Original Article/*Özgün Araştırma*

doi: 10.54875/jarss.2025.74317

Correlation Between Surgical Ward and Preinduction Blood Pressures and Their Relation with Perioperative Organ Injury in Patients Undergoing Hepatic or Pancreatic Resection

Karaciğer veya Pankreas Rezeksiyonu Geçiren Hastalarda Cerrahi Servis ve İndüksiyon Öncesi Kan Basınçları Arasındaki Korelasyon ve Bunların Perioperatif Organ Hasarı ile İlişkisi

Taner Abdullah[1], Huru Ceren Gokduman[1], Isbara Alp Eniste[1], Ilyas Kudas[2], Achmet Ali[3], Funda Gumus Ozcan[1]

[1]Istanbul Basaksehir Cam&Sakura City Hospital, Clinic of Anesthesiology, Istanbul, Türkiye
[2]Istanbul Basaksehir Cam&Sakura City Hospital, Clinic of General Surgery, Istanbul, Türkiye
[3]Istanbul University, Istanbul Medical Faculty, Department of Anesthesiology and Reanimation, Istanbul, Türkiye

ABSTRACT

Objective: Our primary objective was to evaluate the relationship between perioperative organ injury (POI) and prior diagnosis of hypertension (HT), preinduction blood pressure (piBP) and surgical ward BP (swBP) in patients undergoing hepatic or pancreatic resection.

Method: This was a single-center historical cohort study. Perioperative organ injury was defined as the occurrence of perioperative myocardial injury (PMI) or acute kidney injury (AKI) within 3-days after surgery. Perioperative myocardial injury was defined as an increase of at least 14 ng L^{-1} from baseline high-sensitive troponin-T (hsTnT) levels, and AKI was defined in line with KDIGO criteria. Logistic regression models were used for determining independent risk factors for POI.

Results: Out of 209 patients, 104 (50%) were previously diagnosed with HT. While only 17 (8%) patients had elevated swBP (systolic ≥ 140 mmHg or diastolic ≥ 90 mmHg), 131 (63%) patients had elevated piBP. Perioperative organ injury was observed in 74 (35.4%) patients. The presence of stage 2 or 3 piBP (systolic ≥ 160 mmHg or diastolic ≥ 100 mmHg) was the only BP-related risk factor for the occurrence of POI (OR: 2.4, p=0.02). Other risk factors were the presence of chronic hsTnT elevation, fluid balance more than 3550 mL and an estimated blood loss of more than 1000 mL.

Conclusion: Previous diagnosis of HT and swBP are not associated with POI occurrence. However, the presence of stage 2 or 3 piBP is an independent risk factor together with blood loss, fluid balance and chronic hsTnT elevation.

Keywords: Blood pressure, hypertension, perioperative organ injury, hepatectomy, pancreatectomy

ÖZ

Amaç: Birincil amacımız, karaciğer veya pankreas rezeksiyonu geçiren hastalarda perioperatif organ hasarı (POH) ile hipertansiyon (HT) varlığı, indüksiyon öncesi kan basıncı (iöKB) ve cerrahi servis kan basıncı (csKB) arasındaki ilişkiyi değerlendirmekti.

Yöntem: Çalışma, tek merkezli tarihi kohort çalışması olarak planlanmıştır. Perioperatif organ hasarı, ameliyat sonrası ilk 3 gün içinde oluşan perioperatif miyokardiyal hasar (PMH) veya akut böbrek hasarı (ABH) olarak tanımlandı. Perioperatif miyokardiyal hasar, bazal yüksek duyarlı troponin-T (hsTnT) seviyesinde en az 14 ng L^{-1}'lik bir artış olarak; ABH ise KDIGO kriterleri doğrultusunda tanımlandı. Perioperatif organ hasarı için bağımsız risk faktörlerini belirlemede lojistik regresyon modelleri kullanıldı.

Bulgular: 209 hastanın 104'üne (%50) daha önce HT tanısı konmuştu. Sadece 17 (%8) hastada csKB yüksekken (sistolik ≥ 140 mmHg veya diyastolik ≥ 90 mmHg), iöKB için bu durum 131 (%63) hastada izlendi. Perioperatif organ hasarı 74 (%35,4) hastada gözlendi. Evre 2 veya 3 iöKB'nin (sistolik ≥ 160 mmHg veya diyastolik ≥ 100 mmHg) varlığı, POH oluşumu için KB ile ilişkili tek risk faktörüydü (OR: 2,4, p=0,02). Diğer risk faktörleri kronik hsTnT yüksekliğinin varlığı, 3550 mL'den fazla sıvı dengesi ve 1000 mL'den fazla hesaplanan kan kaybıydı.

Sonuç: Hipertansiyon tanısı ve csKB, POH oluşumuyla ilişkili değildir. Ancak, evre 2 veya 3 iöKB'nin varlığı; kan kaybı, sıvı dengesi ve kronik hsTnT yüksekliği ile birlikte bağımsız bir risk faktörüdür.

Anahtar sözcükler: Kan basıncı, hipertansiyon, perioperatif organ hasarı, hepatektomi, pankreatektomi

Received/Geliş tarihi : 19.06.2025
Accepted/Kabul tarihi : 02.10.2025
Publication date : 30.10.2025

***Corresponding author:** Huru Ceren Gokduman • cerengokduman@hotmail.com

Taner Abdullah 0000-0002-2096-4646 / Huru Ceren Gokduman 0000-0003-1904-4954
Isbara Alp Eniste 0000-0003-2882-6376 / Ilyas Kudas 0000-0002-1319-9114
Achmet Ali 0000-0002-7224-6654 / Funda Gumus Ozcan 0000-0003-3264-4356

Cite as: Abdullah T, Gokduman HC, Eniste IA, Kudas I, Ali A, Gumus Ozcan F. Correlation between surgical ward and preinduction blood pressures and their relation with perioperative organ injury in patients undergoing hepatic or pancreatic resection. JARSS 2025;33(4):284-291.

INTRODUCTION

Hypertension (HT) is the most frequent comorbidity that complicates the perioperative period (1-6). Approximately 30% of adults are hypertensive and the ratio increases with age (2). Moreover, a wide range of hypertensive patients do not receive adequate treatment (1,3).

Elevated blood pressure (BP) results in myocardial and renal damage over time (2,5). Thus, patients with HT are more vulnerable to the detrimental effects of surgical stress and therefore have an increased risk of suffering from perioperative myocardial injury (PMI) and acute kidney injury (AKI) (7,8). Moreover, this risk is even higher in patients whose BP is poorly controlled (9). Hence, ensuring normal BP levels in hypertensive patients during the preoperative period is recommended (1,2). Additionally, although it is controversial, surgery cancellation can be justified for patients with stage 2 HT (BP ≥ 160/100) accompanied by end-organ damage or stage 3 HT (BP ≥ 180/110) (1). In fact, elevated preinduction BP (piBP) is one of the common reasons for the cancellation of elective surgery (10).

Hepatic and pancreatic resections are classified as high-risk surgeries in terms of the occurrence of perioperative organ injury (POI) (1,4,11). Moreover, considering the age distribution of patients undergoing these procedures, HT is more frequently observed in this group than in the general population. Since the indications of these surgeries are mostly time-sensitive due to malignancies, cancellation of the procedures becomes even more controversial.

The primary aim of this study is to evaluate the relationship between POI and prior diagnosis of HT, piBP and surgical ward BP (swBP) in patients undergoing hepatic or pancreatic resection. The secondary aims are to investigate the correlation between swBP and piBP and frequencies of BP stages both on the surgical ward and in the operating room in the same patient group.

MATERIAL and METHODS

Study Design and Patient Inclusion

This was a single-center historical cohort study of consecutive patients undergoing hepatic or pancreatic resection between June 2021 and June 2024 at Istanbul Basaksehir Cam&Sakura City Hospital. We identified the patients from a prospectively maintained data file containing perioperative data of patients undergoing surgery at this center. This study was conducted in accordance with the Declaration of Helsinki. Ethical approval for the study design and data analysis was obtained from the Clinical Research Ethics Committee of Istanbul Basaksehir Cam&Sakura City Hospital (number: 2024.296 date: 16.12.2024), and the written informed consent was waived. All patients above the age of 18 were included, and those with the following conditions were excluded: presence of arrhythmia, presence of end-stage kidney disease, left ventricular ejection fraction below 40%, clamp application to inferior vena cava, concomitant gastrointestinal resection, and emergency and non-neoplastic procedures (to ensure that all surgeries were time-sensitive as the type of the surgery – elective, time sensitive or emergency – can affect the preoperative management of hypertension including cancellation of the procedure).

Definitions and Calculations for Blood Pressure

All measurements relevant to this article were performed using upper-arm cuff oscillometry (12). A pressurized cuff capable of determining the oscillation amplitudes was applied around the right arm (brachial artery).

Surgical ward BP (baseline BP) was defined using the recordings on the day before the surgery on the surgical ward (at least three measurements). Preinduction BP was defined using the lowest measurement before the anesthesia induction in the operating room (at least three measurements were performed).

Hypertensive patients were defined as those who had a prior diagnosis of HT or those who received this diagnosis during the preoperative evaluation according to the most recent guidelines (Systolic BP [SBP] ≥ 140 mmHg or diastolic BP [DBP] ≥ 90 mmHg) (13). The mean value of at least three measurements conducted on the same day was used for this purpose.

Patients were classified into stages 0 – 3 based on their swBP and piBP values, as follows: Stage 0: SBP < 140 mmHg and DBP < 90 mmHg; Stage 1: 140 mmHg ≤ SBP < 160 mmHg or 90 mmHg ≤ DBP < 100 mmHg; Stage 2: 160 mmHg ≤ SBP < 180 mmHg or 100 mmHg ≤ DBP < 110 mmHg; Stage 3: SBP ≥ 180 mmHg or DBP ≥ 110 mmHg (13).

Perioperative Management

All patients were managed by the same anesthesiologists (TA, HCG, IAE) who maintained substantial agreement on the perioperative management protocol detailed in this section.

Patients were evaluated at least seven days prior to surgery. Their BP status was evaluated, and their treatments were optimized if needed according to the most recent guidelines (13). All medications were continued until the time of transfer to the operating room, except angiotensin-converting enzyme inhibitors and angiotensin receptor antagonists. These drugs were discontinued 24 hours before surgery and alternative drugs/doses were used for keeping the patient normotensive. The drugs and comorbidities presented in this study

were noted down 24 hours before surgery, which is the time for the last evaluation of the patient by an anesthesiologist.

In the operating room, together with standard anesthesia monitoring, the patient state index (PSI) (Masimo Inc., Irvine, CA) was routinely used for monitoring the depth of anesthesia.

Anesthesia induction was performed with 1% propofol, 1 μg kg^{-1} fentanyl and 0.6 mg kg^{-1} rocuronium bromide. The dose of propofol was titrated by aiming at a PSI value below 50. Sevoflurane (1%-2%) and remifentanil (0.03-0.3 μg kg^{-1} min^{-1}) infusions were used for the maintenance of anesthesia, targeting a PSI of 25-50. Neuromuscular blockade was maintained with 0.1 mg kg^{-1} rocuronium bromide boluses administered every 30 min. Pharyngeal temperature was monitored in all patients and maintained within 36-37°C.

A balanced crystalloid solution was used for both maintenance and bolus fluid replacement. Colloids were only used when there was hypotension due to active bleeding and the usage was limited to 20 mL kg^{-1}. The hemoglobin threshold for packed red blood cell transfusion ranged between 7–9 g dL^{-1} depending on patients' comorbidities, hemodynamic and laboratory parameters, and the presence of active bleeding. Mean blood pressure (MBP) was rigorously maintained above baseline MBP × 0.8 and ≥ 65 mmHg in every patient.

Blood samples for laboratory follow-up (including high-sensitive troponin-T [hsTnT] and creatinine) were collected once within the week before the surgery, right after the surgery and on the first three mornings following the surgery day. After the third day, the intervals between blood samplings gradually increased unless there was a significant finding.

Study Endpoints and Definitions

The primary endpoint was the occurrence of POI. Kidney Disease: Improving Global Outcomes (KDIGO) criteria was used for the definition of AKI and was defined as at least 0.3 mg dL^{-1} or 50% increase from baseline creatinine levels within the first 3 days after the surgery (14). Perioperative myocardial injury was defined as at least 14 ng L^{-1} increase from baseline hsTnT levels within the same time duration (1). Chronic kidney disease and chronic hsTnT elevation were defined as a baseline glomerular filtration rate <60 mL min^{-1} 1.73 m^{-2} and hsTnT> 14 ng L^{-1}, respectively. Blood loss was calculated using the intraoperative hematocrit change in line with the formula defined by Lopez-Picado et al (15).

Statistical Analysis

The distribution of interval data was assessed using the d'Agostino-Pearson test. Data that followed a normal distribution are presented as mean ± standard deviation, while non-normally distributed data are shown as median (25^{th} percentile–75^{th} percentile). Student's t-test and Mann-Whitney U test were used to compare the variables in line with their distributions. Categorical data are expressed as number (percentage) and were compared with the chi-square test. Pearson's and Spearman's correlation coefficients were used for evaluating normally and non-normally distributed data, respectively. Logistic regression analysis was performed using statistically significant patient and surgery-dependent variables to determine the risk factors for POI. Only statistically significant variables were used. Youden index (sensitivity + specificity – 1) and upper and lower points of the gray zones (the points where positive likelihood ratio is 0.1, and negative likelihood ratio is 10) calculated from ROC curves were used to categorize the continuous variables (16).

The sufficiency of the sample size was evaluated post hoc. According to the Green formula for the sample size of a logistic regression model, the sample size was sufficient to evaluate up to 19 variables in a model (N≥50+8*number of variables) (17). For the given sample size and incidence, the margin error for the incidence of POI was calculated as 6.5%.

Statistical analyses were conducted using SPSS for Windows version 21.0 (SPSS Inc., Chicago, IL) and MedCalc version 16.1 (MedCalc Software Ltd, Ostend, Belgium).

RESULTS

Two hundred and nine patients were included in the analysis (Figure 1), of which 104 (50%) were previously diagnosed with HT. However, only 17 (8%) patients were hypertensive on the surgical ward (SBP ≥ 140 mmHg or DBP ≥ 90 mmHg), and most of them were classified as stage 1 (Table I). On the other hand, when evaluated in the operating room prior to anesthesia induction, 131 patients (63%) were found to be hypertensive (Table I).

Perioperative organ injury was observed in 74 (35.4%) patients (28.9% – 41.9% with 6.5% margin of error). Periopera-

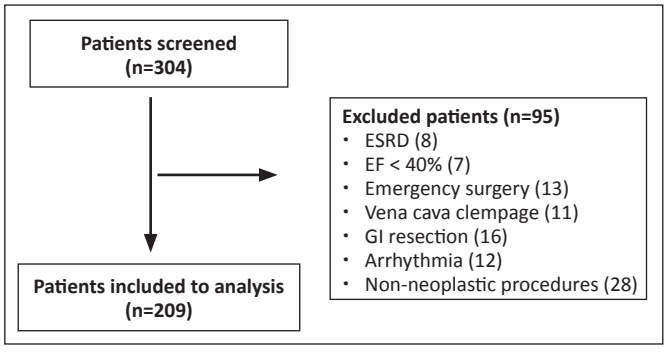

Figure 1. Study flow-chart. **ESRD:** End stage renal disease, **EF:** Ejection fraction of the left ventricle, **GI:** Gastrointestinal.

Table I. Characteristics of Patients

	All (209)	Injury - (135)	Injury + (74)	p-value
Sex				0.60
Male	118 (57)	78 (58)	40 (54)	
Female	91 (43)	57 (42)	34 (46)	
Age (years)	59 ± 12	58 ± 12	59 ± 14	0.51
Weight (kg)	73 ± 14	73 ± 13	74 ± 15	0.38
Height (cm)	166 ± 9	166 ± 9	166 ± 9	0.96
Comorbidities				
Hypertension	104 (50)	64 (47)	40 (54)	0.36
Known HT	101 (48)	62 (46)	39 (53)	0.35
Undiagnosed HT	3 (1)	2 (1)	1 (1)	1
Elevated swBP	17 (8)	11 (8)	6 (8)	0.99
Stage Distribution				0.99
Stage 1	14 (7)	9 (7)	5 (7)	
Stage 2	3 (1)	2 (1)	1 (1)	
Stage 3	0	0	0	
Elevated piBP	131 (63)	85 (63)	46 (62)	0.91
Stage Distribution				**0.001**
Stage 1	**82 (39)**	**62 (46)**	**18 (24)**	
Stage 2	**35 (17)**	**16 (12)**	**21 (28)**	
Stage 3	**13 (6)**	**6 (4)**	**7 (10)**	
Diabetes mellitus	57 (27)	35 (26)	22 (30)	0.55
Hyperlipidemia	20 (10)	9 (7)	11 (15)	0.06
Coronary artery disease	43 (21)	27 (20)	16 (22)	0.78
Congestive Heart Disease	10 (5)	5 (4)	5 (7)	0.32
Cerebrovascular disease	5 (2)	3 (2)	2 (3)	0.83
Pulmonary disease	10 (5)	7 (5)	3 (4)	0.71
Thyroid disease	22 (11)	16 (12)	6 (8)	0.40
Chronic Kidney Disease	20 (10)	11 (8)	9 (12)	0.34
Chronic hsTnT Elevation	22 (11)	8 (6)	14 (19)	**0.003**
ASA Score				0.66
1	35 (17)	24 (18)	11 (15)	
2	127 (61)	84 (62)	43 (58)	
3	41 (19)	24 (18)	17 (23)	
4	6 (3)	3 (2)	3 (4)	
Medications				
Beta blocker	43 (21)	25 (19)	18 (24)	0.32
ACEi/ARB	60 (29)	36 (27)	24 (32)	0.38
CCB	48 (23)	27 (20)	21 (28)	0.17
Statin	20 (10)	9 (7)	11 (15)	0.06
Antiplatelet Therapy	40 (19)	26 (19)	14 (19)	0.95
NOACs	4 (2)	3 (2)	1 (1)	0.66
OAD	57 (27)	35 (26)	22 (30)	0.55
Insulin	18 (9)	14 (10)	4 (5)	0.22

Values are expressed as frequency (percentage) and mean ± Standart devision. **HT:** Hypertension, **BP:** Blood pressure, **sw:** Surgical ward, **pi:** Preinduction, **hsTnT:** High-sensitive troponin T, **ACEi:** Angiotensin converting enzyme inhibitors, **ARB:** Angiotensin receptor blockers, **CCB:** Calcium channel blockers, **NOAC:** New oral anticoagulants, **OAD:** Oral antidiabetic drugs.

tive myocardial injury and AKI occurred in 57 (27.2%) and 35 (16.7%) patients, respectively. Based on the development of POI, patients were allocated into two groups (POI + and POI –) and compared.

Data regarding patients' demographic characteristics, comorbidities, medications, and surgical diagnosis are given in Table I, while the parameters regarding the surgery and perioperative management are presented in Table II.

Regarding the BP variables, only the stage of piBP was significantly different between the POI + and POI – patients. Subgroup analyses revealed that the patient group who had stage 2 or 3 piBP values had a higher POI frequency than the group who had stage 0 or 1 piBP (Figure 2).

The results of the logistic regression analysis performed with the variables that are significant between the POI + and POI – groups are presented in Table III. The presence of stage 2 or 3 piBP was an independent risk factor for the occurrence

Table II. Intraoperative Characteristics

	All (209)	Injury - (135)	Injury + (74)	p-value
Surgery				0.23
Hepatic resection	124 (59)	76 (56)	48 (65)	
Pancreatic resection	85 (41)	59 (44)	26 (35)	
Duration of anesthesia (min)	400 (300 – 470)	390 (297 – 464)	403 (360 – 480)	**0.03**
Duration of surgery (min)	360 (260 – 420)	345 (243 – 420)	378 (315 – 430)	**0.02**
Fluids				
Crystalloids during surgery (mL)	3500 (2850 – 5000)	3200 (2500 – 4500)	4500 (3500 – 5500)	**<0.001**
Total fluids (mL)	3750 (3000 – 5000)	3500 (2500 – 4500)	4750 (3500 – 6500)	**<0.001**
Urine output (mL)	590 (372 – 950)	550 (350 – 900)	650 (440 – 1010)	0.17
Estimated blood loss (mL)	150 (100 – 700)	150 (100 – 600)	250 (100 – 1100)	**0.04**
Fluid Balance (mL)	2550 (1833 – 3658)	2400 (1550 – 3205)	3000 (2395 – 4250)	**<0.001**
Fluid balance per hour (mL)	450 (344 – 579)	424 (321 – 553)	507 (404 – 632)	**0.01**
Patients received colloids (n)	42 (20)	20 (15)	22 (30)	**0.01**
Patients received PRBC (n)	40 (19)	16 (12)	24 (32)	**<0.001**
Vasopressors and Inotropes				
Noradrenaline (n)	136 (65)	80 (59)	56 (76)	**0.02**
Noradrenaline# (μg kg^{-1} min^{-1})	0.11 (0.08 – 0.20)	0.1 (0.08 – 0.17)	0.12 (0.09 – 0.20)	0.21
Dobutamine (n)	41 (20)	25 (19)	16 (22)	0.59
Dobutamine# (μg kg^{-1} min^{-1})	3 (2 – 4.3)	3 (2 – 3)	3 (2 – 5)	0.19

Values are expressed as frequency (percentage) and median (25^{th} to 75^{th} percentile). **PRBC:** Packed red blood cells. # patients who did not receive the drug were not included in the calculation.

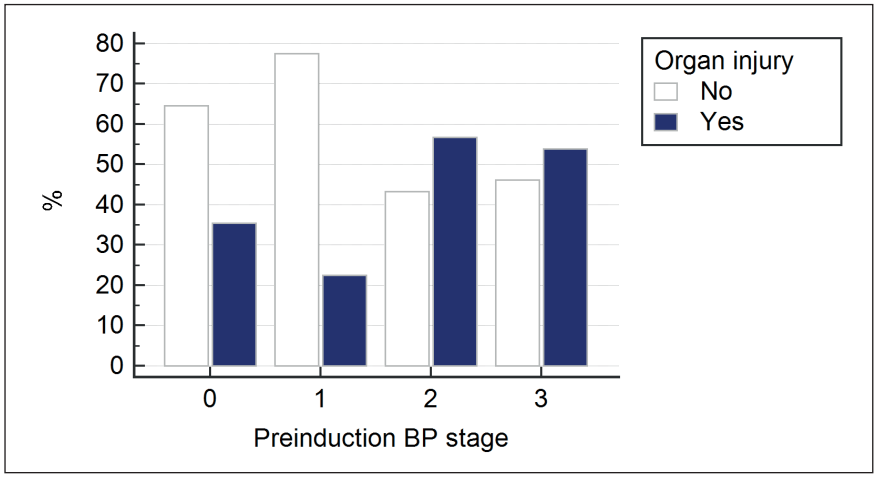

Figure 2. Perioperative organ injury frequency of patients with different preinduction blood pressure stages.

Table III. Multivariable Logistic Regression Analysis for the Association Between Perioperative Organ Injury and Patient Characteristics

	Odds Ratio	95% CI	p-value
Chronic hsTnT Elevation	**3.7**	**1.3 – 10.4**	**0.01**
Stage 2 or 3 piBP	**2.4**	**1.1 – 5.1**	**0.02**
Fluid Balance			
FB ≤ 2350 (mL)	reference		
2350 < FB < 3550 (mL)	2.3	0.9 – 5.7	0.07
FB ≥ 3550 (mL)	**3**	**1.1 – 8.8**	**0.04**
Estimated Blood Loss > 1000 mL	**4.1**	**1.6 – 10.6**	**0.004**
Use of PRBC	1.7	0.7 – 4.1	0.26
Use of noradrenaline infusion	1	0.5 – 2.2	0.99
Surgery Duration			
SD < 300 (min)	reference		
300 ≤ SD < 540 (min)	1.5	0.6 – 3.8	0.39
SD ≥ 540 (min)	1.9	0.5 - 8	0.38

CI: Confidence interval, **hsTnT:** High sensitive troponin T, **piBP:** Preinduction blood pressure, **PRBC:** Packed red blood cells, **FB:** Fluid blance, **SD:** Surgery duration, **min:** minute.

of POI. Other risk factors were the presence of chronic hsTnT elevation, fluid balance more than 3550 mL and an estimated blood loss of more than 1000 mL.

Surgical ward BP was not a good determinant of piBP. Systolic, diastolic and mean BPs measured on the surgical ward and the operating room showed only mild to moderate correlation (r values= 0.55, 0.42, 0.52 for SBP, DBP and MBP, respectively, p=0.01 for all correlations). The correlation between the stages of swBP and piBP was also weak (rho= 0.31, p=0.01). Nevertheless, patients classified as hypertensive in the surgical ward exhibited a significantly higher likelihood of developing stage 2 or 3 piBP compared to normotensive patients (13 out of 17 patients, 76% vs. 37 out of 192 patients, 19%, p<0.001).

DISCUSSION

In the current study, we identified the presence of stage 2 or 3 piBP was an independent risk factor for the occurrence of POI (OR: 2.4, p=0.02). There was no significant difference between POI + and POI – patients in terms of the frequency of HT or the stage of swBP.

Several previous studies have investigated the association between elevated piBP and patient outcomes. Abdelmalak et al. reported that a preinduction SBP of more than 160 mmHg was associated with an increased risk of postoperative complications (3). Similarly, Wax et al. found that the increasing severity of piBP was an independent risk factor for postoperative cardiac complications and mortality (8). Although our findings are in line with the literature, this is the first study that systematically examines the relationship between piBP with systematically screened PMI and AKI, as defined by the most recent guidelines (1,14). This is also the reason why we reported much higher PMI and AKI incidences compared to the studies mentioned above. In fact, the PMI and AKI incidences in this study are consistent with the recent studies that have reported these outcomes in accordance with the said guidelines (1,4,18). Epidemiological studies demonstrate that more than 60% of hypertensive patients are not adequately treated (1,3). However, this ratio was very low in the current cohort (17 out of 104 patients with elevated BP, 16%). This was attributed to the fact that these patients were identified and treated during the preoperative consultation. This finding suggests that securing normotension in inadequately treated patients during the preoperative period is achievable. Although we were unable to observe such a reduced percentage prior to the anesthesia induction, the fact that patients who were hypertensive on the surgical ward had a higher possibility of having a stage 2 or 3 piBP compared to normotensive patients (76% vs. 19%) supports that securing normotension on the surgical ward might be beneficial.

The discordance between the ratio of hypertensive patients on the surgical ward and the ratio of hypertensive patients prior to anesthesia induction needs to be addressed. A higher piBP compared to swBP is expected mainly due to stress-induced effects (19). However, observing stage 2 or 3 piBP values in patients who are normotensive on the surgical ward is not physiological. In a previous study, Matthews et al. investigated the relation between BP reactivity and psychological stress (20). They found that those with higher BP reactivity had a higher chance of becoming hypertensive in the following years. In their article, they speculated that BP reactivity

might be an indicator of endothelial dysfunction or the inability of the endothelium to adequately counteract the vasoconstrictive forces induced by sympathetic stimuli. Therefore, a normotensive individual with such dysfunction may present with stage 2 or 3 piBP. From this perspective, after normotension is secured, elevated piBP might be an incorrigible risk factor for POI, as stress-induced BP elevation is not an indication for treatment. Consequently, it is plausible to claim that it is not logical to postpone surgery due to a stage 2 or 3 piBP if the patient is normotensive during the resting period. Nevertheless, close postoperative monitoring should be applied for POI screening.

Although this study mainly focuses on HT and elevated BP, it should be noted that of all the risk factors listed in Table III, the presence of stage 2 or 3 piBP was the one with the lowest odds ratio. Applying anesthetic management with rational fluid therapy and performing surgery with limited blood loss seem to be not only more important, but also more corrigible than piBP.

The only independent risk factor that can be identified during the preoperative evaluation is chronic hsTnT elevation. Chronic elevation of hsTnT, an indicator for myocardial damage, demonstrates that there might be a systemic condition which continuously causes injury to end organs (21). It has also been reported that hypertensive patients have higher hsTnT values compared to a normotensive cohort (22). However, our results demonstrate that chronic hsTnT elevation is a risk factor for POI development while hypertension is not. These findings support the theory that the main risk factor for POI might not be the condition per se but rather its chronic effects on the end-organs.

The main strength of this study is the homogeneity of the cohort regarding its preoperative evaluation and perioperative management, as the time window was relatively short, and all patients were managed by the same three anesthesiologists. Additionally, a systematic patient follow-up registry prevented significant data losses. Moreover, this is the first study to report an association between BP reactivity and POI. However, there are still several limitations. Firstly, this was a retrospective cohort study with a relatively small sample size that consisted of patients undergoing high-risk open abdominal surgery. Therefore, the results should be extrapolated cautiously for other cohorts. Secondly, we were unable to collect intraoperative hemodynamic data and, therefore, could not evaluate the relation between hemodynamic variables and end-organ damage. However, the strict intraoperative management of MBP and data collected on bleeding and fluid balance support the significance of cardiac output and tissue edema. Thirdly, we did not collect data on ICU and surgical ward follow-ups except for hsTnT and creatinine values. Fourthly, only creatinine criteria were used for the definition of AKI and urine output criteria were waived. Fifthly, although we used the latest guidelines for adopting the definition of PMI, it varies widely in literature.

CONCLUSION

Previous diagnosis of HT and swBP are not associated with POI occurrence. However, the presence of stage 2 or 3 piBP is an independent risk factor, alongside blood loss, fluid balance and chronic hsTnT elevation. Additionally, patients with elevated swBP exhibit a higher likelihood of developing stage 2 or 3 piBP.

AUTHOR CONTRIBUTIONS

Conception or design of the work: TA, HCG, IAE, IK, AA, FGO
Data collection: HCG, IAE, TA, IK
Data analysis and interpretation: TA, AA, FGO
Drafting the article: TA, HCG
Critical revision of the article: AA, FGO
The author (TA, HCG, IAE, IK, AA, FGO) reviewed the results and approved the final version of the manuscript.

REFERENCES

1. Halvorsen S, Mehilli J, Cassese S, et al; ESC Scientific Document Group. 2022 ESC Guidelines on cardiovascular assessment and management of patients undergoing non-cardiac surgery. Eur Heart J 2022;43(39):3826-924. Erratum in: Eur Heart J 2023;44(42):4421.
2. Howell SJ. Preoperative hypertension. Curr Anesthesiol Rep 2018;8(1):25-31.
3. Abdelmalak BB, Abd-Elsayed AA, Dalton JE, et al. The association between preinduction arterial blood pressure and postoperative cardiovascular, renal, and neurologic morbidity, and in-hospital mortality in elective noncardiac surgery: An observational study. J Hypertens 2018;36(11):2251-9.
4. Abdullah T, Gökduman HC, Enişte İA, et al. Mean arterial pressure versus cardiac index for haemodynamic management and myocardial injury after hepatopancreatic surgery: A randomised controlled trial. Eur J Anaesthesiol 2024;41(11):831-40.
5. Whitworth JA; World Health Organization, International Society of Hypertension Writing Group. 2003 World Health Organization (WHO)/International Society of Hypertension (ISH) statement on management of hypertension. J Hypertens 2003;21(11):1983-92.
6. Talmaç MA, Görgel MA, Birsel SE, Sönmez MM, Özdemir HM. The effect of single high-dose preoperative ıntravenous tranexamic acid administration to reduce blood loss in patients with primary total knee replacement. Sisli Etfal Hastan Tip Bul 2019;53(2):137-42.

7. Goren O, Matot I. Perioperative acute kidney injury. Br J Anaesth 2015;115(2):3-14.
8. Chang Y, Zhou M, Huang J, Wang Y, Shao J. Incidence and risk factors of postoperative acute myocardial injury in noncardiac patients: A systematic review and meta-analysis. PLoS One 2023;18(6):e0286431.
9. Wax DB, Porter SB, Lin HM, Hossain S, Reich DL. Association of preanesthesia hypertension with adverse outcomes. J Cardiothorac Vasc Anesth 2010;24(6):927-30.
10. Dix P, Howell S. Survey of cancellation rate of hypertensive patients undergoing anaesthesia and elective surgery. Br J Anaesth 2001;86(6):789-93.
11. Fujii T, Takakura M, Taniguchi T, Tamura T, Nishiwaki K. Intraoperative hypotension affects postoperative acute kidney injury depending on the invasiveness of abdominal surgery: A retrospective cohort study. Medicine (Baltimore) 2023;102(48):e36465.
12. Bartels K, Esper SA, Thiele RH. Blood Pressure monitoring for the anesthesiologist: A practical review. Anesth Analg 2016;122(6):1866-79.
13. Williams B, Mancia G, Spiering W, et al; ESC Scientific Document Group. 2018 ESC/ESH Guidelines for the management of arterial hypertension. Eur Heart J 2018;39(33):3021-104. Erratum in: Eur Heart J 2019;40(5):475.
14. Khwaja A. KDIGO clinical practice guidelines for acute kidney injury. Nephron Clin Pract 2012;120(4):179-84.
15. Lopez-Picado A, Albinarrate A, Barrachina B. Determination of perioperative blood loss: Accuracy or approximation? Anesth Analg 2017;125(1):280-6.
16. Coste J, Pouchot J. A grey zone for quantitative diagnostic and screening tests. Int J Epidemiol 2003;32(2):304-13.
17. Green SB. How many subjects does it take to do a regression analysis. Multivariate Behav Res 1991;26(3):499-510.
18. Zarbock A, Weiss R, Albert F, et al; EPIS-AKI Investigators. Epidemiology of surgery associated acute kidney injury (EPIS-AKI): A prospective international observational multi-center clinical study. Intensive Care Med 2023;49(12):1441-55.
19. Van Klei WA, van Waes JA, Pasma W, et al. Relationship between preoperative evaluation blood pressure and preinduction blood pressure: A cohort study in patients undergoing general anesthesia. Anesth Analg 2017;124(2):431-7.
20. Matthews KA, Katholi CR, McCreath H, et al. Blood pressure reactivity to psychological stress predicts hypertension in the CARDIA study. Circulation 2004;110(1):74-8.
21. Hong J, Chatila KF, John JJ, Thakker RA, Kassem H. Insight on the etiologies of chronically elevated troponin. Curr Probl Cardiol 2023;48(8):101204.
22. Young J, Lyngbakken MN, Hveem K, Røsjø H, Omland T. Systolic blood pressure, diastolic blood pressure and pulse pressure and the risk of subclinical myocardial injury: The HUNT study. J Am Heart Assoc 2024;13(9):e031107