



Carotid artery stenosis as an independent risk factor for perioperative strokes following mitral valve surgical intervention



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ABSTRACT

Objective: To examine the role of carotid stenosis (CS) and other independent risk factors of perioperative stroke following either mitral valve repair or replacement.

Methods: Using data from the National Inpatient Sample (NIS) database for analysis, all patients who underwent either mitral valve repair or replacement were identified using ICD-9 codes.

Results: A total of 79,583 patients who underwent either mitral valve replacement or repair were studied. 3.39% of the total cohort developed perioperative stroke. With a mean age of 62.78 ± 0.23 , there was a statistically significant amount of stroke cases in age ranges 65–74 and 75–84 ($p < 0.05$). Risk stratification was done using Van Walraven (VWR) scoring and the cohort had a mean of 2.73 ± 0.06 . The following independent predictors were found to be significant: age, female gender, moderate and high VWR risk, both symptomatic and asymptomatic CS, atrial fibrillation, previous h/o smoking, and other cardiac valve procedures performed, and congestive heart failure (CHF).

Conclusion: CS is a significant risk factor for perioperative strokes following mitral valve surgery. Further prospective clinical studies are needed that look into risk stratification of patients for better patient selection and the question of whether carotid revascularization procedures will be beneficial in reducing stroke rates.

1. Introduction

Perioperative strokes are a feared complication secondary to mitral valve surgical intervention with a high incidence rate of 8–10% and are a dominant cause for post-operative morbidity and quality of life [1–4]. Over 10,000 mitral valve (MV) procedures are performed each year in the US [5] with the number of procedures increasing annually due to a growing elderly population as well as a better understanding of valvular assessment, exposure, and repair [5–7]. An operative mortality of 2% for MV repair and 6% for MV replacement has been reported with mortality rates increasing depending on the complexity of the intervention [5]. Perioperative strokes secondary to emboli and hypoperfusion has been shown to be the strongest risk factor for post-operative morbidity and mortality following cardiac valve procedures including MV surgery [3,4,8,9]. A detailed analysis of the risk factors contributing to perioperative strokes on a large patient cohort will help us move forward in strategies to prevent them and thereby improve overall post-operative survival following MV surgery.

Symptomatic carotid stenosis appears to be a significant risk factor for the incidence of perioperative strokes following cardiac operations [1,4,9–11]. Previous studies show that the prophylactic treatment of carotid stenosis by carotid revascularization leads to lower mortality rates following coronary artery bypass and other cardiovascular procedures [10,11].

Extracorporeal pump systems house internal surfaces with foreign materials that promote the formation of gaseous or particulate micro-emboli despite heparinization, and cannulation and clamping/unclamping of the aorta elicits embolic showers, which increases the risk of ischemia during surgery [12]. Additionally, impaired cerebral autoregulation distal to the stenotic carotid artery further increases the risk of stroke in patients with comorbid diseases such as hypertension and diabetes [4,12–14]. Vertebral and basilar artery stenoses have been reported to contribute to ischemic strokes following cardiac procedures [15].

Our primary aim of this study is to see if carotid artery stenosis is an independent risk factor for perioperative stroke secondary to mitral

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Table 1
Baseline characteristics and perioperative stroke univariate analysis in patients undergoing either mitral valve replacement or mitral valve repair.

Variables	% of Patients	Perioperative strokes			
		Yes % (n)	No % (n)	Unadjusted odds ratio (95% confidence interval CI)	p-Value
Age - M ± SD	62.78 ± 0.23				
< 65	47.53%	2.84% (1069)	97.16% (36,589)	NA	NA
65–74	28.45%	3.65% (821)	96.35% (21,737)	1.296 (1.178–1.426)	< 0.001
75–84	22.70%	4.14% (742)	95.86% (17,220)	1.478 (1.342–1.627)	< 0.001
> 85	13.08%	3.56% (36)	96.44% (994)	1.263 (0.907–1.759)	0.167
Gender					
Male	50.11%	2.98% (1188)	97.02% (38,779)	NA	NA
Female	49.89%	3.80% (1511)	96.20% (38,290)	1.288 (1.189–1.394)	< 0.001
Race/ethnicity					
White	78.25%	3.40% (1625)	96.60% (46,186)	NA	NA
African American	8.58%	3.81% (200)	96.19% (5105)	1.123 (0.960–1.313)	0.148
Hispanic	6.62%	3.52% (143)	96.48% (3937)	1.036 (0.865–1.241)	0.7
Asian	2.70%	3.48% (56)	96.52% (1590)	1.023 (0.783–1.338)	0.864
Native American	0.50%	3.37% (10)	96.63% (287)	0.990 (0.530–1.848)	0.975
Other/missing	3.34%	3.49% (72)	96.51% (1960)	1.027 (0.813–1.298)	0.823
Admission status					
Emergent	18.38%	5.59% (728)	94.41% (12,326)	NA	NA
Urgent	19.36%	4.14% (572)	95.86% (13,294)	0.729 (0.636–0.836)	< 0.001
Elective	62.22%	2.52% (1113)	97.48% (43,117)	0.436 (0.388–0.491)	< 0.001
Risk Category					
Average von Walraven score	2.73 ± 0.06				
Low risk (VWR < 5)	70.19%	2.15% (1198)	97.85% (54,782)	NA	NA
Moderate risk (VWR 5–14)	27.62%	5.65% (1246)	94.35% (20,813)	0.729 (0.636–0.836)	< 0.001
High risk (VWR > 14)	2.19%	14.43% (254)	85.57% (1493)	0.436 (0.387–0.490)	< 0.001
Outcome					
Perioperative stroke	3.39%				
Pre-operative risk factors					
Asymptomatic carotid stenosis	1.21%	5.08% (48)	94.02% (927)	1.535 (1.151–2.047)	0.004
Symptomatic carotid stenosis	0.04%	50.02% (15)	48.98% (15)	28.704 (13.965–58.999)	< 0.001
Asymptomatic + symptomatic carotid stenosis	1.24%	6.44% (63)	93.56% (942)	1.987 (1.543–2.559)	< 0.001
Pre-cerebral artery stenosis (other)	0.44%	4.05% (14)	95.95% (340)	1.203 (0.6899–2.099)	0.514
Cerebral occlusion	0.15%	10.29% (12)	89.71% (105)	3.283 (1.828–5.897)	< 0.001
Vertebral artery stenosis	0.01%	0.00% (0)	100% (9)	NA	NA
Basilar artery stenosis	0.00%	0.00% (0)	100% (2)	NA	NA
Congestive heart failure (CHF)/Left ventricular dysfunction	8.08%	3.04% (197)	96.96% (6286)	0.885 (0.760–1.032)	0.119
Atrial fibrillation	51.61%	3.13% (1288)	96.87% (39,872)	0.0852 (0.789–0.920)	< 0.001
Previous h/o stroke or transient ischemic attack	13.66%	2.53% (28)	97.47% (1070)	0.738 (0.505–1.079)	0.117
Infective endocarditis	4.55%	16.42% (597)	83.58% (3030)	6.905 (6.208–7.681)	< 0.001
Aortic stenosis	1.63%	3.66% (48)	96.34% (1244)	1.085 (0.824–1.431)	0.56
Previous h/o smoking	9.50%	1.95% (146)	98.05% (7403)	0.541 (0.456–0.643)	< 0.001
Previous h/o MI and angina	39.70%	3.18% (1009)	96.82% (30,758)	0.900 (0.831–0.976)	0.011
Previous h/o cardiac surgery	0.88%	1.13% (8)	98.87% (693)	0.324 (0.161–0.649)	0.001
Other cardiac valve procedures performed	0.78%	0.65% (4)	99.35% (620)	0.185 (0.081–0.421)	< 0.001
Previous h/o coronary artery disease w/CABG	0.01%	0.00% (0)	100% (8)	NA	NA
Cardiopulmonary bypass	88.76%	3.31% (2342)	96.69% (68,446)	0.826 (0.737–0.926)	0.001
Elixhauser comorbidities					
CHF	1.53%	12.68% (152)	87.32% (1044)	4.332 (3.625–5.177)	< 0.001
Multivalvular disease	1.29%	13.21% (134)	86.79% (880)	4.517 (3.743–5.450)	< 0.001
Pulmonary circulation disorders	0.42%	12.37% (42)	87.63% (289)	4.074 (2.856–5.812)	< 0.001
Peripheral vascular disease	5.59%	5.20% (235)	94.80% (4226)	1.617 (1.378–1.896)	< 0.001
Paralysis	1.12%	54.05% (487)	45.95% (413)	40.662 (34.879–47.404)	< 0.001
Other neurological disorders	2.71%	17.57% (382)	82.43% (1784)	6.914 (6.170–7.748)	< 0.001
Chronic pulmonary disorders	18.62%	2.90% (431)	97.10% (14,471)	0.822 (0.734–0.921)	0.001
DM, uncomplicated	13.31%	3.16% (339)	96.84% (10,312)	0.922 (0.812–1.047)	0.209
DM, complicated	2.28%	5.42% (98)	94.58% (1713)	1.659 (1.314–2.095)	< 0.001
Hypothyroidism	7.86%	2.28% (141)	97.72% (6127)	0.648 (0.551–0.762)	< 0.001
Renal failure	8.67%	5.38% (375)	94.62% (6567)	1.722 (1.537–1.929)	< 0.001
Liver failure	1.13%	3.97% (36)	96.03% (861)	1.183 (0.813–1.721)	0.38
Peptic ulcer disease	0.44%	4.03% (14)	95.97% (337)	1.200 (0.724–1.988)	0.48
AIDS	0.10%	2.43% (2)	97.57% (75)	0.711 (0.184–2.743)	0.621
Lymphoma	0.49%	3.04% (12)	96.96% (374)	0.893 (0.486–1.642)	0.716
Metastatic cancer	0.12%	3.13% (3)	96.87% (94)	0.922 (0.292–2.906)	0.89
Solid tumor w/o metastasis	1.97%	2.72% (42)	97.28% (1522)	0.795 (0.587–1.076)	0.138
Collagen vascular disorders	1.97%	2.59% (40)	97.41% (1534)	0.753 (0.558–1.017)	0.065
Coagulopathy	16.20%	4.20% (546)	95.80% (12,403)	1.313 (1.182–1.459)	< 0.001
Obesity	5.65%	2.61% (119)	97.39% (4403)	0.754 (0.617–0.923)	0.006
Weight loss	3.05%	10.29% (250)	89.71% (2179)	3.502 (3.016–4.066)	< 0.001

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