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Stroke after coronary artery bypass grafting (CABG): A single center experience

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Ethics Committee Approval
The study was approved by the Institutional Review Board (IRS) on 05/02/2024 – May 2 or February 5?, number 95954 at the University of Kentucky.
All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

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No conflict of interest was declared by the authors.

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Abstract

Background/Aim: Coronary artery bypass grafting (CABG) is among the ten most commonly performed surgical procedures in the United States. Despite advances in surgical techniques and perioperative care, stroke remains a serious complication, associated with significant morbidity and mortality. The aim of this study is to determine the incidence of stroke following CABG at a single institution, compare it with published rates from other centers, and identify common perioperative risk factors to support targeted, population specific prevention strategies.

Methods: We conducted a retrospective chart review of 3,126 adult patients who underwent isolated coronary artery bypass grafting at our institution between 2016 and 2023. Data were collected on demographic variables, comorbidities, and perioperative factors. The incidence of postoperative stroke was determined, and comparative statistical analysis were performed to identify potential risk factors.

Results: Postoperative stroke occurred in 1.3% of patients (41 of 3,126). The majority of affected individuals were white males aged 61 years or older. Common preoperative comorbidities included hypertension (95%), hyperlipidemia (87.8%), diabetes mellitus (75.6%), and a history of atrial fibrillation (26.7%). Postoperative respiratory failure was observed in 92.7% of stroke patients. Overall mortality in this group was 29.3%, with 24.2% of the casualties occurring within 30 days of surgery and an additional 4.9% within five years.

Conclusions: The incidence of stroke following CABG at our institution (1.3%) falls within the range reported in the literature (1.2%–5.2%). Stroke was associated with longer hospital stays and increased mortality. Hypertension, diabetes mellitus, and hyperlipidemia emerged as the most prominent risk factors. These findings highlight the need for early risk stratification and proactive management of modifiable comorbidities to minimize stroke incidence in patients undergoing CABG.

Keywords: coronary artery bypass grafting, stroke, hypertension, diabetes, hyperlipidemia, risk factors

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Introduction

Cerebrovascular injury following coronary artery bypass grafting (CABG) remains a serious complication associated with high morbidity and mortality rates [1]. CABG is often indicated for patients with significant coronary artery disease who are not suitable candidates for percutaneous coronary intervention (PCI), and it continues to be the preferred revascularization strategy in cases involving diabetes mellitus, left ventricular systolic dysfunction, or rescue intervention after failed PCI [2]. Although the overall incidence of stroke following CABG is relatively low [3], its profound impact on patient recovery and long-term survival underscores the importance of continued investigation.

Despite a global decline in stroke incidence after CABG procedures [4], gaps remain in the literature regarding institutional variations in outcomes and the longitudinal impact of specific risk factors. Numerous studies have explored associations between stroke and both preoperative and postoperative characteristics. Factors, such as advanced age, hypertension, diabetes mellitus, peripheral vascular disease, atrial fibrillation, and the number of grafts, have been identified as significant contributors to stroke risk [1, 3, 5–7]. However, comparative analyses across healthcare centers remain limited.

The primary objective of this study is to determine the incidence of stroke following CABG at our institution and compare it with rates reported by other centers. Additionally, we aim to identify perioperative risk factors associated with both early and delayed stroke occurrence to support improved risk stratification and preventative strategies in this population.

Materials and methods

After obtaining approval from the Institutional Review Board (IRB), we conducted a retrospective cohort study of adult patients (aged 18-90 years) who underwent isolated CABG between January 1, 2016, and December 31, 2023, at our institution.

Clinical and demographic data were extracted from electronic medical records, including age, sex, smoking history, and medical comorbidities such as diabetes mellitus, hypertension, peripheral vascular disease, atrial fibrillation, prior stroke, previous cardiac surgery, hyperlipidemia, and chronic obstructive pulmonary disease (COPD). Surgical details, stroke type, discharge status, and postoperative complications were also recorded.

In-hospital outcomes and long-term events (up to 10 years) were assessed when data were available. Patients were included if they had undergone isolated CABG, but had no preoperative neurological deficits.

Statistical analysis

Statistical analyses were performed using Microsoft Excel (Microsoft Corp., Redmond, WA, USA). Continuous variables were summarized as mean values, and categorical variables were expressed as frequencies and percentages.

Comparisons between short-term (<72 hours) and long-term (>72 hours) stroke groups were performed using the Student's t-test for continuous variables and the chi-square test or Fisher's exact test for categorical variables, as appropriate. A two-tailed *P*-value <0.05 was considered statistically significant.

Results

Among 3,126 patients who underwent isolated CABG, 41 (1.3%) experienced postoperative stroke. Affected patients were predominantly older, white males with elevated BMI. Hypertension, diabetes mellitus, and hyperlipidemia were the most usual comorbidities among stroke patients. Prior stroke, atrial fibrillation, and smoking history were also common. Full distributions of demographic and preoperative variables are presented in Table 1.

Nearly all stroke patients underwent on-pump CABG, with mean bypass and clamp times exceeding two hours. Strokes were more common after multi-vessel procedures, particularly those involving three or more grafts (Table 2).

Table 1: Preoperative characteristics of stroke patients undergoing CABG (n=41)

Variable	No. (%)
Hypertension	39 (95)
Hyperlipidemia	36 (87.8)
Diabetes mellitus	31 (75.6)
Prior stroke	15 (36.6)
Smoker	14 (34)
Past smoker	13 (31.7)
Prior Atrial Fibrillation	11 (26.7)
Chronic Obstructive Pulmonary Disease (COPD)	11 (26.7)
Peripheral vascular disease	6 (14.5)
Prior cardiac surgery	6 (14.5)

Table 2: Operative characteristics of stroke patients (n=41)

Variable	No. (%)
On pump	40 (97.6)
Cardiopulmonary Bypass time, mean	157.5
Clamp time, mean	115.4
Patients with unknown clamp and bypass time	2 (4.9)
Type of surgery	
CABG single vessel	2 (4.9)
CABG two vessels	5 (12.2)
CABG three vessels	**16 (39)**
CABG four vessels	**12 (29.3)**
CABG five vessels	5 (12.2)
CABG six vessels	1 (2.3)

CABG: coronary artery bypass graft

Most strokes occurred within 24 hours of surgery, with an additional cluster around day 10. Respiratory failure and myocardial infarction were the most frequent complications, and mortality approached one-third of these cases. Only a minority of patients were discharged and sent home, with many requiring rehabilitation or long-term care (Table 3).

When stratified by timing, short-term (<72h) and long-term (>72h) strokes shared similar risk profiles. However, patients with short-term stroke were more likely to require rehabilitation (*P*=0.02), whereas those with long-term stroke were more frequently discharged and sent home (*P*=0.01). Stroke subtypes also differed, with periventricular infarctions predominating early and thalamic events occurring more commonly later (*P*=0.03) (Table 4).

Table 3: Postoperative outcomes among stroke patients (n=41)

Variable	No. (%)
30-d after surgery mortality	10 (24.2)
1-y after surgery mortality	0 (0)
5-y after surgery mortality	2 (4.9)
+5-y after surgery mortality	0 (0)
Time between surgery and stroke	
Time between surgery and stroke (24h)	14 (34)
Time between surgery and stroke (3d)	3 (7.2)
Time between surgery and stroke (10d)	13 (31.7)
Time between surgery and stroke (20d)	6 (14.5)
Time between surgery and stroke (30d)	5 (12.2)
Length of Stay Data	
Days at hospital, mean	21.9
Days at ICU, mean	8.4
Perioperative stroke	33 (80.5)
Discharge	
Discharge status (home)	13 (31.7)
Discharge status (rehab)	17 (41.5)
Discharge status (hospice)	1 (2.3)
Discharge status (Nursing home/long-term)	3 (7.2)
Discharge status (dead)	6 (14.5)
Discharge status (other)	1 (2.3)
Post-Op Complications	
Post-op bleeding	4 (9.7)
Post-op infection	2 (4.9)
Post-op atrial fibrillation	18 (43.9)
Post-op renal failure	15 (36.6)
Post-op respiratory failure	38 (92.7)
Perioperative myocardial infarction	31 (75.6)
Type of stroke	
White matter periventricular infarction	20 (48.8)
Thalamic stroke	7 (17)
Stroke due to occlusion of left middle cerebral artery	3 (7.2)
Stroke due to stenosis of left anterior cerebral artery	2 (4.9)
Occlusion of left posterior inferior cerebellar artery with infarction	1 (2.3)
Stroke due to occlusion of left carotid artery	1 (2.3)
Stroke due to embolism of right middle cerebral artery	1 (2.3)
Stroke due to embolism of cerebral artery	1 (2.3)
CVA due to thrombosis of left middle cerebral artery	1 (2.3)
CVA due to thrombosis of right middle cerebral artery	1 (2.3)
CVA due to bilateral occlusion of posterior cerebral arteries	1 (2.3)
Right temporal lobe infarction	1 (2.3)
Right pontine stroke	1 (2.3)

CVA: cerebrovascular accident

Table 4: Comparison of short-term and long-term stroke cases after CABG

Variable	Short term (n=17)	Long term (n=24)	*P*-values
	No. (%)	No. (%)	No.
Age, mean	66.8	64.7	-
Male	13 (76.5)	15 (62.5)	0.499
Body Mass Index, mean	32.3	31.9	-
White	16 (94)	24 (100)	0.415
Diabetes Mellitus	13 (76.5)	18 (75)	1.000
Hyperlipidemia	16 (94)	20 (83.2)	0.382
Hypertension	16 (94)	23 (95.7)	1.000
Peripheral vascular disease	3 (17.5)	3 (12.5)	0.679
Atrial fibrillation	6 (35.3)	5 (20.7)	0.476
Chronic Obstructive Pulmonary Disease (COPD)	5 (29.3)	6 (25)	1.000
Prior stroke	8 (47)	7 (29.2)	0.328
Prior cardiac surgery	3 (17.5)	3 (12.5)	0.679
Smoker	4 (23.4)	10 (41.7)	0.321
Past smoker	4 (23.4)	9 (37.5)	0.499
Days at hospital, mean	20.4	23.1	-
Days at ICU, mean	16.3	11.2	-
Discharge status (home)	1 (5.9)	12 (50)	0.005
Discharge status (rehab)	11 (64.7)	6 (25)	0.023
Discharge status (hospice)	0 (0)	1 (4.2)	1.000
Discharge status (Nursing home/long-term)	1 (5.9)	2 (8.2)	1.000
Discharge status (dead)	4 (23.4)	2 (8.2)	0.212
Discharge status (other)	0 (0)	1 (4.2)	1.000
Post-op bleeding	2 (11.8)	2 (8.2)	1.000
Post-op infection	1 (5.9)	1 (4.2)	1.000
Post-op atrial fibrillation	7 (41.2)	11 (45.7)	1.000
Post-op renal failure	7 (41.2)	8 (33.2)	0.745
Post-op respiratory failure	15 (88.1)	23 (95.7)	0.560
Mortality	4 (23.4)	8 (33.2)	0.729
On pump	17 (100)	24 (100)	1.000
Perioperative myocardial infarction	12 (70.6)	19 (79.2)	-
Cardiopulmonary Bypass time, mean	167.1	150.2	-
Clamp time, mean	130	104.2	-
Patients with unknown clamp and bypass time	0 (0)	2 (8.2)	0.502
Type of surgery			
CABG single vessel	1 (5.9)	1 (4.2)	1.000
CABG two vessels	3 (17.5)	2 (8.2)	0.633
CABG three vessels	7 (41.2)	9 (37.5)	1.000
CABG four vessels	5 (29.3)	7 (29.2)	1.000
CABG five vessels	1 (5.9)	4 (16.7)	0.072
CABG six vessels	0 (0)	1 (4.2)	0.417
Type of stroke			
White matter periventricular infarction	7 (41.2)	3 (12.5)	0.152
Occlusion of left posterior inferior cerebellar artery with infarction	1 (5.9)	0 (0)	1.000
Stroke due to occlusion of left middle cerebral artery	1 (5.9)	2 (8.2)	0.523
Stroke due to occlusion of left carotid artery	1 (5.9)	0 (0)	1.000
Stroke due to embolism of right middle cerebral artery	0 (0)	1 (4.2)	0.417
Stroke due to embolism of cerebral artery	1 (5.9)	0 (0)	1.000
Stroke due to stenosis of left anterior cerebral artery	1 (5.9)	1 (4.2)	1.000
CVA due to thrombosis of left middle cerebral artery	1 (5.9)	0 (0)	1.000
CVA due to thrombosis of right middle cerebral artery	0 (0)	1 (4.2)	0.417
CVA due to bilateral occlusion of posterior cerebral arteries	1 (5.9)	0 (0)	1.000
Thalamic stroke	2 (11.8)	5 (20.7)	0.028
Right temporal lobe infarction	0 (0)	1 (4.2)	0.417
Right pontine stroke	1 (5.9)	0 (0)	1.000

Discussion

Neurologic complications after CABG remain a significant concern despite advances in surgical and perioperative care [5]. In our single-center cohort of 3,126 patients, the stroke incidence was 1.3%, consistent with published rates of 1.2% - 5.2% [3, 8–12].

Age emerged as an important non-modifiable risk factor, as stroke patients were on average older than the general CABG population. These findings are parallel with prior studies linking advanced age with increased susceptibility to both embolic and hypoperfusion-related stroke [5–6, 13–14].

Common comorbidities among stroke patients included hypertension, diabetes, and hyperlipidemia. While these conditions are prevalent in the CABG population overall, their high frequency in our cohort underscores their shared pathophysiologic role in atherosclerosis. This aligns with earlier reports that identified these comorbidities as independent predictors of perioperative stroke [2]. Optimizing their control remains central to prevention strategies.

Interestingly, the majority of stroke cases occurred in men, in contrast with some studies that reported higher risk in women [3, 15]. This discrepancy may reflect population-specific differences and warrants further study.

We also observed a trend toward greater stroke risk in patients undergoing multi-vessel CABG. Prior research similarly links surgical complexity, longer bypass times, and increased aortic manipulation with elevated stroke risk [6].

Postoperative atrial fibrillation was frequent among stroke patients, reinforcing its role as a modifiable predictor of embolic stroke [6, 16, 17]. Careful rhythm surveillance and timely anticoagulation may help mitigate this risk.

Complications such as respiratory and renal failure were common, consistent with previous studies associating multisystem complications with poor neurologic outcomes [8]. Neuroimaging patterns suggested dual mechanisms: hypoperfusion (white matter infarctions) and embolism (thalamic and MCA strokes); this aligns with prior pathophysiologic models.

Mortality among stroke patients was high, with most deaths occurring within 30 days of surgery, a trend also described in previous studies [3, 8]. These findings highlight the need for early identification of high-risk patients [18] and system-level preventive strategies, including comprehensive preoperative evaluation and intraoperative monitoring.

Overall, our results support the implementation of targeted risk reduction and dedicated stroke-prevention pathways for CABG patients [19].

Limitations

This study was a single-center retrospective analysis, which may limit the generalizability of the findings to other institutions or populations. Additionally, the relatively small number of stroke cases (n=41) reduced the statistical power to detect associations with less prevalent risk factors. Missing data on certain intraoperative variables, such as bypass and clamp times, and incomplete long-term follow-up for some patients may have introduced bias. Future prospective, multicenter studies with larger sample sizes and comprehensive data collection are needed to validate and extend these observations.

Conclusions

The incidence of stroke following CABG at our institution aligns with rates reported by other centers. Notably, the identification of key risk factors including hypertension, diabetes mellitus, and perioperative respiratory failure, underscores critical targets for intervention. The implementation of tailored perioperative strategies addressing these modifiable risks may help reduce postoperative complications and improve overall patient outcomes. Future prospective studies are needed to assess the effectiveness of such interventions in lowering stroke incidence and improving long-term prognoses in this population.

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