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The Effect of Different Anesthetic Techniques on Patients with Hypertension Undergoing Surgery at the Bamenda Regional Hospital: A Prospective Quantitative Cohort Study

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1. Abstract

1.1. Background

Even though general anesthetics often cause hypotension, patients with hypertension may exhibit significant increases in heart rate and blood pressure during the induction of general anesthesia (GA). In this study, we aimed to assess the effects of general and spinal anesthetic techniques on blood pressure, heart rate variability, and hemodynamic factors in patients with hypertension undergoing surgery at the Bamenda Regional Hospital, Cameroon.

1.2. Methods

We conducted a prospective quantitative cohort study at the Bamenda Regional Hospital from April to June 2025. We used a semi-structured questionnaire to collect participants' demographic data, medical history, and medication usage. Additionally, systolic blood pressure (SBP), diastolic blood pressures (DBP), and heart rate (HR) were recorded using a standard monitoring scope before and after surgery. The data was analyzed using SPSS version 27. An independent sample t-test was used to determine the relationship between variables. Statistical significance was set at $P < 0.05$.

1.3. Results

Of the 86 participants, patients under general anesthesia had significantly higher estimated marginal means (3.391) compared to that of those who received spinal anesthesia (SA) (2.172), with a mean difference of 1.219 ($p < 0.001$). The SA group had higher pre-induction SBP, DBP, and HR. Patients who received GA consistently exhibited significantly higher intraoperative SBP, DBP, and HR at all-time points (T0–T4). Among those who received GA, 14.0%, 20.9%, and 15.1% reported mild, moderate, and severe pain, respectively. Similarly, among those who received SA, 15.1%, 22.1%, and 12.8% reported mild, moderate, and severe pain, respectively.

1.4. Conclusion

SA was more effective than GA in controlling intraoperative blood pressure and maintaining hemodynamic stability in patients with hypertension undergoing surgery. SA may be a better option for patients with hypertension undergoing surgery to optimize intraoperative blood pressure control. Additionally, standardized postoperative protocols can ensure consistent recovery outcomes.

2. Introduction

The World Health Organization defines hypertension (HTN) as a blood pressure reading of ≥ 140/90 mmHg [1]. HTN is a major global public health problem. It was predicted that the population of adults with HTN would increase to 1.56 billion by 2025 [2]. Presently, HTN accounts for about 7.5 million deaths (12.8% of all annual deaths) worldwide, as it is one of the major risk factors for coronary events, heart failure, stroke, chronic kidney disease, peripheral arterial disease, dissecting aneurysm, and mortality [3].

Approximately 75 million people are affected by HTN in Sub-Saharan Africa. There are high rates of critical incidents and mortality related to anesthesia in low-and middle-income countries compared to that in high-income countries [4]. These challenges are more frequent during the perioperative period, leading to a higher risk of cardiovascular complications. General anesthesia (GA) is usually administered in surgeries that involve middle-aged and older-adult patients. The depth of GA and other anesthetics influence cardiovascular stability and hemodynamic variations during the perioperative period [5]. The heart rate (HR) is a valuable tool for the assessment of the autonomic nervous system's regulations and cardiovascular function [5]. Surgical nociceptive stimulation has a reproducible effect on HR variability [6], which is usually nullified by adequate analgesia.

In Cameroon, HTN is a major public health concern, mostly affecting adults. Cameroon faces significant challenges in the management of HTN, including limited access to healthcare, insufficient healthcare provider training, and inadequate blood pressure monitoring. These challenges are more pronounced during the perioperative period, increasing the risk of cardiovascular complications. Specifically, there is a lack of standardized protocols for the management of perioperative blood pressure in patients with HTN. In this study, to identify the most effective anesthetic techniques for controlling blood pressure in these patients, we aimed to assess the effect of the use of different anesthetic techniques on patients with HTN undergoing surgery at the Bamenda regional hospital. This will help improve surgical outcomes and reduce the risk of intraoperative and postoperative complications.

3. Materials and Methods

3.1. Study Design

This was a prospective study. This design was chosen because it allows for data collection over a short period of time, making it feasible within a limited time frame. Further, it gives insight into the effectiveness of different anesthetic techniques and is easier to implement.

3.2. Study Population

The study involved 86 adult patients with HTN scheduled for surgical procedures requiring anesthesia at the Bamenda Regional Hospital. Of these, we included patients aged ≥ 21 years with a documented diagnosis of HTN. Patients with acute hypertensive crises, secondary HTN, or those undergoing emergency surgical procedures were excluded.

3.3. Variables

Dependent variables were systolic blood pressure (SBP), diastolic blood pressure (DBP), HR, and mean arterial pressure. The independent variables comprised GA and spinal anesthesia (SA).

3.4. Data Analysis

All data were collected prospectively using structured data collection tools. Data analysis was conducted using SPSS version 27. Descriptive statistics were used to summarize the data. Categorical variables are presented as frequencies and percentages. Continuous variables are presented as means and standard deviations. Independent sample t-test was used to compare mean hemodynamic parameters (SBP, DBP, and HR, which were measured using a standardized scope) between the GA and SA groups at each time point. Repeated-measures analysis of variance was employed to assess changes in hemodynamic stability over time within each anesthesia group. The chi-square test was used to examine the association between anesthesia type and postoperative pain severity (mild/moderate/severe). Graphical representations, including line graphs, were used to illustrate the trends in estimated marginal means for SBP, DBP, and HR across time points, between the various anesthesia types. Statistical significance was set at $P < 0.05$.

3.5. Ethical Consideration

The study design was approved by the Institutional Review Board of the Faculty of Health Sciences, University of Buea. Authorizations were obtained from the Regional Delegation of Public Health, Northwest Region, Cameroon, and the Bamenda Regional Hospital where the research. Informed consent was obtained from all participants.

4. Results

4.1. Sociodemographic Data

The participants' sociodemographic and clinical characteristics are shown in Table 1. Most participants were aged ≥ 66 years (27, 31.4%). The least represented age group was 26–35 years (10, 11.6%). There were more female participants (62, 72.1%) than male participants (24, 27.9%). Regarding the duration of HTN, 43 (50.0%) participants had been living with HTN for ≥ 10 years, whereas 18 (20.9%) had been living with it for 1−3 years. Most participants had no comorbidity (60, 69.8%), whereas 21 (24.4%) and 5 (5.8%) had diabetes and heart failure, respectively. Regarding anti-hypertensive medications, nearly half of the participants (40, 46.5%) used angiotensin-converting enzyme (ACE) inhibitors, while 25 (29.1%) reported using no drugs. Some surgeries were gynecologic (n = [36 41.9%]) or neurosurgical (18.6%). An equal number of patients received either anesthesia type (43, 50.0%).

Table 1: Participants' sociodemographic and clinical characteristics.

Variable	**Category**	**Frequency**	**Percent (%)**
Age (years)	26−35	10	11.6
	36−45	15	17.4
	46−55	14	16.3
	56−65	20	23.3
	≥ 66	27	31.4
Sex	Male	24	27.9
	Female	62	72.1
Duration of HTN (years)	1−3	18	20.9

	4–9	25	29.1
	≥ 10	43	50.0
Comorbidity	Diabetes	21	24.4
	Heart failure	5	5.8
	None	60	69.8
Antihypertensive drug	Calcium Channel Blockers	21	24.4
	ACE inhibitors	40	46.5
	None	25	29.1
Surgery type	Neurosurgery	16	18.6
	Gynaecologic	36	41.9
	Urologic	14	16.3
	Trauma	5	5.8
	Orthopaedic	15	17.4
Anesthesia type	General anesthesia	43	50.0
	Spinal anesthesia	43	50.0
Total		**86**	**100**

HTN, hypertension; ACE, Angiotensin-converting enzyme.

Comparison of the Effectiveness of Different Anesthetic Techniques in Controlling BP in Patients with HTN Undergoing Surgery SA provided significantly better intraoperative control of blood pressure in this study. Although the SA group had higher pre-induction SBP, DBP, and HR, patients who received GA significantly exhibited consistently higher intraoperative SBP, DBP, and HR at all time points (T0, 15 min–T4, 60 min) ($P < 0.001$). These differences increased progressively during surgery; the coded values were 1−1.7 units higher in GA patients than in SA patients. This suggests that SA leads to more stable and lower intraoperative hemodynamic parameters, making it a safer and more effective option for managing HTN during surgery (Table 2).

Table 2: The mean hemodynamic parameters of patients with HTN undergoing surgery according to anesthetic technique.

Time Point	GA Mean (SD)	SA Mean (SD)	t-value	P value	Mean Difference (GA−SA)
Systolic Blood Pressure (SBP)					
T0 (Pre-induction)	3.37 (0.49)	2.53 (0.51)	7.81	< 0.001	**+0.837**
T1 post induction (15 min)	3.47 (0.51)	2.51 (0.51)	8.75	< 0.001	**+0.953**
T2 (30 min)	3.42 (0.50)	2.02 (0.74)	10.25	< 0.001	**+1.395**
T3 (45 min)	3.51 (0.51)	2.05 (0.65)	11.63	< 0.001	**+1.465**
T4 (60 min)	3.37 (0.49)	1.77 (0.78)	11.41	< 0.001	**+1.605**
Diastolic Blood Pressure (DBP)					
T0 (Pre-induction)	3.40 (0.50)	2.49 (0.51)	8.41	< 0.001	**+0.907**
T1 (15 min)	3.28 (0.45)	2.49 (0.51)	7.63	0.001	**+0.791**
T2 (30 min)	3.23 (0.43)	1.56 (0.50)	16.64	< 0.001	**+1.674**
T3 (45 min)	3.33 (0.47)	1.63 (0.49)	16.34	< 0.001	**+1.698**
T4 (60 min)	3.30 (0.47)	1.56 (0.50)	16.71	< 0.001	**+1.744**

GA, general anesthesia; SA, spinal anesthesia; SD, standard deviation.

The Effects of Different Anesthetic Techniques on Hemodynamic Stability, Blood Pressure Variability, and Heart Rate in Patients with HTN Undergoing Surgery. There was a significant difference in hemodynamic stability between the GA and SA groups. The GA group had significantly higher estimated marginal means (3.391) than the SA group (2.172), with a mean difference of 1.219 ($P < 0.001$). This difference was significant, with a large effect size (partial eta squared = 0.830). There was a general decline in marginal mean scores over time, especially in the SA group where the means dropped from 2.535 at Time 1 to 1.767 at Time 5 (Figure 1). Conversely, GA scores remained consistently higher throughout (3.279¬–3.512).

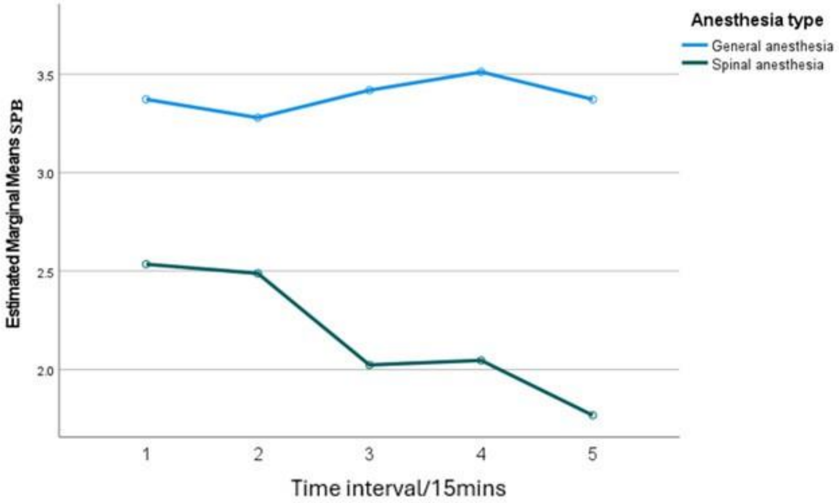

Figure 1: Effect of anesthetic technique on hemodynamic stability.

Patients who received GA had a mean DBP of 3.05, which was significantly higher than that of those who received SA (2.21). This resulted in a significant mean difference of 0.842 (P < 0.001) (Figure 2) and a large effect size (partial Eta squared = 0.767). Patients who received GA had a significantly higher mean HR (3.321) than those who received SA (2.256), with a mean difference of 1.065 (P < 0.001). HR varied over time, starting at a mean of 2.988 at Time 1, dropping to 2.570 at Time 4, and slightly rising to 2.884 at Time 5. Patients under GA consistently had higher HRs across all time points, peaking at 3.512 (Time 3) and falling to 2.837 (Time 5); those under SA generally had lower values (Figure 3).

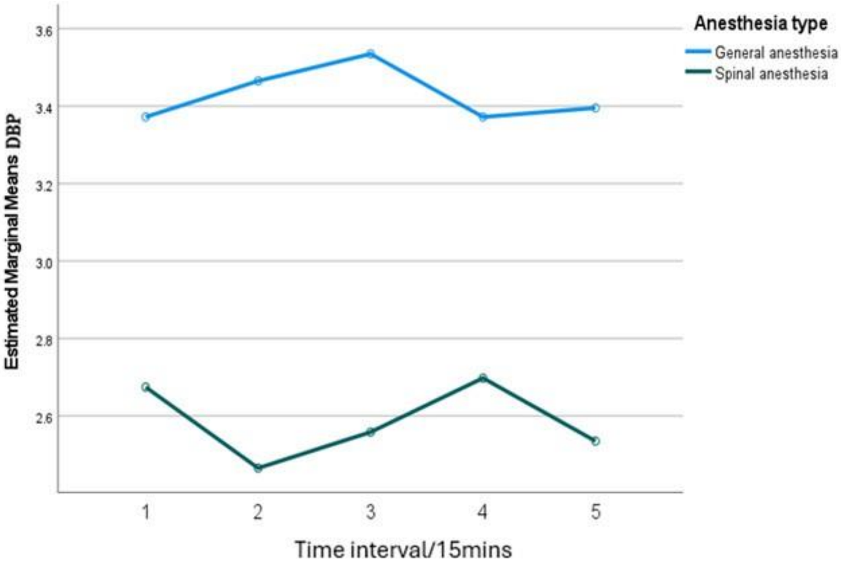

Figure 2: Effect of anesthetic technique on blood pressure variability with time.

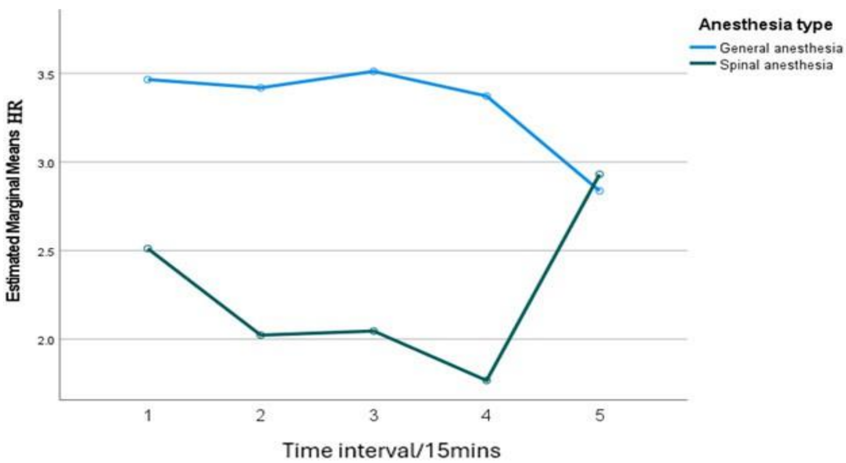

Figure 3: Effect of anesthetic technique on heart rate.

4.2. The Effect of The Anesthetic Technique on Post Operative Pain and Hemodynamic Stability

The independent sample t-test results indicated no significant differences in postoperative SBP, DBP, or HR between the GA and SA groups across all time points (T1 5 min–T3 15 min) (Table 3).

Table 3: Effect of anesthetic technique on postoperative pain and hemodynamic stability.

Vital Sign	Time (min)	Mean	Difference	P value	95% CI
Systolic BP					
	5	123.5	+3.5	0.038	0.18−6.82
	10	121.2	+1.2	0.502	−2.31−4.71
	15	119.9	−0.1	0.952	−3.25−3.05
Diastolic BP					
	5	78.1	−1.9	0.076	−3.98−0.18
	10	79.3	−0.7	0.521	−2.89−1.49
	15	77.5	**−2.5**	**0.015**	−4.53−-0.47
HR					
	5	85.6	**+5.6**	**< 0.001**	2.88−8.32
	10	83.1	**+3.1**	**0.017**	0.54−5.66
	15	82.8	+2.8	0.051	−0.03−5.63

BP, blood pressure; CI, confidence interval; HR, heart rate.

4.3. Anesthesia type Pain Score Cross Tabulation

Pain severity was similarly distributed between the GA and SA. Among those who received GA, 14.0%, 20.9%, and 15.1 reported mild, moderate, and severe pain, respectively. In the SA group, 15.1%, 22.1%, and 12.8% reported mild, moderate, and severe pain, respectively. There was no significant association between anesthesia type and postoperative pain intensity (χ^2 = 0.234, df = 2, P = 0.890). This suggests that patients' reported pain levels after surgery were not influenced by the anesthetic technique.

Table 4: Anesthesia type against pain score cross tabulation.

Anesthesia type	Mild	Moderate	Severe	Total	χ^2 Value	P-Value
General anesthesia	12 (14.0%)	18 (20.9%)	13 (15.1%)	43 (50.0%)	0.22	0.890
Spinal anesthesia	13 (15.1%)	19 (22.1%)	11 (12.8%)	43 (50.0%)		
Total	**25 (29.1%)**	**37 (43.0%)**	**24 (27.9%)**	**86 (100.0%)**		

5. Discussion

5.1. Demographic Characteristics of Patients with HTN

In our study, 27 participants were aged ≥ 66 years, accounting for 31.4% of the population, while the 26–35 years age group had the least representation, with only 10 (11.6%) participants. This suggests that patients with HTN undergoing surgery in our setting were predominantly older adults, consistent with the findings of a study by Ponthus et al. [7] in which surgery was common among geriatric patients with HTN. The predominance of older participants in both studies was expected, as HTN prevalence increases with age, and older adults are more likely to undergo surgeries due to degenerative conditions such as fractures or chronic diseases. This similarity might reflect the global demographic trend of aging populations, which increases surgical caseloads among older adults.

Comparing the Effectiveness of Different Anesthetic Techniques in Controlling Blood Pressure in patients with HTN Undergoing Surgery.

The findings of this study indicate that SA was significantly more effective in maintaining stable intraoperative blood pressure in patients with HTN undergoing surgery than GA. SBP and DBP were consistently lower and more stable in the SA group than in the GA group across all measured time points (P < 0.001). This supports the hypothesis that SA provides better hemodynamic control during surgery in these participants.

These results align with previous empirical evidence suggesting that regional anesthesia techniques reduce sympathetic activation and attenuate the hemodynamic response to surgical stress [8]. SA achieves this by blocking the thoracolumbar sympathetic outflow, thereby reducing catecholamine surges and minimizing fluctuations in blood pressure [9]. In contrast, GA often requires deeper planes of anesthesia to suppress these responses and may still be associated with significant intraoperative variability due to airway manipulation, intubation, and emergence phenomena [10].

Although SA was associated with better overall stability, it led to initial hypotension in some patients, particularly those with pre-existing autonomic dysfunction, consistent with previous reports [9]. This highlights the need for proactive fluid loading and vasopressor support in patients with HTN receiving SA to prevent complications such as cerebral or myocardial hypo perfusion.

The findings of this study are consistent with a study by Li et al. [7]; they suggested that since GA involves rendering the patient completely unconscious and insensible to pain, it may lead to a higher rate of intraoperative complications such as cardiovascular events, respiratory depression, and intraoperative hypotension. This is particularly concerning for older patients with existing cardiovascular and pulmonary conditions, as GA can increase perioperative risk [7].

Impact of Anesthetic Techniques on Hemodynamic Stability, Blood Pressure Variability, and Heart Rate

Analysis of estimated marginal means revealed that patients under GA had significantly higher SBP, DBP, and HR values throughout the surgical period compared to those under SA. These findings suggest that GA is associated with greater cardiovascular stimulation, likely due to increased sympathetic activity in response to surgical stimuli and laryngoscopy [7].

This trend supports earlier observations, indicating that even with modern anesthetics like propofol and remifentanil, GA may not fully prevent hemodynamic instability unless carefully titrated and managed [10]. Conversely, SA demonstrated a progressive decline in hemodynamic parameters over time, indicating a predictable and controlled sympathetic block that is beneficial in managing HTN during surgery [8]. These findings are also in line with those of a study [11], wherein SA was associated with a higher rate of hypotension (Odds ratio, OR = 1.85 [95% CI, 0.2–3.4]; $P < 0.035$; I2 = 0.0%). The administration of pre-SA fluid ($P = 0.11$) had no impact on the incidence of hypotension after SA, which is likely due to other factors like age or pre-existing comorbidity.

This is also consistent with the findings of a previous study [12] that reported a mean baseline HR of 141.15 ±15.76 in patients with HTN; this mean baseline HR gradually dropped after the administration of SA, with a maximum drop at 25 min (117.92 ± 17.07), and subsequently rose to normal. However, the mean DBP at baseline was higher in patients with HTN (83 ± 6.23mmHg) and later dropped (79 ± 9.35 mmHg) 20 min after SA was administered, creating a significant mean difference between the SBP and DBP [12].

Additionally, the results align with those of a previous study [5], indicating that the HR at the 10th, 30th, and 60th min were significantly lower in the SA group than in the GA group. The differences observed during the 2nd, 3rd, 6th, 12th, and 24th h were not significant [5]. Additionally, the differences in the change in blood pressure from baseline in patients with pre-eclampsia were not significant between the SA and GA groups [5]. The SBP in the SA group was significantly lower than that in the GA group over the first 24 h with significant differences at the 30th and 60th min. Conversely, the patients in the GA group had lower DBP than those in the SA group, with significant differences at the 30th and 60th min [5].

Despite the risk of initial hypotension, SA appears to offer a more favorable intraoperative profile for patients with HTN. This underscores the importance of selecting an anesthetic technique based on patient comorbidities and procedural requirements. Therefore, anesthetists must be trained not only to administer SA but also to recognize and manage its potential complications promptly.

This is also in line with a study of patients with HTN [9] in which the mean SBP was 132.9 mmHg at baseline; it dropped after the induction of SA to 116.6 (12.3%) and 116.3 (12.45%) mmHg at 25 min and 30 min, respectively, followed by an insignificant increase in systolic blood pressure to a steady level. This suggests that the hypotension episodes could be effectively managed without any serious hazards to the patient. Additionally, the mean DBP at baseline was 78.5 mmHg before the administration of SA. After the administration of SA, the maximum drop (78.5 to 73.9 mmHg [5.9%]) was observed at 25 min, after which there was an increase in mean DBP [9]. Furthermore, the baseline mean HR was 78.6 mmHg and 79.4 mmHg at the 1st and 3rd min. The maximal drop of mean HR was from 78.3 mmHg to 73.9 mmHg (5.6%) at 35 min, followed by an increase in mean HR [9].

5.2. Effect of the Anesthetic Technique on Pain and Hemodynamic Stability Postoperatively

There were significant differences between the postoperative hemodynamic parameters or pain scores of the GA and SA groups. Both techniques resulted in comparable levels of pain intensity and postoperative blood pressure control. However, this finding contrasts with those of other studies that have reported better pain outcomes with regional anesthesia techniques [13] and improved recovery profiles with opioid-free regimens [14].

A possible explanation for this discrepancy lies in the absence of extended analgesic techniques such as continuous epidurals or peripheral nerve blocks in our setting. Additionally, both groups received standardized systemic analgesia postoperatively, which may have masked any residual analgesic advantage of the SA. This suggests that while SA has inherent advantages in pain management due to prolonged sensory blockade, these benefits may not be fully realized without structured postoperative pain protocols [15].

This is in line with the findings of a previous study in which numerical rating scale values were compared according to surgery type and anesthetic technique. [16]. The median numerical rating scale scores of hip and knee replacement surgeries were comparable, with values of 3 versus 3.5 at rest (minimum), 7 versus 7 during exertion, and 8 versus 8 at peak intensity (maximum). Owing to the similarity in the primary outcome pain scores and in a bid to improve clarity and statistical power, data from both surgery types were pooled for all subsequent analyses. There was no significant difference between the pain scores of the group that received GA (n = 195) and the group that received SA (n = 61) (minimum intensity: P= 0.508; intensity on exertion: P= 0.097; maximum intensity: P= 0.547). The median value of patient satisfaction with pain therapy was 7 (on a scale from 0 to 10) in both groups [16]. This study [16] also reported that patients in the GA group received a significantly higher (P

< 0.001) amount of oral morphine (averagely 25.5 mg) postoperatively in the recovery room than those in the GA group (averagely 12.5 mg) [16].

Therefore, future improvements should focus on the choice of intraoperative anesthesia and on optimizing postoperative pain management strategies tailored to the type of anesthesia. Integration of multimodal analgesia into routine care could enhance recovery and reduce opioid-related complications regardless of the primary anesthetic technique used.

6. Conclusion

We found that SA was more effective than GA in controlling intraoperative blood pressure and maintaining hemodynamic stability in patients with HTN undergoing surgery at the Bamenda Regional Hospital. SA was associated with lower and more stable SBP and DBP, as well as reduced HR variability during surgery. However, postoperatively, both anesthetic techniques showed similar hemodynamic profiles and pain control, indicating comparable recovery outcomes. These findings suggest that while SA offers superior intraoperative cardiovascular management, postoperative stability and pain relief depend on other factors beyond the initial anesthetic choice.

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