Cancer Management and Research

Open Access Full Text Article

ORIGINAL RESEARCH

Clinical Implications of Marked Postoperative Blood Pressure Variability in Head and Neck Cancer Surgeries: A Retrospective Analysis

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Background: Prolonged major surgery for head and neck cancers presents challenges with potential implications for blood pressure fluctuations (BPF). This study aims to assess the incidence of significant BPF in such patients and explore its clinical associations.

Methods: Ninety-eight patients underwent continuous BP monitoring during and after surgery. Demographic, clinical, echocardiographic, and laboratory data, including N-terminal pro-B-type natriuretic peptide (nt-pro BNP) levels, were analyzed. Multivariate analysis identified predictors of BPF.

Results: Thirty-five percent (n=34) exhibited significant BPF (standard deviation ≥20) post-surgery. The BPF group showed associations with recurrent cancer, lower BMI, increased complications, and higher 30-day mortality. Elevated postoperative systolic BP, wider variability, and prolonged ICU and hospital stays were observed. While echocardiographic parameters showed no significant differences, increased postoperative nt-pro BNP levels suggested a potential link to heart failure in BPF cases.

Conclusion: Extreme BPF in head and neck cancer surgery, particularly in recurrent cases, has significant clinical implications. The challenges in pharmacological management and patient care underscore the need for targeted interventions and vigilant monitoring. Given the elevated risk in this patient subset, implementing structured postoperative surveillance and tailored therapeutic strategies is essential to optimize outcomes and improve overall clinical care.

Keywords: blood pressure fluctuation, head and neck cancers, recurrent cancer, cardiovascular outcome

Introduction

Blood pressure fluctuations (BPF) are a physiological phenomenon that occur on a beat-by-beat basis and over a 24-hour period, governed by autonomic nervous system regulation via baroreflexes.[1] While transient postoperative hypertension is common and often attributed to factors such as anesthesia, inflammation, or pain,[2,3] it typically resolves within 24 hours. However, in a subset of patients undergoing major head and neck cancer (HNC) surgeries—particularly those involving skull base tumors or requiring extensive neck dissection—BP instability may persist beyond the immediate postoperative period, manifesting as extreme and unpredictable BPF.

Barboi and Pocica[4] recently described 23 patients with afferent baroreflex failure (ABF) after treatment for skull base tumors, highlighting the role of impaired baroreceptive signaling in autonomic dysfunction. The glossopharyngeal (IX) and vagus (X) nerves—key conduits of baroreceptor input—are frequently damaged during radiation therapy or salvage surgical interventions involving the carotid sheath or skull base, disrupting brainstem-mediated cardiovascular control.[5–7] In such cases, the loss of afferent baroreflex signaling leads to erratic blood pressure control, characterized by sustained severe hypertension (SBP ≥180 mmHg)[8] followed by abrupt drops of ≥20 mmHg or even hypotensive episodes (SBP <90 mmHg), which can significantly complicate postoperative management in the intensive care unit (ICU).

Despite these clinical observations, there is a lack of research evaluating the prevalence, characteristics, and prognostic implications of extreme BPF in patients undergoing major HNC surgery. Existing studies on BPF have

Received: 15 April 2025
Accepted: 16 August 2025
Published: 21 August 2025

primarily focused on populations with neurological disorders such as spinal cord injury or Guillain-Barré syndrome,[9,10] with limited relevance to the surgical oncology setting.

Therefore, the primary objective of this study is to define and characterize extreme postoperative BPF in patients with head and neck cancer, to evaluate its clinical implications, and to identify predictors of poor outcomes. Addressing this gap may inform the development of targeted perioperative monitoring strategies and improve patient outcomes in this high-risk surgical population.

Patients and Methods

Study Design and Participants

This retrospective study included 98 patients who underwent long (duration ≥ 6 hours), major surgery for head and neck cancers from January 2019 to December 2022. Patients with simple thyroid cancer without metastasis who underwent thyroidectomy, or those with benign masses, infections, or other lymphadenopathy were excluded. In all patients, BP was measured at one-hour intervals for 24 hours post-surgery, and the standard deviation (SD) of BP variation was calculated. It is based on the definition of orthostatic hypotension,[11] and since the mean SD of systolic BP (SBP) in this study was 18.7, patients with an SD of 20 or higher were defined as having BPF.

Figure 1A depicts the BP measured at hourly intervals over 24 hours post-surgery for the top 10 patients with severe postoperative BPF and the bottom 10 patients without BPF. The highest and lowest BP during the 24 hours after surgery were investigated, focusing on cases where systolic BP exceeded 200 mmHg and where it fell below 90 mmHg. Figure 1B illustrates the difference between the highest and lowest BP recorded in groups with and without BPF.

We analyzed clinical factors including baseline characteristics, echocardiographic and laboratory parameters, and clinical outcomes, such as the occurrence of complications (infection, re-operation, heart failure, arrhythmia, thrombosis, etc)., mortality within 30 days after surgery, hopeless discharge, or death within 6 months to 1 year after surgery. Mortality, hopeless discharge, and death were defined as poor outcomes. The surgical approach was categorized based on the location of neck dissection into unilateral and bilateral, and further classified according to the extent as selective neck dissection (SND), modified radical neck dissection (MRND), radical neck dissection (RD), and extended radical neck dissection (ERND) in accordance with medical literature.[12]

Ethical Considerations

All procedures conducted in this study involving human participants adhered to the ethical standards set by the institutional and/or national research committee, as well as the principles outlined in the 1964 Declaration of Helsinki

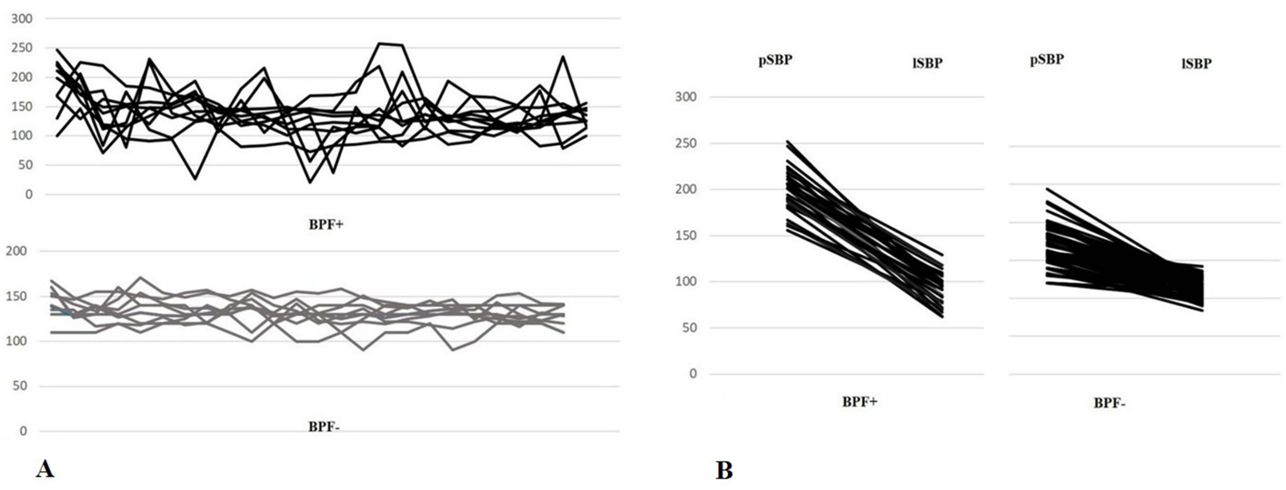

Figure 1 (**A**) Blood pressure variations at one-hour intervals over the 24 hours following surgery. The upper panel shows the top decile with pronounced extreme blood pressure fluctuations (BPF), while the lower panel depicts the bottom decile without BPF. The graph clearly illustrates heightened BP fluctuations over the 24-hour period in the group with BPF. Y-axis: Systolic blood pressure (SBP) (**B**) The difference in postoperative peak and lowest BP between the groups with and without extreme BPF. The figure highlights that the magnitude of this difference is more pronounced in the group with BPF, indicating increased variability in BP observed in this subgroup. Y-axis: SBP.

and its subsequent amendments or equivalent ethical guidelines. As this study was retrospective and observational, data were obtained through a review of medical records, and informed consent from individual participants was not required. The authors did not have access to any personally identifiable patient information. The ethics committee granted a waiver for informed consent. This study received approval from the Institutional Review Board (IRB no. 2024–02-001).

Transthoracic Echocardiography

Transthoracic echocardiography was performed using standard techniques with a 2.5-MHz transducer, following established guidelines.[13] The left ventricular end-diastolic dimension (LVEDD) and end-systolic dimension (LVESD) were measured, and left ventricular ejection fraction (LV EF) was assessed using the biplane Simpson method. The maximal left atrial volume was determined using the Simpson method and indexed to body surface area. Left ventricular (LV) mass was calculated according to the Devereux formula, and LV wall thickness (both septal and posterior) was measured in both systole and diastole.

Mitral inflow velocities were recorded from the apical four-chamber view, with measurements including peak early (E) and peak late (A) flow velocities, as well as the E/A ratio. Tissue Doppler imaging was used to assess early diastolic (E') and late diastolic (A') velocities, along with the E/E' ratio, based on mitral annular motion obtained from the apical four-chamber view. Adequate mitral inflow and tissue Doppler signals were successfully recorded for all patients. Right ventricular systolic pressure (RVSP) was estimated using tricuspid regurgitation (TR) velocity, which was acquired from the apical four-chamber or right ventricular (RV) inflow view using continuous wave (CW) Doppler imaging.

Statistical Analysis

Continuous variables are reported as mean ± SD, while categorical variables are presented as percentages or absolute counts. Comparisons of continuous variables among three independent groups were conducted using one-way analysis of variance (ANOVA), whereas comparisons between two independent groups were performed using the Student's *t*-test. The chi-square test was used for categorical variables. Additionally, multivariable analysis was conducted using logistic regression (SPSS for Macintosh, version 27.0, IBM Corp., Armonk, NY, USA). Non-normally distributed variables were analyzed using the Kruskal–Wallis test or the Mann–Whitney *U*-test. A p-value < 0.05 was considered statistically significant.

Results

Clinical Characteristics of the Study Population (Table 1)

In a cohort of 98 patients undergoing neck dissection for various HNC, the mean SD of SBP was 18.7 ± 7.2. Postoperatively, 35% exhibited an SD of BP ≥ 20, 30% had the highest systolic BP (SBP) ≥ 200 mmHg, and 17% had the lowest SBP ≤ 90 mmHg. The majority of patients were male (86%), with a mean age of 63.8 ± 9.4 years. The most prevalent diagnoses included laryngeal cancer (29%) and hypopharyngeal/esophageal cancer (24%).

Operative procedures involved both unilateral (53%) and bilateral (47%) approaches, with selective neck dissection (41%) and modified radical neck dissection (40%) being common. Tracheostomy was performed in 79% of cases. The

Table 1 Clinical Parameters of the Study Population

	Total N = 98
Mean 24 BP SD	18.7 ± 7.2
Post op 24 BP SD ≥20	34 (35%)
Post op highest SBP ≥200mmHg	29 (30%)
Post op lowest SBP ≤90 mmHg	17 (17%)
Both	6 (6%)
Mean age	63.8 ± 9.4
Male gender	84 (86%)

(*Continued*)

Table 1 (Continued).

	Total N = 98
Diagnosis	
Laryngeal cancer	28 (29%)
Hypopharyngeal/esophageal cancer	23 (24%)
Tonsil cancer	13 (13%)
Oropharyngeal cancer	12 (12%)
Tongue cancer	8 (8%)
Oral cavity cancer	6 (6%)
Maxillary sinus cancer/nasal cavity cancer	2 (2%)
Tracheal cancer	2 (2%)
Et al.	4 (4%)
Operative procedure	
Unilateral/Bilateral	52 (53%)/46 (47%)
SND	40 (41%)
MRND	39 (40%)
RND	10 (10%)
ERND	9 (9%)
Tracheostomy	78 (79%)
Mean hospital days	31.6 ± 23.4
Mean ICU days	7.3 ± 16.0
Complications	46 (47%)
30 days mortality[a]	3 (3%)
Hopeless discharge[b]	6 (6%)
1 year mortality[c]	17 (17%)
Poor outcome (a~c)	23 (24%)

Notes: Data are mean ± standard deviation (SD) or n (%). [a]30 days mortality, [b]Hopeless discharge, [c]1 year mortality, n cases of a, b, or c: poor outcome.
Abbreviations: Op, operative; SND, selective neck dissection; RND, radical neck dissection; MRND, modified radical neck dissection; ICU, intensive care unit.

mean hospital and ICU stays were 31.6 ± 23.4 days and 7.3 ± 16.0 days, respectively. Complications occurred in 47% of cases, with a 3% 30-day mortality rate, 6% experiencing a hopeless discharge, and a 17% 1-year mortality rate, contributing to a 24% overall poor outcome rate.

Analysis of Complications (Table 2)

In a cohort of 98 patients, postoperative complications were observed, underscoring the significance of vigilant postoperative care. Thirty cases experienced infections, prompting reoperation for issues such as wound defects, fistula, leakage, and

Table 2 Postoperative Complications

	Total N = 98
Infection	30
Re-OP (wound infection, fistula, leakage, bleeding et al)	20
Thromboembolism (CVA, VTE)	2
Feeding jejunostomy/gastrostomy	2
Syncope due to carotid artery compression	1
Pneumothorax	1
Foot drop	1
Encephalopathy	1

(*Continued*)

Table 2 (Continued).

	Total N = 98
Cardiac complications	12
Tachyarrhythmia (AF, SVT, VT, ST et al)	8
Heart failure (TTS, CHF, ischemia et al)	11
*EF	42.6% (64%)
*LAVI	32.2 mL/m^2 (24.7 mL/m^2)
*E/E' ratio	9.8 (9.2)
*RVSP	30 mmHg (27 mmHg)

Notes: Data are n or *post operative echocardiographic mean values (compared to pre operative mean values).
Abbreviations: Op, operation; AF, atrial fibrillation; SVT, supraventricular tachycardia; VT, ventricular tachycardia ST, sinus tachycardia; TTS, takotsubo syndrome; CHF, congestive heart failure; EF, ejection fraction; LAVI, left atria volume index; E/E', E/E' ratio; RVSP, right ventricular systolic pressure.

bleeding. Other complications included thromboembolism (2 cases), interventions related to feeding tubes due to the inability to take orally (2 cases), syncope due to carotid artery compression (1 case), pneumothorax (1 case), foot drop (1 case), and encephalopathy (1 case). Notably, 12 cases presented with postoperative cardiac problems, comprising tachycardia (8 cases – atrial fibrillation, supraventricular, ventricular, or sinus tachycardia) and heart failure (11 cases – congestive heart failure [CHF], Takotsubo syndrome [TTS], or myocardial ischemia), with specific cardiac parameters documented.

Comparison of Patients' Clinical Characteristics Between the Groups (Table 3)

This study compared two patient groups, those with BPF (n=34) and those without (n=64), revealing significant differences. Patients with BPF exhibited a higher prevalence of recurrent cancer (38% vs 9%, p=0.001), lower BMI (21.2 ± 3.8 vs 22.9 ± 3.3, p=0.020), and increased complications, notably cardiac problems (29% vs 3%, p<0.001). Moreover, the BPF group displayed elevated postoperative peak SBP and a higher frequency of peak SBP ≥ 200 mmHg (p<0.001).

Table 3 Comparison of Baseline Characteristics and Clinical Parameters of the Study Population

	BPF (n=34)	No BPF (n=64)	p
Age (yeas)	65.1 ± 7.5	63.1 ± 10.3	0.311
Male gender	32 (94%)	52 (81%)	0.072
BMI (kg/m^2)	21.2 ± 3.8	22.9 ± 3.3	0.020
Diabetes mellitus	7 (21%)	15 (23%)	0.479
Hypertension	12 (35%)	28 (44%)	0.277
CVD	3 (9%)	8 (13%)	0.427
Other malignancy	7 (21%)	7 (11%)	0.159
Recurrent cancer	13 (38%)	6 (9%)	0.001
Tracheostomy	30 (88%)	48 (75%)	0.187
Pre OP SBP (mmHg)	122.6 ± 15.2	121.8 ± 13.1	0.535
DBP	75.4± 11.8	74.3 ± 9.7	0.618
Heart rate (bpm)	76.4 ± 14.4	72.8 ± 11.8	0.189
Post op peak SBP	200.7 ± 22.7	170.5 ± 27.1	<0.001
Lowest SBP	92.6 ± 17.7	111.9 ± 13.0	<0.001
Mean pSBP-lSBP	108.1 ± 24.4	59.2 ± 25.9	<0.001
SD of SBP	29.5 ± 8.7	13.4 ± 5.4	<0.001
Peak SBP ≥200 mmHg	20 (59%)	9 (14%)	<0.001
Lowest SBP ≤90	15 (44%)	2 (3%)	<0.001
Both	6 (18%)	0	0.001

(*Continued*)

Table 3 (Continued).

	BPF (n=34)	No BPF (n=64)	p
ICU days	13.6 ± 25.0	4.0 ± 6.0	0.033
Hospital days	39.3 ± 29.4	27.5 ± 18.5	0.038
Complications	23 (68%)	23 (36%)	0.003
Infection	14 (41%)	16 (25%)	0.112
Wound revision	13 (38%)	7 (11%)	0.003
Cardiac problems	10 (29%)	2 (3%)	<0.001
30 days mortality[a]	3 (9%)	0	0.039
Hopeless discharge[b]	3 (9%)	3 (5%)	0.415
1-year mortality[c]	10 (29%)	7 (11%)	0.028
Poor outcome [(a~c)]	13 (38%)	10 (16%)	0.023

Notes: Data are represented as mean ± SD or n (%). [a]30 days mortality, [b]Hopeless discharge, [c]1 year mortality, n cases of a, b, or c: poor outcome.
Abbreviations: BPF, blood pressure fluctuation; BMI, body mass index; CVD, cerebrovascular diseases; OP, operative; DBP, diastolic BP; p, peak; l, lowest; ICU, intensive care units.

The study further revealed that patients with BPF experienced a longer duration of ICU stay (13.6 ± 25.0 vs 4.0 ± 6.0 days, p=0.033) and overall hospital stay (39.3 ± 29.4 vs 27.5 ± 18.5 days, p=0.038), along with higher rates of complications, including infection and wound revision. Notably, 30-day mortality was higher in the BPF group (9% vs 0%, p=0.039), as was 1-year mortality (29% vs 11%, p=0.028), contributing to a higher overall rate of poor outcomes (38% vs 16%, p=0.023).

Echocardiographic Parameters and Laboratory Findings (Table 4)

When comparing patients with BPF to those without, there were no significant differences in echocardiographic parameters, including cardiac chamber size and both systolic and diastolic functions, suggesting that BP variations were not indicative of preexisting heart failure or fluid deficit. Notably, there was no substantial difference in pre-operative blood test results between the two groups. However, a noteworthy observation was an increase in postoperative N-terminal pro-B-type natriuretic peptide (NT-proBNP) levels in the BPF group, suggesting a potential association with the development of heart failure and BPF.

Table 4 Echocardiographic Parameters and Laboratory Results of the Study Population

	BPF (n=34)	No BPF (n=64)	p
LAVI (mL/m^2)	26.4 ± 10.7	23.8 ± 6.8	0.168
LVEDD (mm)	47.5 ± 5.1	47.4 ± 4.9	0.933
LVESD (mm)	30.8 ± 4.1	30.6 ± 4.2	0.820
EF (%)	63.8 ± 7.4	64.6 ± 6.7	0.638
GS (%)	−16.7 ± 2.8	−17.6 ± 3.	0.280
LVMI (g/m^2)	102.5 ± 23.1	93.5 ± 21.8	0.199
E velocity (cm/s)	62.1 ± 18.3	61.1 ± 18.5	0.345
A velocity (cm/s)	80.8 ± 16.5	75.7 ± 17.1	0.417
E' velocity (cm/s)	6.4 ± 1.6	7.2 ± 2.1	0.848
A' velocity (cm/s)	9.8 ± 2.7	9.9 ± 1.7	0.753
E/E' ratio	9.7 ± 3.5	8.9 ± 3.2	0.752
S' velocity (cm/s)	7.8 ± 1.9	7.7 ± 1.7	0.752
RAP (mmHg)	5.6 ± 2.1	5.1 ± 1.1	0.171
RVSP (mmHg)	29.1 ± 7.1	28.7 ± 5.5	0.383

(*Continued*)

Table 4 (Continued).

	BPF (n=34)	No BPF (n=64)	p
Pre op nt-pro BNP*	1016.2 ± 3728.4	220.1 ± 575.5	0.309
Median (IOR)	109.5	74.0	
Post op nt-pro BNP*	3588.0 ± 7111.8	538.2 ± 761.8	0.058
Median (IOR)	820.0	261.5	
Pre op hb	12.9 ± 1.9	13.4 ± 1.6	0.176
Post op hb	12.0 ± 2.1	12.4 ± 2.0	0.272
Pre op cr	0.85 ± 0.46	0.76 ± 0.21	0.224
Pre op albumin	3.8 ± 0.6	3.9 ± 0.5	0.126

Notes: Data are represented as mean ± SD or n (%). *indicates the assumption of unequal variance.
Abbreviations: LAVI, left atrial volume index; LVEDD and ESD, left ventricular end-diastolic and systolic dimension; EF, ejection fraction; GS, global strain; LVMI, LV mass index; RAP, right atrial pressure; RVSP, right ventricular systolic pressure; op, operative; nt-pro BNP, N-terminal pro-B-type natriuretic peptide; hb, hemoglobin; cr, creatinine.

Uni and Multivariable Analyses (Table 5)

In the univariable analysis, key factors associated with adverse outcomes in patients with BPF were identified. These factors included lower BMI (p=0.023), higher postoperative peak SBP (p<0.001), lower postoperative lowest SBP (p<0.001), presence of recurrent cancer (p=0.001), prolonged ICU stay (p=0.027), extended hospital stay (p=0.033), overall complications (p=0.003), need for reoperation (p=0.002), cardiac problems (p=0.002), and poor overall outcome (p=0.014).

In the multivariable analysis, after adjusting for other variables, recurrent cancer (p=0.003) and cardiac problems (p=0.040) remained significantly associated with BPF. Other factors, including BMI, ICU stay, hospital stay,

Table 5 Uni-and Multivariable Analysis on the Associating Factors of Elevated RVSP

	Odds Ratio	95% CI	p
Univariate Analysis			
BMI	0.865	0.763–0.981	0.023
Post OP peak SBP	1.049	1.207–1.072	<0.001
Post OP lowest SBP	0.918	0.884–0.953	<0.001
Recurrent cancer	5.984	2.015–17.772	0.001
ICU stay	1.088	1.010–1.172	0.027
Hospital stay	1.023	1.002–1.044	0.033
Complications	3.727	1.544–83,999	0.003
Re-op	5.041	1.771–14.351	0.002
Cardiac problems	12.917	2.635–63.316	0.002
Poor outcome	3.343	1.272–8.786	0.014
Multivariate analysis			
BMI	0.949	0.813–1.107	0.505
ICU stay	1.110	0.982–1.231	1.000
Hospital stay	0.975	0.936–1.016	0.224
Recurrent cancer	6.974	1.902–25.567	0.003
Complications	0.914	0.205–4.079	0.907
Re-operation	4.700	0.909–24.298	0.065
Cardiac problems	8.180	1.100–60.831	0.040
Poor outcome	0.604	0.128–2.852	0.524

Abbreviations: BMI, body mass index; OP, operative; SBP, systolic blood pressure; ICU, intensive care units.

https://doi.org/10.2147/CMAR.S534580

complications, reoperation, and poor outcome, did not show significant associations after multivariate adjustment. These findings underscore the importance of considering recurrent cancer and cardiac problems as critical factors impacting patient outcomes in the presence of postoperative BPF.

Discussion

In this retrospective study of 98 patients undergoing prolonged major surgery for head and neck cancers, significant postoperative BPF were observed in 35% of patients. The group with BPF, characterized by recurrent cancer, lower BMI, and increased complications, showed elevated postoperative SBP, heightened SBP variability, and longer stays in both the intensive care unit and hospital. Preoperative echocardiographic parameters did not differ significantly between groups, but an increase in postoperative NT-proBNP levels in the BPF group suggested a potential link with heart failure. Multivariate analysis highlighted recurrent cancer as a significant predictor of severe BPF, while increased cardiac problems were associated with patients experiencing BPF, underscoring its clinical implications in this patient population.

Clinical Implications of Postoperative BPF in Hear and Neck Cancer Surgeries

Physiologically, BPF are intricately regulated by neural responses, including central sympathetic drive and reflex modulation by arterial and cardio-pulmonary reflexes.[1] In specific medical conditions such as SCI and GBS, characterized by autonomic nervous system dysfunction, BPF encompass both hypertensive autonomic dysreflexia and hypotensive events.[9,10,14] Following surgery, transient hypertension is common, yet prolonged extreme BPF pose challenges, especially in extended head and neck cancer surgeries.[2]

This study explores the clinical implications of postoperative BPF in head and neck cancer surgeries. Recent research by Barboi and Pocica in Clinical Autonomic Research identified 23 patients with pronounced BPF attributed to afferent baroreflex failure and prior treatment for skull base tumors.[4] Damage to glossopharyngeal (IX) and vagus (X) cranial nerves, crucial for baroreceptor signaling in the brainstem, disrupts BP control following neck radiation or dissection surgeries.[5–7] Figure 2 illustrates preoperative PET-CT (A) and postoperative spine MRI (B) images of a patient who underwent surgery for recurrent hypopharyngeal cancer, highlighting severe BP fluctuations and postoperative hypotension. The PET scan shows evidence of hypopharyngeal cancer and metastatic lymph nodes in various neck regions, while the MRI reveals a significant soft tissue lesion along the prevertebral space, suggestive of nerve damage.

Mechanisms and Implications of BPF in HNC Surgeries

Understanding mechanisms underlying BPF in HNC surgeries is crucial for targeted interventions. The study underscores the impact of glossopharyngeal and vagus nerve damage on BP control, emphasizing the need for neuroprotective measures during skull base surgeries. Future research should explore strategies to mitigate nerve injuries during radiation or dissection surgeries and assess their impact on preventing extreme BPF. These insights align with broader understanding of neural pathways involved in BP regulation, providing clinical context on maintaining autonomic control in extended head and neck cancer surgeries. Further research in this area may refine preventive measures and targeted interventions to optimize BP control postoperatively.[15] Recent findings indicate that patients hospitalized for ischemic stroke face increased complications and mortality with significant BPF.[16] Compared to our study results, severe BP variability in various clinical scenarios associates with unfavorable outcomes and heightened complication rates, emphasizing the need for thorough investigation and subsequent research into appropriate treatments addressing detrimental effects of extreme BPF across diverse clinical situations.

Challenges and Cardiac Implications of BPF in HNC Surgeries

This study on prolonged extreme BPF in head and neck cancer surgeries identifies significant challenges. Factors such as recurrent cancer, lower BMI, and increased complications are linked to higher prevalence of extreme BPF, suggesting potential predictive factors. The BPF group exhibits adverse outcomes, including elevated postoperative SBP, widened variability, and extended hospital stays. The observed correlation between BPF and postoperative NT-proBNP elevation indicates a potential link to heart failure, underscoring the need for vigilant postoperative cardiac monitoring. Patients with BPF experience higher rates of postoperative cardiac complications like tachy-arrhythmias and heart failure (TTS,

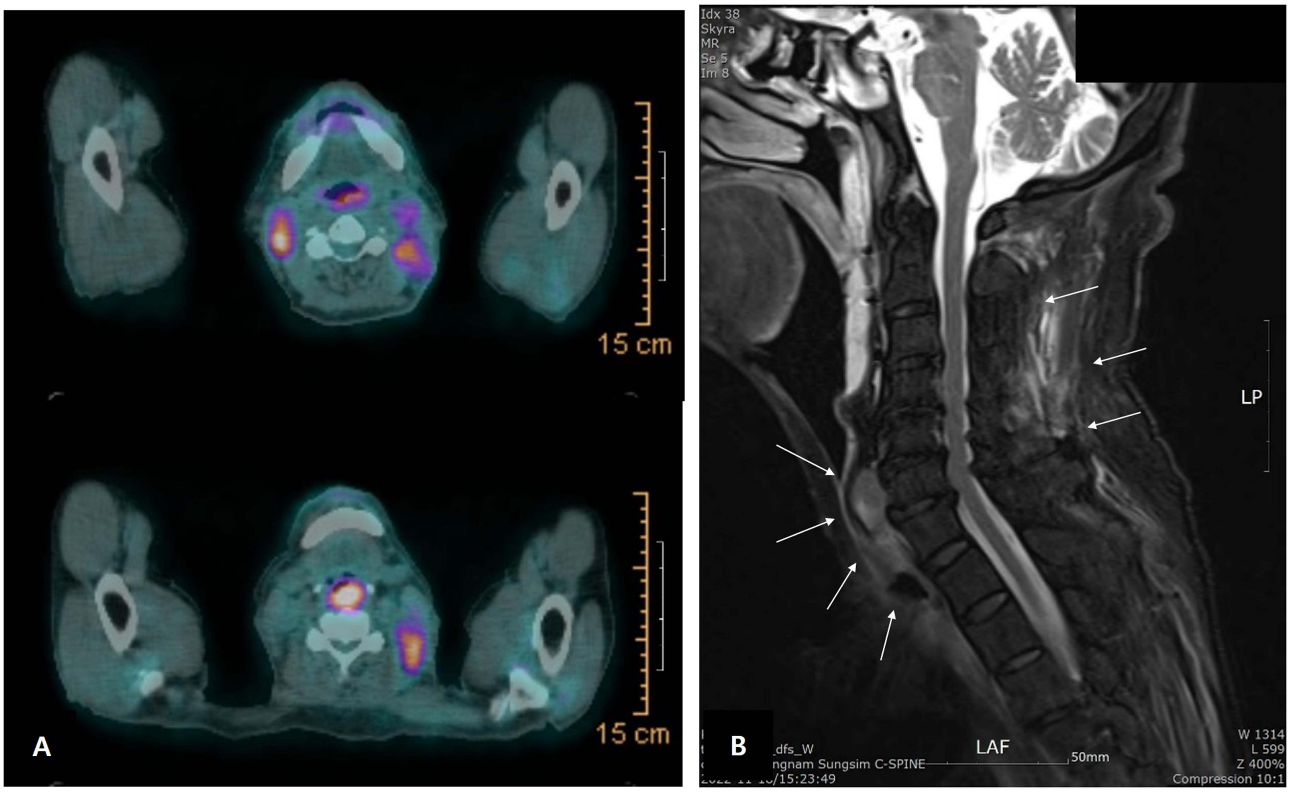

Figure 2 Illustration of preoperative PET-CT (**A**) and postoperative spine MRI (**B**) images of a patient who underwent surgery for recurrent hypopharyngeal cancer, depicting severe blood pressure fluctuations and hypotension post-procedure. PET findings reveal evidence of hypopharyngeal cancer and metastatic lymph nodes in the retropharyngeal, neck level II bilaterally, left neck level V, and left upper paratracheal areas. The postoperative MRI image demonstrates a 3.7×1.6x4cm lobulated soft tissue lesion with marginal contrast enhancement along the C6-T1 prevertebral space (white arrows).

CHF, or ischemia). NT-proBNP serves as a strong prognostic marker in both acute and chronic HF, with higher levels associated with worse outcomes.[17] Studies have shown that a reduction of NT-proBNP by more than 30% during treatment is associated with improved prognosis.[17] Therefore, in cases where acute HF is suspected after surgery, an elevated NT-proBNP level should prompt more proactive monitoring, diagnostic evaluation, and therapeutic intervention for heart failure. Such an approach may help prevent acute complications and improve long-term outcomes. However, NT-proBNP levels may also be elevated in a variety of cardiac and non-cardiac conditions. These include chronic kidney disease, pulmonary diseases, sepsis, anemia, arrhythmias, advanced age, and neurological disorders.[18] To avoid misdiagnosis of HF, clinicians should interpret NT-proBNP levels in the context of the patient's overall clinical status.

Recent studies by De Angelis et al report on management and outcomes in patients with pheochromocytoma-induced cardiogenic shock (PICS), stressing the importance of suspecting PICS in severe cyclic BPF cases, rapid hemodynamic deterioration, and elevated inflammatory markers.[19] While distinct from our study, both underscore the clinical importance of BPF and adverse cardiac outcomes. Patients with PICS typically exhibit rapid recovery post-surgical removal, yet differences in underlying conditions necessitate distinct treatment approaches for our study population. While direct comparison with TTS prognosis in the general population is challenging, existing literature suggests generally favorable prognosis and lower recurrence rates compared to myocardial infarction.[20] However, heightened cardiovascular death risk in TTS mandates consideration of appropriate drug therapy, such as ACE inhibitors. Further research in our cohort is needed to explore additional therapeutic strategies aimed at enhancing recovery and mitigating adverse cardiovascular outcomes.

Study Limitations

The study acknowledges several limitations, including its retrospective design, reliance on single-center data, small sample size, and focus on immediate postoperative outcomes. Additionally, intraoperative variables such as anesthetic

https://doi.org/10.2147/CMAR.S534580

agents, fluid balance, and blood loss were not analyzed in this study, which may have influenced the results. However, it is important to note that patients included in the study received ICU care for more than 24 hours postoperatively without significant intraoperative events such as major bleeding or shock, and no substantial differences in anesthetic agents were observed in this cohort. This strict inclusion criterion may have contributed to the relatively small sample size. Therefore, larger, multicenter studies involving more diverse patient populations, detailed intraoperative data, and long-term follow-up are warranted to validate and expand upon these findings.

Conclusion

This retrospective study suggests that extreme postoperative BPF are associated with adverse cardiac outcomes in patients undergoing head and neck cancer surgery, particularly in recurrent cases. While NT-proBNP may serve as a marker of postoperative cardiac stress, further prospective studies are needed to validate its role. Given the study's limitations, including its single-center design and small sample size, cautious interpretation is warranted. Nonetheless, individualized postoperative monitoring strategies may help improve outcomes in this high-risk population.

Data Sharing Statement

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethical Approval

This study was approved by the Institutional Review Board (IRB no. 2024-02-001). This study was a retrospective observational study for which patient consent was waived, and it received approval from the Institutional Review Board of Hallym University Kangnam Sacred Heart Hospital.

Consent to Participate

This was not available in this study because this study was a retrospective, observational study.

Funding

No funds, grants or other support was received.

Disclosure

The authors report no conflicts of interest in this work.

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