy, consisting of irbesartan, amlodipine, and a thiazide diuretic [9,10]. Angiotensin II receptor blockers (ARB), calcium channel blockers, and thiazide diuretics may independently decrease vascular tone through distinct pharmacological pathways. When used together, these agents may potentiate vasodilatory responses during anesthetic induction, leading to prolonged and refractory hypotension. Literature reports indicate that a 24-hour washout period may be insufficient to eliminate the effects of long-acting ARBs and calcium channel blockers, as their pharmacological effects can persist for several days [11,12]. Sica et al. [12] reported that the pharmacodynamic effects of azilsartan/chlorthalidone therapy may persist beyond 24 hours, using a 1–2-week washout period to minimize residual antihypertensive activity.

Similarly, Lee et al. [11] demonstrated that refractory intraoperative hypotension developed despite 48-hour discontinuation of azilsartan but did not recur after extending the washout period to 96 hours. Consistent with these findings, refractory hypotension has also been reported with telmisartan despite 24-hour discontinuation, while Hojo et al. [13] showed that long half-life ARB and Angiotensin-Converting enzyme inhibitor (ACE-I) agents are associated with a significantly higher risk of induction-related hypotension compared with shorter-acting agents.

The patient's metabolic profile reflects the severity of this pharmacologically induced vasoplegia (Table 2). Hypoperfusion-induced lactic acidosis, compounded by high-dose adrenaline, blunted vasoactive responsiveness to create a dangerous vicious cycle. However, the complete normalization of metabolic parameters and lactate clearance by postoperative hour 24 closely corresponded to the gradual resolution of vasoplegia under norepinephrine support, confirming that this metabolic collapse was entirely secondary to prolonged cardiovascular paralysis.

4. Conclusions

In conclusion, this case highlights that while diabetic cardiac autonomic neuropathy (CAN) and prone positioning create a vulnerable baseline for hemodynamic instability, long-acting triple combination antihypertensive therapy acts as the definitive driver for severe, refractory vasoplegic shock. Concomitant use of RAS inhibitors, calcium channel blockers, and thiazide diuretics can severely impair compensatory vasoconstriction and blunt vasopressor responsiveness under general anesthesia. Although the optimal approach to perioperative RAS inhibitor use remains uncertain, our findings demonstrate that a standard 24-hour discontinuation period is insufficient. Therefore, perioperative antihypertensive management must be strictly individualized based on drug half-lives, specific combined regimens, and patient-specific autonomic comorbidities.

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Data Availability

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AI Assistance

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Ethics Approval and Consent to Participate

Informed consent form was obtained from the patient.

Author Contributions

Mehmet Bulut: *conceptualization, data curation, formal analysis, investigation, methodology, project administration, resources, supervision, validation, visualization, writing – original draft, writing – review & editing.*

Tülay Çardaközü*: conceptualization, data curation, formal analysis, investigation, methodology, project administration, resources, supervision, validation, visualization, writing – original draft, writing – review & editing.*

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References

1. Siripruekpong S, Anchalee S, Benjhawaleemas P, Pakpirom J, Pooriyapan S, Kampeng S. Impact of diabetic mellitus and cardiac autonomic neuropathy cooccurrence on postinduction hypotension incidence in old patients who underwent general anesthesia. *BMC Geriatr*. **2025**;25:859.
2. Çevikkalp E, Topçu İ, Açıkel A, Sarılar S, Tezcan Keleş G, Özyurt BC. Efficacy of pleth variability index (PVI) to evaluate intraoperative fluid management during orthopedic spinal surgery: A randomized controlled trial. *JARSS*. **2020**;28(1):18–25.
3. Ryu KH, Hwang SH, Shim JG, Ahn JH, Cho EA, Lee SH, Byun JH. Comparison of vasodilatory properties between desflurane and sevoflurane using perfusion index: A randomised controlled trial. *Br J Anaesth*. **2020**;125(6):935–942.
4. Rolim LC, Sá JR, Chacra AR, Dib SA. Diabetic cardiovascular autonomic neuropathy: Risk factors, clinical impact and early diagnosis. *Arq Bras Cardiol*. **2008**;90(4):e24–e31.
5. Mustafa HI, Fessel JP, Barwise J, Shannon JR, Raj SR, Diedrich A, Biaggioni I, Robertson D. Dysautonomia: Perioperative implications. *Anesthesiology*. **2012**;116(1):205–215.
6. Riznat M, Issouani J, Malad M, Srifi H, Lakssir I, Guerboub AA. Dysautonomia in diabetic patients: A study of 20 cases. *Sch J Med Case Rep*. **2025**;13(8):1857–1862.
7. Akhter S, Hasan SMZ, Yasin S, Nujhat AN, Azim N, Huda MMN. Perioperative hemodynamic changes in patients is undergoing spine surgery under general anaesthesia. *ARC J Anesthesiol*. **2026**;11(1):7–12.
8. Medetoğlu Köksal EN, Çelik EC, Köksal V, Aydın ME, Yayık AM, Oral Ahiskalioglu E, et al. Hemodynamic effects of surgical positioning in patients undergoing percutaneous nephrolithotomy: A prospective study. *BMC Anesthesiol*. **2026**;26:48.
9. Bramlage P. Fixed combination of irbesartan and hydrochlorothiazide in the management of hypertension. *Vasc Health Risk Manag*. **2009**;5:213–224.
10. Özatamer O, Tarhan A, Oral I. Drug interactions in anesthesia. *Anestezi Derg*. **2011**;19(3):137–153.
11. Lee JH, Kim YY, Heo HJ, Kim G, Oh C. Severe refractory hypotension during induction of general anesthesia in patient after 48 hours of azilsartan discontinuation: A case report. *Medicine (Baltimore)*. **2023**;102(47):e36126.
12. Sica D, Bakris GL, White WB, Weber MA, Cushman WC, Huang P, Roberts A, Kupfer S. Blood pressure-lowering efficacy of the fixed-dose combination of azilsartan medoxomil and chlorthalidone: A factorial study. *J Clin Hypertens (Greenwich)*. **2012**;14(5):284–292.
13. Hojo T, Shibuya M, Kimura Y, Otsuka Y, Fujisawa T. Refractory hypotension during general anesthesia despite withholding telmisartan. *Anesth Prog*. **2020**;67(2):86–89.