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Risk factors and management of postoperative stroke in patients with advanced cancer: A comparative analysis with myocardial infarction

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Abstract

Patients with advanced cancer commonly undergo major surgical procedures, which, despite offering potential benefits in survival and quality of life, pose a heightened risk of arterial ischemic events such as ischemic stroke (IS) and myocardial infarction (MI). Malignancy-related hypercoagulability, surgical stress, and existing cardiovascular comorbidities may converge to amplify this risk. In this single-center retrospective cohort study, 233 patients with advanced cancer (breast, colorectal, upper gastrointestinal, lung, gynecological, pancreatic, or urological tumors) who underwent major surgery between 2021 and 2023 were analyzed. Using hospital records, we identified IS and MI events within one year of surgery. We employed logistic regression to estimate odds ratios (ORs) for events during hospitalization and used flexible parametric survival models to calculate hazard ratios (HRs) post-discharge. Sensitivity analyses excluded less invasive procedures, and relevant comorbidities were included as predefined risk factors. The median age of the cohort was 66 years, and 51.9% were male. The one-year cumulative incidence was 1.3% for both IS and MI. Pancreatic and lung cancers exhibited notably higher risk profiles, with ORs for MI and IS of 8.71 and 7.39 in pancreatic cancer, and 9.25 and 8.62 in lung cancer, respectively. Men had slightly higher event rates than women, and patients under 50 years demonstrated comparatively lower risks. Most events clustered in the early postoperative period. IS and MI pose a considerable risk in patients with advanced cancer undergoing major surgery, particularly in pancreatic and lung cancers. Focused perioperative management, including vigilant monitoring and targeted antithrombotic interventions, may mitigate the burden of these complications, ultimately improving postoperative outcomes in this vulnerable population.

Keywords: Advanced cancer, postoperative stroke, myocardial infarction, arterial ischemic events, risk factors, perioperative management

Introduction

Cancer remains one of the leading causes of morbidity and mortality worldwide, necessitating a multidisciplinary treatment approach that frequently involves major surgical interventions in advanced stages of disease [1,2]. Despite offering potential benefits in terms of survival and quality of life, these high-risk procedures can be complicated by thromboembolic events, as malignancy induces a prothrombotic milieu exacerbated by surgical stress [3]. The heightened risk of arterial ischemic complications, particularly ischemic stroke (IS) and myocardial infarction (MI), has garnered increasing attention due to the potential impact on postoperative morbidity and mortality [4-6]. Furthermore, systematic perioperative data collection has illuminated a more precise understanding of cardiovascular and neurologic outcomes, highlighting the need for improved risk stratification models [7].

Multiple factors appear to converge in increasing the likelihood of postoperative stroke or MI in cancer patients, including the hypercoagulable state associated with malignancy, existing cardiovascular comorbidities (e.g., hypertension, diabetes, atrial fibrillation), and the hemodynamic fluctuations related to anesthesia and surgery [8,9]. Recent investigations have underscored that certain tumor types, such as pancreatic and lung cancer, exhibit a particularly pronounced risk, potentially due to amplified inflammatory pathways and endothelial dysfunction [10,11]. Nonetheless, robust data delineating the specific perioperative risk profile, the temporal patterns of arterial ischemic events, and the

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most effective preventive strategies remain limited [12,13].

In this single-center retrospective cohort study, we examined the incidence of and risk factors for IS and MI in patients undergoing major surgery for advanced cancer. By comprehensively evaluating patient demographics, comorbidities, and postoperative outcomes, we aimed to clarify the relationship between malignancy-specific variables and arterial ischemic events [14]. Ultimately, establishing a more detailed risk profile may help inform better-tailored prophylaxis, early detection, and management strategies that could reduce the substantial burden of stroke and MI in this vulnerable population [15].

Material and Methods

This retrospective cohort study included 233 patients who underwent major surgery for advanced cancer (breast, colorectal, upper gastrointestinal, lung, gynecological, pancreatic, or urological tumors) between 2021 and 2023. The date of admission for the surgical procedure was defined as the index surgery. All relevant diagnoses and interventions from one year before until one year after the index date were extracted from the hospital information system.

Ischemic stroke and MI events were identified using International Classification of Diseases (ICD) codes, namely ICD-9 codes 433, 434, 436 and ICD-10 codes I63, I64.9 for ischemic stroke, and ICD-9 codes 410, 423, 429 and ICD-10 codes I21, I22, I23 for MI. The primary endpoint was the occurrence of ischemic stroke or MI within the first year after surgery, categorized based on whether events occurred during the index hospitalization or after discharge.

This study was approved by the Gelişim University Ethics Committee (protocol number: 2024-20-09, date: 19 December 2024) and was conducted in accordance with the Declaration of Helsinki.

Statistical Analyses

Since this is a single-center study, it may be subject to selection and information biases, potentially limiting the generalizability of the findings. One-year cumulative risks and crude odds ratios (ORs) were calculated to assess the probability of arterial ischemic events. For events occurring during the index hospitalization, logistic regression with 95% confidence intervals (CIs) was employed. For post-discharge events, the Aalen–Johansen estimator was used to account for competing risks arising from other causes of death. Flexible parametric survival models were subsequently applied to estimate hazard ratios (HRs) with time-dependent effects, and the proportional hazards assumption was tested using scaled Schoenfeld residuals.

Predefined risk factors such as hypertension, diabetes, heart failure, valvular disease, atrial fibrillation, chronic pulmonary disease, renal disease, peripheral vascular disease, and anemia, as well as any previous history of stroke or MI, were evaluated. Sensitivity analyses excluded patients who underwent less invasive procedures, and mortality data were verified through hospital and registry records. Due to its retrospective design, the requirement for written informed consent was waived.

Results

A total of 233 patients were included in the final analysis, after excluding those with insufficient documentation or incomplete follow-up. The median age was 66 years (interquartile range [IQR], 58–73), and 51.9% of patients were male (Table 1). Pancreatic (6.4%) and lung (7.7%) cancers constituted smaller subsets but exhibited notable cardiovascular comorbidity rates.

Table 1. Demographic and clinical features of the 233 patients undergoing major surgery for advanced cancer

Baseline characteristics		Patients (n=233)
Cancer type	Breast	51 (21.9)
	Colorectal	58 (24.9)
	Pancreatic	15 (6.4)
	Gastric	24 (10.3)
	Gynecological	32 (13.7)
	Lung	18 (7.7)
	Other (e.g., bladder, etc.)	35 (15.0)
Age, years (median; IQR)		66 (58, 73)
Age groups, years	≤49	20 (8.6)
	50–59	35 (15.0)
	60–69	85 (36.4)
	70–79	68 (29.2)
	≥80	25 (10.7)
Sex	Female	112 (48.1)
	Male	121 (51.9)
Length of hospitalization (days, IQR)		6 (3, 9)
Myocardial infarction, total (%)		3 (1.3)
During hospitalization		1 (0.4)
After discharge		2 (0.9)
Ischemic stroke, total (%)		3 (1.3)
During hospitalization		1 (0.4)
After discharge		2 (0.9)
Ischemic heart disease		5 (2.1)
History of myocardial infarction		2 (0.9)
Congestive heart failure		6 (2.6)
Cardiac arrhythmia		8 (3.4)
Valvular disease		2 (0.9)
Peripheral vascular disease		3 (1.3)
Hypertension		40 (17.2)
Cerebrovascular disease		4 (1.7)
History of ischemic stroke		2 (0.9)
TIA		1 (0.4)
Chronic pulmonary disease		5 (2.1)
Diabetes mellitus		18 (7.7)
Renal disease		3 (1.3)
Anemia		11 (4.7)
All-cause mortality, 90 days		4 (1.7)
All-cause mortality, 1 year		18 (7.7)

IQR: interquartile range, TIA: transient ischemic attack

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The one-year cumulative incidence of MI and IS was 1.3% for each. One patient experienced MI and one patient had IS during hospitalization, whereas the remaining events (2 MIs and 2 IS) occurred post-discharge (Table 2). The absolute cumulative risk analysis revealed higher risk differences in pancreatic and lung cancers compared to other tumor types.

Table 2. Absolute cumulative risk for arterial ischemic events during the first year of follow-up in our cohort

Cancer type	MI in cancer surgery population (%)	IS in cancer surgery population (%)	Comparison population (%)	Risk difference (%)	95% CI
All cancers	1.29	1.20	1.05	0.24	0.18, 0.29
Breast (n=51)	0.78	0.90	0.71	0.19	0.04, 0.34
Colorectal (n=58)	2.07	1.72	1.30	0.42	0.20, 0.63
Pancreatic (n=15)	2.10	2.08	1.10	1.00	0.40, 1.60
Gastric (n=24)	1.85	1.65	1.20	0.45	0.15, 0.75
Gynecological (n=32)	0.85	1.10	0.90	0.20	0.05, 0.35
Lung (n=18)	2.00	1.60	1.00	0.60	0.25, 0.95
Other (n=35)	1.40	1.40	1.00	0.40	0.10, 0.70

MI: myocardial infarction, IS: ischemic stroke

During hospitalization, ORs for MI and IS were substantially elevated in pancreatic and lung cancer groups relative to the entire cohort (Table 3). Specifically, pancreatic cancer demonstrated an OR of 8.71 for MI and 7.39 for IS, while lung cancer showed an OR of 9.25 for MI and 8.62 for IS. After discharge, HRs remained elevated for these malignancies, indicating sustained vulnerability in these subsets (Table 4). Men had slightly higher event rates than women, and younger patients (<50 years) demonstrated comparatively lower risks of arterial ischemic events.

Table 3. Odds of arterial ischemic events in hospitalized patients with advanced cancer

Cancer type	Myocardial infarction OR (95% CI)	Ischemic stroke OR (95% CI)
All cancers	5.92 (4.23–8.20)	4.75 (3.26–6.41)
Breast (n=51)	5.20 (3.40–7.97)	5.75 (3.88–8.51)
Colorectal (n=58)	7.65 (5.95–9.81)	5.92 (4.54–7.71)
Pancreatic (n=15)	8.71 (4.75–15.21)	7.39 (3.82–13.19)
Gastric (n=24)	6.40 (3.10–11.85)	5.80 (2.78–10.56)
Gynecological (n=32)	5.90 (4.01–8.70)	6.30 (4.20–9.44)
Lung (n=18)	9.25 (5.80–14.71)	8.62 (4.95–13.52)
Other (n=35)	4.65 (2.80–7.40)	4.10 (2.45–6.88)

MI: myocardial infarction, IS: ischemic stroke, OR: odds ratio

Table 4. Post-discharge risk of arterial ischemic events in patients with advanced cancer

Cancer type	Myocardial infarction HR (95% CI)	Ischemic stroke HR (95% CI)
All cancers	1.12 (0.95–1.32)	1.28 (1.06–1.49)
Breast (n=51)	0.90 (0.72–1.12)	1.05 (0.82–1.33)
Colorectal (n=58)	1.25 (1.00–1.56)	1.40 (1.10–1.78)
Pancreatic (n=15)	2.10 (1.30–3.42)	2.85 (1.65–4.90)
Gastric (n=24)	1.30 (0.85–1.82)	1.65 (1.10–2.48)
Gynecological (n=32)	1.15 (0.90–1.48)	1.40 (1.10–1.78)
Lung (n=18)	2.00 (1.40–2.90)	1.85 (1.20–2.80)
Other (n=35)	0.85 (0.65–1.10)	1.10 (0.85–1.45)

MI: myocardial infarction, IS: ischemic stroke, HR: hazard ratio

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Discussion

Our study adds to the increasing literature on the burden of arterial ischemic events—specifically IS and MI—in patients with advanced cancer undergoing major surgery [16]. A notable finding is that, despite overlapping pathophysiologic and risk factor profiles, IS and MI differ in both clinical manifestations and management approaches [17,18]. While ischemic stroke is characterized by compromised blood flow in the cerebral vasculature, MI involves occlusion of the coronary arteries [19]. Consequently, a comprehensive postoperative monitoring protocol that addresses both neurologic and cardiac parameters is vital, in accordance with structured perioperative data collection standards [20].

Our results indicate that arterial ischemic events often cluster in the early postoperative period, with older and male patients disproportionately affected. This pattern aligns with prior evidence suggesting that age and sex modify an individual's susceptibility to thrombotic complications [12,13,17]. It also justifies closer clinical monitoring and, in certain high-risk subsets, a more aggressive antithrombotic regimen. Meanwhile, younger patients (<50 years) exhibited fewer ischemic episodes, possibly reflecting lower baseline cardiovascular risk profiles [2,10]. These observations underscore the importance of individualized perioperative decision-making, wherein the balance of pharmacologic prophylaxis benefits versus potential bleeding complications is carefully weighed.

Nonetheless, there are limitations to this study. Since this is a single-center study, it may be subject to selection and information biases, potentially limiting the generalizability of the findings. Additionally, we did not capture the full range of intraoperative management techniques, variations of which might independently influence the incidence of postoperative IS and MI. Moreover, our sample exclusively comprised advanced-stage malignancies; thus, the applicability of these findings to patients with early-stage cancers or non-oncologic surgeries remains uncertain. Future prospective, multicenter studies with larger populations could enhance external validity and refine risk stratification algorithms, incorporating tumor type, comorbidities, and specific perioperative variables.

Conclusion

In conclusion, our data align with the growing recognition that vigilant perioperative monitoring and targeted management are essential to reduce the risk of arterial ischemic events in advanced cancer patients. By integrating refined risk assessment methods, standardized data collection, and timely therapeutic interventions, clinicians may diminish the incidence and severity of these serious complications. Ultimately, this multifaceted approach can improve postoperative outcomes and maintain quality of life in patients facing advanced malignancies as well as significant cardiovascular and neurologic risks.

Conflict of Interests
The authors declare that there is no conflict of interest in the study.

Financial Disclosure
The authors declare that they have received no financial support for the study.

Ethical Approval
This study was approved by the Gelişim University Ethics Committee (protocol number 2024-20-09, date: 19 December 2024).

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