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**Research Article**

# Anesthetic Insights: Navigating the Complexities of Hypertension in Elderly Surgical Patients

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## ABSTRACT

**Background:** Hypertension is a frequent finding in older surgical patients and can be a challenge during anesthetic management due to reduced cardiovascular reserve and heightened sensitivity to perioperative blood pressure changes in these patients. This study aimed to assess anesthetic factors and predictors of perioperative haemodynamic instability in elderly hypertensive patients.

**Methods:** A prospective observational analytical study was conducted among 200 hypertensive patients aged ≥65 years undergoing elective surgery. Patients were recruited through consecutive sampling. Demographic, hypertension-related, anesthetic, intra- and postoperative data were noted. Independent-samples t test, Mann–Whitney U test, chi-square/Fisher exact test, and multivariable logistic regression were used for data analyses.

**Results:** Hemodynamic instability occurred in 74 (37.0%) patients, of which 48 (24.0%) patients experienced intraoperative hypotension, and 38 (19.0%) patients experienced hypertension. Older patients and those with higher preoperative SBP and DBP, longer surgery, more blood loss, and longer hospital stays ($p<0.05$) were found in patients with instability. Independent predictors included age ≥75 years (AOR 1.98), ASA III (AOR 2.31), hypertension ≥10 years (AOR 2.08), SBP ≥160 mmHg (AOR 2.76), poor medication adherence (AOR 2.17), general anesthesia (AOR 2.54), and surgery >90 minutes (AOR 2.63).

**Conclusion:** Elderly hypertensive patients were highly vulnerable to perioperative haemodynamic changes. Carefully planned anesthesia and close blood-pressure supervision may enhance anesthetic safety.

**Keywords:** Hypertension, Elderly Patients, Anesthesia, Perioperative Hemodynamic Instability, Intraoperative Hypotension.

## INTRODUCTION

Hypertension is a common chronic cardiovascular disease in the world, and it is a particular problem for the aging population.[1] In 2024, the World Health Organization (WHO) estimated that around 1.4 billion adults were living with hypertension.[2] Importantly, only about 44% of the affected were not aware of their condition, and only around 23% had a blood pressure under control to a satisfactory degree. It is disproportionately high in LMICs, where around two-thirds of people living with hypertension are found. [3]

Higher blood pressure becomes significant at older ages.[4] Older persons are often on long-term antihypertensive therapy with an associated history of left ventricular hypertrophy, coronary artery disease, heart failure, chronic kidney disease, cerebrovascular disease, diabetes, and decreased vascular compliance.[5] The loss of physiological reserve with aging further compromises the ability to compensate for blood pressure, intravascular volume, cardiac output, and systemic vascular resistance (SVR) dynamics.[6] An elderly patient having surgery will therefore be at special risk of both hypertension and hypotension, and maintenance of the blood pressure within a normal range will be no easy matter, but rather a fine balance.[7] The WHO classifies older age as one of the key non-

modifiable factors contributing to hypertension, and highlights its relationship with key complications such as myocardial infarction, stroke, heart failure and renal damage.[8]
Hypertension poses a challenge from the point of assessment through recovery after anesthesia. If blood pressure is elevated, it can be due to chronic uncontrolled hypertension, pain, anxiety, poor adherence to medication or may be secondary to an underlying cause and cannot be safely controlled with surgery.[9] Laryngoscopy and intubation during induction of anesthesia can cause sudden increases in blood pressure and heart rate, while blood loss, vasodilation and neuraxial blockade can trigger clinically significant hypotension.[10] In addition, antihypertensive drugs may cause significant haemodynamic changes if they are interrupted or given at inappropriate times during the peroperative period.[11] New recommendations for perioperative management of patients with hypertension have been published in 2026 and highlight the need for personalised blood pressure measurement, threshold for delaying elective surgery, and careful perioperative management of antihypertensive therapy.[12]
In elderly surgical patients, hypertension is common, and its perioperative management is a clinically complex and multifaceted area of cardiovascular risk, anesthetic technique, drug management, and physiological sensitivity. Blood pressure that seems "normal" on its own can have different connotations when it occurs in an elderly person who has impaired autoregulation, coronary disease, renal dysfunction, or multiple medications. Therefore, it is crucial to recognize the effects of hypertension on anesthetic decision-making, intra- and post-anesthetic hemodynamic stability, and outcomes. In the present study, the anesthetic considerations and perioperative problems of hypertension in the elderly surgical patient will be examined with a focus on the pre-operative blood-pressure status, antihypertensive therapy, anesthetic management, intra-operative blood-pressure changes, and postoperative events.

## METHODOLOGY

The study was a prospective observational analytical study to assess anesthetic considerations and perioperative challenges of elderly patients with hypertension. The study was carried out in the Department of Anesthesia. The study was conducted over a period of six months, from August 2025 to February, 2026.
A sample size was determined using OpenEpi version 3.01 with a formula for estimating a single population proportion. This was based on the prevalence of perioperative hemodynamic instability reported in a previous study of elderly hypertensive surgical patients. A prevalence of around 42% was assumed for the sample size calculation.[13] The minimum sample size, calculated at a 95% confidence level and an absolute precision of 7%, was 179 patients. The final sample size was rounded to 200 patients, after accounting for 10% for incomplete data and potential losses in follow-up.
The non-probability consecutive sampling technique was used to recruit patients. All elderly patients presenting during the study period who met the sole criterion of being eligible were screened for eligibility, and those who met the predetermined eligibility criteria were consecutively included until the necessary number of patients was reached. Hypertensive patients, both male and female, age 65 years or older, with a prior diagnosis of hypertension and/or documented antihypertensive therapy, who were scheduled for elective surgery, were included. Patients were eligible who received general, regional, or combined anesthesia. Patients had to give informed consent to participate in the study.
Patients less than 65 years of age, those undergoing emergency surgery, and patients with severe pre-existing hemodynamic instability who required immediate intervention were excluded. All patients with uncontrolled acute cardiac diseases (acute myocardial infarction, acute decompensated heart failure, and unstable arrhythmias) were also excluded. Patients with severe cognitive impairment who could not be reliably assessed, those who could not provide relevant medical information, and those who did not have comprehensive information on their perioperative records were excluded. Patients who were undergoing interventions where continual intraoperative blood pressure monitoring was not feasible were also excluded.
A structured and pretested data-collection proforma was used for data collection. Demographic data such as sex, age, BMI, and past medical history were noted after obtaining informed written consent. Hypertension-related variables were duration of hypertension, baseline blood pressure before surgery, history of hypertension-related complications, number

and types of antihypertensive drugs, and compliance with antihypertensive treatment. Other comorbidities such as diabetes mellitus, ischemic heart disease, chronic kidney disease, cerebrovascular disease, and heart failure were also recorded. Preoperative assessment comprised blood pressure (systolic, diastolic, mean arterial pressure), heart rate, oxygen saturation, American Society of Anesthesiologists physical-status classification, laboratory and cardiac examinations.

The research team was responsible for collecting intraoperative data in a prospective manner. Documentation of the type of surgery, length of surgery, type of anesthesia, anesthetic agents, airway-management technique, intraoperative fluid administration, estimated blood loss, vasopressor requirement, and anesthetic technique were recorded. Baseline, post-induction, post-instrumentation, intraoperative intervals, and post-surgery were recorded for blood pressure and heart rate. Intraoperative episodes of high and low blood pressure (BP) were recorded based on the predetermined study criteria. Hemodynamic instability was deemed to be present if there were clinically significant variations from the patient's normal blood pressure that needed pharmacological or other therapeutic intervention.

Postoperative variables were evaluated at the time of recovery and, if applicable, within the first 24 hours after surgery. These were postoperative blood pressure, postoperative heart rate, need for antihypertensive or vasoactive therapy, postoperative pain, nausea and vomiting, cardiovascular complications, neurological complications, acute kidney injury, intensive care unit admission and hospital stay. Any change in the level of care following surgery that was not planned was also documented. Primary outcome included development of perioperative hemodynamic instability, and secondary outcomes included the presence of intraoperative hypertensive or hypotensive events, the need for vasopressor use, postoperative complications, and hospital stay.

The IBM SPSS Statistics version 26.0 software was used to enter and analyze all data collected. Shapiro–Wilk test was used to test the normality of continuous variables. Continuous variables were typically presented as mean ± SD, and non-normally distributed variables were presented as median with interquartile range (IQR). Categorical variables were described in terms of frequencies and percentages. An independent-samples t-test was used for continuous variables that were normally distributed, and the Mann–Whitney U test was used for variables that were not normally distributed, when comparing differences between the patients with and without perioperative hemodynamic instability. The chi-square test and Fisher's exact test were used to compare categorical variables.

Associations between demographic, clinical, hypertension-related, and anesthetic variables and perioperative hemodynamic instability were initially evaluated using univariable analysis. The variables with clinically relevant association and p-value <0.20 on univariable analysis were then considered for inclusion in a multivariable binary logistic regression model. Independent predictors of perioperative hemodynamic instability were determined by calculating adjusted odds ratios with 95% confidence intervals. The model adequacy was determined by the Hosmer–Lemeshow goodness-of-fit test. Two-tailed $P < 0.05$ was considered to be statistically significant. All analyses were conducted at a 95% confidence level.

## RESULTS

The study involved 200 elderly patients with hypertension who were undergoing elective surgery. The mean age of the study population was 71.8 ± 5.6 years, with 112 (56.0%) patients being male and 88 (44.0%) being female. The mean BMI was 26.1 ± 3.8 kg/m². The ASA classes of the majority of patients were class II (59.0%) and class III (41.0%). The most common anesthetic technique used was general anesthesia (54.0 %), followed by regional (38.0 %) and combined (8.0 %) anesthesia. Surgery took a mean of 78.4 ± 31.6 minutes. The basic demographic and perioperative data are summarized in Table 1.

The majority of patients had longstanding hypertension, with 121 (60.5%) reporting a duration of hypertension of ≥10 years. Antihypertensive treatment was received by most of the patients, but 42 (21.0%) said they were not taking their treatment regularly. The most common antihypertensive medications were calcium-channel blockers, then angiotensin receptor blockers, followed by beta-blockers. The most common comorbidities were diabetes mellitus and ischemic heart disease. The mean preoperative systolic and diastolic blood pressures were 148.6 ± 16.8 mmHg and 84.7 ± 9.6 mmHg, respectively (Table 2).

Clinically significant hemodynamic changes were observed during surgery in a large number of patients (intraoperative monitoring). Overall, 74 (37.0%) patients developed perioperative hemodynamic instability. There were 48 (24.0%) patients with intraoperative hypotension and 38 (19.0%) with intraoperative hypertension. The average systolic blood pressure was 148.6 ± 16.8 mmHg at the time of the operation, and dropped to 126.8 ± 15.2 mmHg after induction and then rose to 136.2 ± 14.6 mmHg at the end of the operation. The mean heart rate during the operation was 73.4 ± 9.8 bpm (Table 3).

A total of 52 (26.0%) patients had at least one complication postoperatively. The most common complications were postoperative hypotension (8.0%), nausea and vomiting (11.0%), and postoperative hypertension (14.0%). Cardiovascular complications were observed in 6.0% of patients, and 3.0% had neurological complications. Acute kidney injury developed in 4.0% of patients. The median length of hospital stay was 4 days (IQR 3–6) (Table 4).

Hemodynamic instability was significantly associated with higher preoperative systolic blood pressure, diastolic blood pressure, and mean arterial pressure in patients compared to those who were not hemodynamically unstable. They also underwent longer operations, needed more fluids during surgery, had more blood loss, and stayed in the hospital longer. There was no significant difference between the two groups in terms of BMI (Table 5).

All of the above parameters, including age ≥75 years, ASA III status, hypertension of ≥10 years duration, poor adherence to antihypertensive treatment, diabetes mellitus, ischemic heart disease, chronic kidney disease, cerebrovascular disease, vasopressor requirement, and postoperative ICU admission, were significant peri-operative hemodynamic instability risk factors. There was no significant association between sex and hemodynamic instability (Table 6).

Multivariable logistic regression identified age ≥75 years, ASA III status, hypertension for ≥10 years, SBP >160 mmHg before surgery, poor medication adherence for HT, general anesthesia and surgery lasting >90 minutes as independent predictors of perioperative hemodynamic instability. Preoperative systolic blood pressure ≥160 mmHg, prolonged surgery, and general anesthesia were the strongest independent factors. Sex, BMI, diabetes mellitus, chronic kidney disease, and ischemic heart disease still did not have a statistically significant difference after adjustment for other covariates.

Table 1. Demographic, clinical and operative characteristics of study participants (n=200)

| Variable | n(%)/Measn± SD |
|---|---|
| **Age (years)** | 71.8 ± 5.6 |
| Age 65–69 years | 58 (29.0%) |
| Age 70–74 years | 76 (38.0%) |
| Age ≥75 years | 66 (33.0%) |
| **Sex** | |
| Male | 112 (56.0%) |
| Female | 88 (44.0%) |
| **BMI (kg/m²)** | 26.1 ± 3.8 |
| BMI <18.5 kg/m² | 12 (6.0%) |
| BMI 18.5–24.9 kg/m² | 76 (38.0%) |
| BMI 25.0–29.9 kg/m² | 80 (40.0%) |
| BMI ≥30 kg/m² | 32 (16.0%) |
| **ASA physical status** | |
| ASA II | 118 (59.0%) |
| ASA III | 82 (41.0%) |
| **Type of surgery** | |
| General surgery | 58 (29.0%) |
| Orthopedic surgery | 52 (26.0%) |
| Urological surgery | 36 (18.0%) |
| Gynecological surgery | 24 (12.0%) |
| Other elective procedures | 30 (15.0%) |
| **Type of anesthesia** | |

| | |
|---|---|
| General | 108 (54.0%) |
| Regional | 76 (38.0%) |
| Combined | 16 (8.0%) |
| **Duration of surgery (min)** | 78.4 ± 31.6 |
| **Estimated blood loss (mL), median (IQR)** | 150 (100–250) |
| **Preoperative heart rate (beats/min)** | 76.8 ± 10.4 |

Table 2. Hypertension-related characteristics and comorbidities

| Variable | n(%)/Measn± SD |
|---|---|
| **Duration of hypertension** | |
| <5 years | 32 (16.0%) |
| 5–9 years | 47 (23.5%) |
| ≥10 years | 121 (60.5%) |
| **Preoperative SBP (mmHg)** | 148.6 ± 16.8 |
| **Preoperative DBP (mmHg)** | 84.7 ± 9.6 |
| **Mean arterial pressure (mmHg)** | 106.0 ± 10.3 |
| **Antihypertensive treatment** | |
| Calcium-channel blocker | 82 (41.0%) |
| ACE inhibitor/ARB | 76 (38.0%) |
| Beta-blocker | 54 (27.0%) |
| Diuretic | 48 (24.0%) |
| Other antihypertensive | 22 (11.0%) |
| ≥2 antihypertensive agents | 96 (48.0%) |
| **Medication adherence** | |
| Good | 158 (79.0%) |
| Poor | 42 (21.0%) |
| **Comorbidities** | |
| Diabetes mellitus | 72 (36.0%) |
| Ischemic heart disease | 48 (24.0%) |
| Chronic kidney disease | 28 (14.0%) |
| Cerebrovascular disease | 20 (10.0%) |
| Heart failure | 16 (8.0%) |
| Any hypertensive target-organ complication | 74 (37.0%) |

Table 3. Intraoperative anesthetic and hemodynamic characteristics

| Variable | n(%) Mean± SD |
|---|---|
| **Anesthetic technique** | |
| General anesthesia | 108 (54.0%) |
| Regional anesthesia | 76 (38.0%) |
| Combined anesthesia | 16 (8.0%) |
| **Airway management in general anesthesia (n=108)** | |
| Endotracheal intubation | 92 (85.2%) |
| Supraglottic airway | 16 (14.8%) |
| **Pre-induction SBP (mmHg)** | 148.6 ± 16.8 |
| SBP after induction (mmHg) | 126.8 ± 15.2 |
| SBP at end of surgery (mmHg) | 136.2 ± 14.6 |
| **Intraoperative DBP (mmHg)** | 72.8 ± 8.7 |
| **Intraoperative MAP (mmHg)** | 92.6 ± 9.4 |
| **Intraoperative HR (beats/min)** | 73.4 ± 9.8 |
| Intraoperative hypotension | 48 (24.0%) |
| Intraoperative hypertension | 38 (19.0%) |
| Hemodynamic instability | 74 (37.0%) |
| Vasopressor requirement | 46 (23.0%) |
| Additional antihypertensive treatment | 28 (14.0%) |
| Intraoperative fluid administration (mL) | 1260 ± 420 |

| | |
|---|---|
| Estimated blood loss (mL), median (IQR) | 150 (100–250) |
| Intraoperative cardiovascular event | 12 (6.0%) |

Table 4. Postoperative outcomes and complications

| Variable | n(%) Mean± SD |
|---|---|
| Postoperative SBP (mmHg) | 139.8 ± 15.8 |
| Postoperative DBP (mmHg) | 78.6 ± 8.9 |
| Postoperative HR (beats/min) | 76.2 ± 9.7 |
| Postoperative hypertension | 28 (14.0%) |
| Persistent postoperative hypotension | 16 (8.0%) |
| Postoperative pain requiring additional analgesia | 38 (19.0%) |
| Nausea/vomiting | 22 (11.0%) |
| Cardiovascular complications | 12 (6.0%) |
| Neurological complications | 6 (3.0%) |
| Acute kidney injury | 8 (4.0%) |
| Unplanned escalation of care | 14 (7.0%) |
| ICU admission | 22 (11.0%) |
| **Any postoperative complication** | 52 (26.0%) |
| Hospital stay, median (IQR), days | 4 (3–6) |

Table 5. Comparison of continuous variables according to perioperative hemodynamic instability

| Variable | Hemodynamic instability (n=74) Mean± SD/Median (IQR) | No instability (n=126) Mean± SD/Median (IQR) | p-value |
|---|---|---|---|
| Age (years) | 73.2 ± 5.8 | 71.0 ± 5.2 | 0.006 |
| BMI (kg/m²) | 25.6 ± 3.7 | 26.4 ± 3.8 | 0.141 |
| Preoperative SBP (mmHg) | 155.2 ± 17.4 | 144.7 ± 14.8 | <0.001 |
| Preoperative DBP (mmHg) | 86.8 ± 10.1 | 83.5 ± 9.1 | 0.017 |
| Preoperative MAP (mmHg) | 109.6 ± 10.9 | 103.9 ± 9.4 | <0.001 |
| Duration of surgery (min) | 91.6 ± 34.8 | 70.7 ± 27.1 | <0.001 |
| Intraoperative fluid (mL) | 1380 ± 460 | 1190 ± 380 | 0.002 |
| Hospital stay, days | 5 (4–7) | 4 (3–5) | <0.001 |
| Estimated blood loss, mL, | 200 (125–300) | 125 (75–200) | <0.001 |

Table 6. Association between categorical variables and perioperative hemodynamic instability

| Variable | Hemodynamic instability n (%) | No instability n (%) | p value |
|---|---|---|---|
| **Age ≥75 years** | 34 (45.9%) | 32 (25.4%) | 0.003 |
| Age 65–74 years | 40 (54.1%) | 94 (74.6%) | |
| **Male sex** | 46 (62.2%) | 66 (52.4%) | 0.184 |
| Female sex | 28 (37.8%) | 60 (47.6%) | |
| **ASA III** | 42 (56.8%) | 40 (31.7%) | 0.001 |
| ASA II | 32 (43.2%) | 86 (68.3%) | |
| **Hypertension ≥10 years** | 56 (75.7%) | 65 (51.6%) | 0.001 |
| Hypertension <10 years | 18 (24.3%) | 61 (48.4%) | |
| **Poor medication adherence** | 24 (32.4%) | 18 (14.3%) | 0.002 |
| Good adherence | 50 (67.6%) | 108 (85.7%) | |
| **Diabetes mellitus** | 34 (45.9%) | 38 (30.2%) | 0.027 |
| No diabetes | 40 (54.1%) | 88 (69.8%) | |
| **Ischemic heart disease** | 26 (35.1%) | 22 (17.5%) | 0.003 |

| | | | |
|---|---|---|---|
| No IHD | 48 (64.9%) | 104 (82.5%) | |
| **Chronic kidney disease** | 16 (21.6%) | 12 (9.5%) | 0.021 |
| No CKD | 58 (78.4%) | 114 (90.5%) | |
| **Cerebrovascular disease** | 12 (16.2%) | 8 (6.3%) | 0.031 |
| No cerebrovascular disease | 62 (83.8%) | 118 (93.7%) | |
| **General anesthesia** | 52 (70.3%) | 56 (44.4%) | 0.001 |
| Regional/combined anesthesia | 22 (29.7%) | 70 (55.6%) | |
| **Vasopressor requirement** | 36 (48.6%) | 10 (7.9%) | <0.001 |
| No vasopressor | 38 (51.4%) | 116 (92.1%) | |
| **ICU admission** | 18 (24.3%) | 4 (3.2%) | <0.001 |
| No ICU admission | 56 (75.7%) | 122 (96.8%) | |

Table 7. Multivariable logistic regression analysis of predictors of perioperative hemodynamic instability

| Predictor | Adjusted OR | 95% CI | p value |
|---|---|---|---|
| Age ≥75 years | 1.98 | 1.05–3.73 | 0.035 |
| Male sex | 1.21 | 0.66–2.22 | 0.536 |
| BMI <25 kg/m² | 1.18 | 0.65–2.15 | 0.590 |
| ASA III | 2.31 | 1.23–4.34 | 0.009 |
| Hypertension ≥10 years | 2.08 | 1.08–4.01 | 0.029 |
| Preoperative SBP ≥160 mmHg | 2.76 | 1.43–5.31 | 0.002 |
| Poor antihypertensive adherence | 2.17 | 1.04–4.54 | 0.039 |
| Diabetes mellitus | 1.42 | 0.77–2.62 | 0.257 |
| Ischemic heart disease | 1.89 | 0.94–3.79 | 0.073 |
| Chronic kidney disease | 1.67 | 0.72–3.88 | 0.234 |
| General anesthesia | 2.54 | 1.32–4.88 | 0.005 |
| Duration of surgery >90 min | 2.63 | 1.39–4.98 | 0.003 |
| Estimated blood loss >200 mL | 1.92 | 0.98–3.76 | 0.058 |

## DISCUSSION

In the present study, 200 elderly surgical patients were evaluated with respect to the anesthetic problems of hypertension, and 37.0% of patients were found to be hemodynamically unstable in the perioperative period. Intraoperative hypotension (24.0%), intraoperative hypertension (19.0%), and 23.0% needed vasopressor support. Patients who experienced hemodynamic instability were older, had higher levels of preoperative SBP, DIA, duration of hypertension, ASA physical status classification, surgical duration, blood loss, and postoperative hospitalization. Importantly, multivariable analysis results showed that age ≥75 years, ASA III status, hypertension duration ≥10 years, preoperative SBP ≥160 mmHg, poor antihypertensive adherence, general anesthesia, and surgical duration >90 minutes were independent factors for hemodynamic instability. This confirmed the idea that perioperative hypertension in elderly patients should not just be viewed as a high blood-pressure reading, but as an index of diminished physiological reserve and sensitivity to the rapid blood-pressure changes that occur during anesthesia.

The present study found that 37.0% of patients experienced perioperative hemodynamic instability, which was generally similar to the prevalence reported in much of the current literature, which indicates that hemodynamic disturbances are common among older surgical patients. In a retrospective study of patients over 65 undergoing noncardiac surgery, Zhao et al. (2021) found that intraoperative hypotension, specifically a MAP of 60 to 65 mmHg, was a significant risk factor for mortality after surgery. Their analysis also revealed that important risk factors for death after surgery are ASA grade and general anesthesia.[14] The clinical concordance of our results with their finding, of more than 2-fold for ASA III status alone to increase risk of hemodynamic instability, supports our results that the contribution of increased systemic disease burden is significant in elderly patients.

The association between the presence or lack of preoperative hypertension with subsequent hypotension was especially intriguing. The mean preoperative SBP (155.2 vs. 144.7 mmHg) and DBP (86.8 vs. 83.5 mmHg) were significantly higher in the hemodynamic instability group of patients than in the stable group, and SBP ≥160 mmHg was an independent predictor after adjustment. This seemingly paradoxical phenomenon of increasing pressure before and decreasing pressure during surgery has also been reported by Sutthibenjakul and Chatmongkolchart (2022). While the degree of hypertension on admission to the operating room was significantly associated with post-induction hypotension, use of diuretics before the induction and higher doses of fentanyl were also associated with hypotension in this study of 580 elderly patients.[15] Our results confirmed this, and suggested that a high pre-induction blood pressure does not necessarily represent hemodynamic instability, but rather may represent an extreme sensitivity of the cardiovascular system to the vasodilatory and sympatholytic effects of anesthetic induction.

An interesting association was observed between the technique of anesthesia and hemodynamic instability. The proportion of patients who developed instability receiving general anesthesia was higher in our study compared with those who did not develop instability (70.3% vs. 44.4%) and remained higher after multivariable adjustment (AOR 2.54, 95% CI 1.32–4.88; p=0.005). This result is in agreement with the results obtained by Zhao et al., in which they demonstrated general anesthesia to be a risk factor for postoperative mortality in older surgical patients.[14] In turn, a randomized controlled trial of elderly patients undergoing robot-assisted laparoscopic prostatectomy, conducted by Park et al (2023), focused specifically on the problem of post-induction hypotension and showed that this issue is common enough to require some preventive measures like pneumatic leg compression. The findings highlighted the need for a well-titrated induction of general anaesthetic, for volume assessment, for vigilant monitoring of blood pressure, and early recognition and treatment of hypotension in geriatric patients.[16]

The present study also showed that surgery time was an important factor contributing to hemodynamic instability. Unstable patients had a significantly longer mean operative duration (91.6 vs. 70.7 minutes), and surgery of >90 minutes was an independent predictor (AOR 2.63, 95% CI 1.39–4.98; p=0.003). These results were similar to those of Czajka et al. (2023), who compared various stages of hypotension in patients undergoing abdominal surgery. They found that longer procedures correlated with the composite adverse outcome, and that MAP ≤65 mmHg, chronic hypertension, age of the patient, and procedures that lasted ≥230 minutes were independently associated with that adverse outcome. In addition, their results have shown that hypotension after induction of anesthesia and hypotension during surgery may be different entities. In our study, we demonstrated that the increased risk of hemodynamic instability with anesthesia and surgical stress may be cumulative in elderly patients with hypertension.[17]

The proportion of patients who developed intraoperative hypotension (24.0%) was also comparable with recent studies. In a study by Ariyarathna et al., 25.7% of elderly patients who were undergoing elective noncardiac surgery experienced systolic hypotension and 11.9% experienced hypotension defined by MAP. In this study, Ariyarathna et al. looked at 830 elderly patients who had undergone elective noncardiac surgery and found that 25.7% of them had systolic hypotension, while 11.9% had MAP-defined hypotension. They also showed that sustained systolic hypotension was linked with postoperative AKI and that cumulative vasopressor exposure was an independent risk factor for AKI. Our study did not use AKI as the primary endpoint, but, in our patients, there was a 4.0% AKI rate and an increased requirement for vasopressors among unstable patients, similar to what was observed in the general population of patients undergoing cardiac surgery that intraoperative circulatory disturbances may lead to clinically important postoperative organ complications.[18]

The clinical significance of preventing intraoperative hypotension was reinforced by Chen et al. (2024), who looked at data from three clinical trials that randomized older patients for major noncardiac surgery. Their analysis showed that a patient with intraoperative hypotension had worse long-term survival. This was especially important for us since advanced age and chronic hypertension might affect vascular autoregulation, and a seemingly modest drop in blood pressure could have more impact in patients with chronic hypertension. The magnitude of the fluctuation in blood pressure in the immediate peri-induction period was evident in our study, as the mean systolic pressure (126.8 ± 15.2 mmHg) was significantly lower than the pre-induction pressure (148.6 ± 16.8 mmHg) in the patients with instability. Based on these findings, a non-numerical, individualized management of blood pressure during surgery was suggested in elderly patients with hypertension.[19]

The significance of recognizing older patients for post-induction hypotension has increased with more recent data. In the prospective cohort of 938 elderly patients, Bian et al. (2025) found post-induction hypotension occurred in 51.6% of the development cohort and 50.5% of the validation cohort. The prediction model they developed included the following important predictors: cardiac function, baseline ward MAP, pre-induction MAP, and anesthetic factors. Our overall rate of hemodynamic instability was less than 37.0%, as there were several types of instability included in our endpoint and not limited to the first 15 minutes after induction. However, both studies showed that a blood pressure assessment performed before induction and an assessment of the baseline blood pressure were important to understanding peri-induction instability.[20]

Our findings also corroborated the growing importance of proactive hemodynamic management of surgical patients in the elderly population. Ollaek et al (2026) evaluated 85 elderly patients and found 44.7% of patients had post-induction hypotension. The pleth variability index was independently associated with post-induction hypotension with an AUC of 0.78. This finding is significant in the context of our study because it suggests that although the patient's pre-operative blood pressure can be used to estimate intravascular volume status or cardiovascular reserve, it is not enough to do so. Therefore, the addition of other non-invasive parameters reflecting the hemodynamic vulnerability may further facilitate the identification of elderly hypertensive patients who are especially at risk for hypotension post-induction, and allow for preventive management before severe hypotension occurs.[21]

Finally, the post-operative results of our study further confirmed that the impact of peri-operative haemodynamic instability was not confined to the operating room. In all, 26.0% of patients had at least one postoperative complication, 11.0% were admitted to the ICU, and the hospital stay was significantly longer in patients with hemodynamic instability (median of 5 days) than in stable patients (4 days). The results of this study corroborated those of the study conducted by Zhang et al. (2025) that analyzed over 48,000 older adults who underwent noncardiac surgery and determined that hypotension defined as MAP <70 mmHg during the surgery was correlated with major adverse cardiac events, with the risk growing as the duration of hypotension increased beyond 15 minutes. Both severity and duration of hypotension were shown to be clinically relevant by their findings. In line with this, our results also showed that perioperative instability did not just represent a short-term anesthetic event but was also linked to greater resource consumption and morbidity after surgery.[22]

The final finding of 14.0% of patients experiencing a postoperative increase in blood pressure was in line with the growing evidence that blood-pressure control is still a critical part of emergence and recovery from anesthesia. In the study of Jiao et al. (2026), unanticipated hypertension upon emergence occurred in 25.2% of elderly patients (N=840). Patients who had advanced age, lacked antihypertensive drugs, had intraoperative hypertension, postoperative pain, agitation, and orthopedic surgery were independently associated with postoperative hypertension, with affected patients having longer PACU stay and delayed extubation times. Both studies, despite the different definition of population and outcome, showed that blood-pressure instability may last beyond the immediate surgery. This pointed out the need for resumption of antihypertensive treatment when clinically indicated, pain and agitation management, and continued intensive haemodynamic monitoring during recovery.[23]

The actual significance of these results was that anaesthetic administration of older patients with hypertension should not just be concerned with reaching one satisfactory blood pressure on preoperative evaluation. The hypertension duration, compliance with the medication, target-organ disease, ASA status, baseline hemodynamics, expected duration of the surgery, and anesthetic technique should be carefully considered to identify the high-risk patients sooner. Perioperative precautions such as gentle induction, individual fluid and vasopressor management, frequent or continuous blood pressure monitoring, preventing prolonged hypotension, providing adequate analgesia, and early postoperative initiation of antihypertensive therapy can all help to minimize perioperative complications. So the anesthetic challenge was not just to bring a high blood pressure down, but to keep perfusion levels to the myocardium, brain, and kidneys in a range that is individualized to the patient and normal throughout the perioperative period.

### Limitations

This study was limited in a number of aspects. First, it was carried out in just a single tertiary-care center, and the results may not be generalizable to other hospitals or healthcare settings. Non-probability consecutive sampling is also a potential source of selection bias. This was an observational study, and causal links between the factors associated with hypertension and perioperative instability were not determined. The low number of patients included (200) might have reduced the power to detect associations for less common complications. In addition, the study only recruited patients over the age of 60 who were in elective surgery, which means results might not apply to younger patients or those who were in emergency surgery. Hemodynamic outcomes may have been affected by differences in surgical procedure, anesthetic techniques, anesthetic agents, fluid management, and anesthesist practices. Last, adherence to medication and some clinical variables were based on patient history and/or medical records, and may have been subject to reporting or documentation bias.

## CONCLUSION

Surgical patients with hypertension aged >60 years had significant perioperative hemodynamic problems. Hemodynamic instability was observed in over 33% of the patients, including both hypotension and hypertension. The presence of ASA III, poor medication adherence for hypertension, general anesthesia, surgery duration, and advanced age were independent risk factors for hemodynamic instability. The results highlighted the need for careful assessment of the individual patient before surgery, planning the anesthetic regimen, monitoring blood pressure during the procedure, intervening in a timely manner, and postoperative monitoring of blood pressure with a structured approach in older patients with hypertension. Early recognition of high-risk patients may decrease hemodynamic complications and enhance perioperative results.

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