

## ORIGINAL ARTICLE

# Determinants of Carotid Artery Stenosis in Patients Undergoing Coronary Artery Bypass Grafting – A Logistic Regression Approach

DOI: 10.5281/zenodo.18132837

Abdullah Al Shoyeb<sup>1</sup>, Atiqur Rahman<sup>2</sup>, Ibrahim Khalilullah<sup>3</sup>, Khaleda Parvin Deepa<sup>4</sup>, Jesmin Ara Parven<sup>4</sup>, Rakibul Hasan<sup>5</sup>, Mostafizur Rahman Ratan<sup>6</sup>

Received: 27 Dec 2025  
Accepted: 30 Dec 2025  
Published Online: 02 Jan 2026

Published by:  
Gopalganj Medical College, Gopalganj,  
Bangladesh

Correspondence to  
Abdullah Al Shoyeb

ORCID  
0009-0000-2383-7397

Copyright © 2025 The Insight



This article is licensed under a Creative Commons Attribution 4.0 International License.



## ABSTRACT

**Background:** Extracranial carotid artery stenosis (CAS) is a significant risk factor for perioperative stroke in coronary artery bypass graft (CABG) patients. CAS  $\geq 50\%$  occurs in up to one-third of patients, with severe stenosis ( $\geq 70\%$ ) in 7–11%. Stroke risk and mortality rise with stenosis severity. Key predictors include advanced age, hypertension, prior stroke, peripheral vascular disease, and left main coronary disease. CAS increases the risk of cerebral hypoperfusion and postoperative neurological complications. Preoperative screening of high-risk patients is recommended to enable timely management, reduce perioperative stroke, and improve CABG outcomes. **Methods & Materials:** This hospital-based study at BSMMU, Dhaka (March 2017–Feb 2019) included 112 CABG patients, grouped by carotid artery stenosis (CAS) status. Demographic, clinical, and comorbidity data were collected, and preoperative carotid Doppler assessed CAS. Data analysis used SPSS v23 with Chi-square/Fisher's tests and multivariate logistic regression to identify independent CAS predictors ( $p < 0.05$ ). **Results:** Among 112 CABG patients, those with CAS were older and had higher rates of hypertension, diabetes, and smoking. Logistic regression identified age, smoking, hypertension, and diabetes as independent risk factors for CAS, while LMCAD and CKD were not significant predictors. **Conclusion:** Age, smoking, hypertension, and diabetes were independent predictors of carotid artery stenosis (CAS) in CABG patients, while LMCAD and CKD were not. These findings emphasize the need for targeted preoperative CAS screening in older, hypertensive, diabetic, and smoking patients to reduce perioperative cerebrovascular complications.

**Keywords:** Carotid Artery Stenosis, Coronary Artery Bypass Grafting, Logistic Regression

(The Insight 2025; 8(4): 765-768)

1. Assistant Professor and Associate Consultant, Department of Cardiac Surgery, Ibrahim Cardiac Hospital and Research Institute, Dhaka, Bangladesh (ORCID: 0009-0000-2383-7397)
2. Associate Professor, Cardiovascular and Thoracic Surgery, Ad-Din Akij Medical College Hospital, Khulna, Bangladesh
3. Associate Professor, Department of Anesthesiology, Ibrahim Cardiac Hospital & Research Institute, Dhaka, Bangladesh
4. Assistant Professor and Associate Consultant, Department of Radiology and Imaging, Ibrahim cardiac hospital and research institute, Dhaka, Bangladesh
5. Associate Professor, Department of Vascular Surgery, Bangladesh Medical University, Dhaka, Bangladesh
6. Professor, Department of Cardio thoracic surgery, Bangladesh Medical University, Dhaka, Bangladesh

## INTRODUCTION

Cardiovascular disease (CVD) accounts for approximately 30% of deaths worldwide, while cerebrovascular disease contributes to around 10% [1]. Traditional risk factors include smoking, elevated blood lipids, hypertension, and diabetes, but recent studies have shown that microRNAs (miRNAs) also play a role in the development, progression, and potential treatment of CVD [2]. Extracranial carotid artery stenosis (CAS) is a recognized risk factor for perioperative stroke in patients undergoing coronary artery bypass graft (CABG) surgery [3]. Significant CAS is common among CABG patients. Studies report that nearly one-third of CABG patients have CAS  $\geq 50\%$  [4, 5]. In Western populations, CAS  $\geq 50\%$  occurs in 12.8–22% of patients, while severe stenosis ( $\geq 70\%$ ) is seen in 7–11% (Naylor et al., 2002; Brener et al., 1984). Meta-analyses show that perioperative stroke risk varies from 2% to 7.4%, depending on stenosis severity, pattern, and revascularization strategies [6]. Asian data are more limited, but prevalence of

50% stenosis has been reported at 25.4% in Japanese CAD patients [7], 23.9% in Korean CABG patients [8], and 11% for internal carotid and 2% for common carotid arteries in Chinese CAD patients [9]. Based on these findings, some authors recommend universal preoperative screening in Japanese CABG patients [10].

Current guidelines differ slightly. In the US, patients over 65 or with risk factors such as left main CAS, hypertension, PAD, smoking, or diabetes should undergo preoperative duplex ultrasonography [11]. European guidelines recommend screening for patients  $\geq 70$  years or with carotid bruit, multivessel CAD, PAD, or prior cerebrovascular disease [12]. Stroke risk correlates with stenosis severity, ranging from 3–10% in patients with 50–80% stenosis and reaching 22% in those with  $>80\%$  stenosis. Mortality rates in CABG patients with CAS range from 3.6% to 15.8% [13]. The economic burden of diagnosing and managing CAS further underscores the need for optimized CABG strategies [14].

Several studies have identified risk factors for significant CAS. Advanced age, hypertension, prior stroke, peripheral vascular disease (PVD), dialysis, and left main coronary artery disease are consistently associated with CAS, while predictors of severe stenosis (>70%) include prior cerebrovascular events and PVD [14]. Female gender is not a direct predictor, although women undergoing CABG are at higher risk of complications due to older age and comorbidities at presentation [15]. The presence of CAS increases the risk of neurological complications during cardiopulmonary bypass procedures. Intraoperative hemodynamic instability and anemia may lead to cerebral hypoperfusion, particularly in patients with extracranial carotid disease. Studies have demonstrated a direct relationship between the degree of CAS and ipsilateral stroke risk [16, 17].

Despite the recognized risk of CAS in CABG patients, data on the prevalence, severity, and determinants of CAS in South Asian populations remain scarce. Furthermore, clinical and demographic factors that independently predict CAS in this population have not been well established. Therefore, this study aimed to assess the prevalence and severity of CAS among patients undergoing CABG surgery and to identify the independent clinical and demographic determinants of CAS using logistic regression analysis. Findings from this study will help inform preoperative risk stratification and targeted management strategies in CABG patients in the South Asian context.

**METHODS & MATERIALS**

This hospital-based observational study was conducted at the Department of Cardiac Surgery, Bangabandhu Sheikh Mujib Medical University (BSMMU), Shahbagh, Dhaka, Bangladesh, from March 2017 to February 2019. A total of 112 patients who were scheduled to undergo coronary artery bypass grafting (CABG) surgery were recruited through purposive sampling. Based on the presence or absence of carotid artery stenosis (CAS), participants were divided into two groups: Group A (without CAS) and Group B (with CAS). Demographic, clinical, and comorbidity data—including age, sex, body mass index (BMI), hypertension, diabetes mellitus, dyslipidemia, smoking history, family history of coronary artery disease (CAD), left main coronary artery disease (LMCAD), and chronic kidney disease (CKD)—were collected using a

structured proforma. Carotid Doppler ultrasonography was performed preoperatively to determine the presence and degree of CAS. Data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 23. Descriptive statistics were used to summarize baseline characteristics, while comparisons between groups were conducted using the Chi-square or Fisher’s exact test, as appropriate. Variables showing significant associations in univariate analysis were entered into a multivariate logistic regression model to identify independent determinants of CAS. A p-value <0.05 was considered statistically significant.

**RESULTS**

A total number of 112 patients undergoing CABG surgery were recruited for this study and according to the present or absent of CAS they are divided into Group A and Group B.

**Baseline Characteristics between Group A and Group B**

Table I presents the comparison of baseline characteristics between Group A and Group B. The majority of participants aged below 60 years were in Group A (77.77%), while those aged above 60 years were significantly higher in Group B (72.36%), showing a highly significant difference (p<0.000001). The male-to-female ratio was similar between the groups, with no significant difference (p=0.724). Regarding body mass index (BMI), both groups had comparable distributions of normal and overweight individuals (p=0.596). Hypertension and diabetes mellitus were significantly more prevalent among participants in Group B compared to Group A (p=0.002 and p=0.001, respectively). Dyslipidemia showed no significant difference between the groups (p=0.908). A history of smoking was found to be significantly higher in Group B (61.84%) than in Group A (27.77%) (p=0.000758). Family history of coronary artery disease (CAD) did not differ significantly between the two groups (p=0.448). However, left main coronary artery disease (LMCAD) was significantly more common in Group B (36.85%) compared to Group A (16.67%) (p=0.003). Similarly, chronic kidney disease (CKD) was also significantly higher in Group B (22.37%) than in Group A (5.56%) (p=0.0268). Overall, the findings indicate that Group B participants were older and had a higher prevalence of hypertension, diabetes, smoking, LMCAD, and CKD compared to Group A.

**Table – I: Comparison of Baseline Characteristics between Group A and Group B**

| Variable                     | Category   | Group A (n=36) | Group B (n=76) | p-value                 |
|------------------------------|------------|----------------|----------------|-------------------------|
| Age                          | <60 years  | 28 (77.77%)    | 21 (27.63%)    | <0.000001 <sup>ts</sup> |
|                              | ≥60 years  | 8 (22.22%)     | 55 (72.36%)    |                         |
| Sex                          | Male       | 29 (80.55%)    | 59 (77.63%)    | 0.724685 <sup>ns</sup>  |
|                              | Female     | 7 (19.44%)     | 17 (22.36%)    |                         |
| BMI                          | Normal     | 17 (47.22%)    | 40 (52.63%)    | 0.596 <sup>ns</sup>     |
|                              | Overweight | 19 (52.77%)    | 36 (47.36%)    |                         |
| Hypertension (HTN)           | Yes        | 20 (55.55%)    | 69 (90.78%)    | 0.002 <sup>s</sup>      |
|                              | No         | 16 (44.44%)    | 7 (9.21%)      |                         |
| Diabetes Mellitus (DM)       | Yes        | 13 (36.11%)    | 52 (68.42%)    | 0.001 <sup>s</sup>      |
|                              | No         | 23 (63.89%)    | 24 (31.58%)    |                         |
| Dyslipidemia (DL)            | Yes        | 19 (52.78%)    | 41 (53.95%)    | 0.908 <sup>ns</sup>     |
|                              | No         | 17 (47.22%)    | 35 (46.05%)    |                         |
| Smoking History              | Yes        | 10 (27.77%)    | 47 (61.84%)    | 0.000758 <sup>s</sup>   |
|                              | No         | 26 (72.22%)    | 29 (38.15%)    |                         |
| Family History of CAD        | Yes        | 12 (33.33%)    | 31 (40.79%)    | 0.448 <sup>ns</sup>     |
|                              | No         | 24 (66.67%)    | 45 (59.21%)    |                         |
| LMCAD                        | Yes        | 6 (16.67%)     | 28 (36.85%)    | 0.003 <sup>s</sup>      |
|                              | No         | 30 (83.33%)    | 48 (63.75%)    |                         |
| Chronic Kidney Disease (CKD) | Yes        | 2 (5.56%)      | 17 (22.37%)    | 0.0268 <sup>s</sup>     |
|                              | No         | 34 (94.44%)    | 59 (77.63%)    |                         |

Chi-square test and Fisher’s exact test was done; <sup>s</sup> = Significant, <sup>ns</sup> = Not significant

**Logistic Regression analysis**

Table II shows the results of logistic regression analysis performed on variables that were found to be significant in the univariate analysis. The findings indicate that age, smoking, hypertension (HTN), and diabetes mellitus (DM) were identified as independent risk factors for coronary artery stenosis (CAS). Increasing age was significantly associated with CAS (OR = 1.148, 95% CI = 0.044–0.496,  $p = 0.002$ ). Smoking also emerged as an independent predictor (OR = 7.26, 95% CI = 1.994–26.464,  $p = 0.003$ ). Similarly,

hypertension showed a strong and significant association with CAS (OR = 27.831, 95% CI = 4.577–169.226,  $p < 0.001$ ). Diabetes mellitus was another significant independent risk factor (OR = 17.673, 95% CI = 3.654–85.137,  $p < 0.001$ ). However, left main coronary artery disease (LMCAD) (OR = 0.672, 95% CI = 0.204–2.221,  $p = 0.515$ ) and chronic kidney disease (CKD) (OR = 5.227, 95% CI = 0.732–37.331,  $p = 0.099$ ) were not found to be independent predictors of CAS in the regression model.

**Table - II: Logistic regression analysis of the significant factors associated with CAS**

| Variables | B      | WALD   | P VALUE             | OR     | 95% CI of OR |         |
|-----------|--------|--------|---------------------|--------|--------------|---------|
|           |        |        |                     |        | LOWER        | UPPER   |
| Age       | -1.911 | 9.579  | 0.002 <sup>s</sup>  | 1.148  | 0.044        | 0.496   |
| Smoking   | 1.983  | 9.036  | 0.003 <sup>s</sup>  | 7.26   | 1.994        | 26.464  |
| HTN       | 3.326  | 13.043 | 0.000 <sup>s</sup>  | 27.831 | 4.577        | 169.226 |
| LMCAD     | -0.397 | 0.424  | 0.515 <sup>ns</sup> | 0.672  | 0.204        | 2.221   |
| DM        | 2.870  | 12.768 | 0.000 <sup>s</sup>  | 17.673 | 3.654        | 85.137  |
| CKD       | 1.654  | 2.718  | 0.099 <sup>ns</sup> | 5.227  | 0.732        | 37.331  |

Logistic regression analysis of the significantly associated factors; B=Regression coefficient; OR = Odds Ratio; CI = Confidence Interval; <sup>s</sup> = Significant; <sup>ns</sup> = Not significant

**DISCUSSION**

In the present study, CAS-positive patients (Group B) were significantly older ( $\geq 60$  years), and had higher proportions of hypertension, diabetes mellitus, smoking history, LMCAD, and CKD compared with CAS-negative patients (Group A), while sex distribution, BMI categories, dyslipidemia, and family history of CAD showed no significant differences. These findings are partly consistent with previous literature [18,19], both identified cigarette smoking as the primary and most consistent risk factor for coronary artery spasm, supporting our observation of markedly higher smoking prevalence in Group B. However, those studies reported limited associations with hypertension, diabetes, or dyslipidemia—contrasting with our results where hypertension, diabetes, and CKD were significantly more common in the CAS group [20]. also emphasized smoking and dyslipidemia as key CAS predictors, with sex-related patterns not observed in our sample. Importantly, in a perioperative CABG context [21], noted that older age, hypertension, and diabetes were frequent among patients developing coronary artery spasm, aligning more closely with our findings and suggesting that comorbidity clustering in surgical patients may heighten susceptibility to CAS. Thus, the increased age, hypertension, diabetes, smoking, LMCAD, and CKD in our CAS-positive group reflect risk patterns more consistent with perioperative CABG studies than with general vasospastic angina populations.

Logistic regression results—showing that increasing age, smoking, hypertension (HTN), and diabetes mellitus (DM) are independent risk-factors for coronary artery stenosis (CAS), while left main coronary artery disease (LMCAD) and chronic kidney disease (CKD) are *not* significant in multivariate analysis—are broadly consistent with findings reported in the cardiology literature, although with some notable differences in effect magnitude and variable selection.

In many published studies on coronary artery disease (CAD) or stenosis, age, hypertension, diabetes, and smoking emerge as independent predictors. For example, in a Middle Eastern population undergoing coronary angiography, increasing age (age 45-54: OR 4.8; 55-64: OR 6.0;  $\geq 65$ : OR 15.7), diabetes (OR 2.6) and smoking (OR 2.1) were significant independent predictors [22].

**CONCLUSION**

Based on the findings of this study, age, smoking, hypertension, and diabetes mellitus were identified as significant independent determinants of carotid artery stenosis (CAS) among patients undergoing coronary artery bypass grafting (CABG). Older age and the presence of these cardiovascular risk factors substantially increased the likelihood of developing CAS. In contrast, left main coronary artery disease (LMCAD) and chronic kidney disease (CKD) were not found to be independent predictors after multivariate adjustment. These results highlight the importance of comprehensive preoperative screening for CAS, particularly among elderly, hypertensive, diabetic, and smoking patients, to optimize surgical outcomes and reduce perioperative cerebrovascular complications in CABG candidates.

**REFERENCES**

1. Akat KM, Tuschl T, Marks AR. A selective microRNA-based strategy inhibits restenosis while preserving endothelial function. *The Journal of clinical investigation*. 2014 Sep 2;124(9):4102-14.
2. Wronska A, Kurkowska-Jastrzebska I, Santulli G. Application of micro RNA s in diagnosis and treatment of cardiovascular disease. *Acta physiologica*. 2015 Jan;213(1):60-83.
3. Roffi M, Ribichini F, Castriota F, Cremonesi A. Management of combined severe carotid and coronary artery disease. *Current cardiology reports*. 2012 Apr;14(2):125-34.
4. Drohomirecka A, Kołtowski Ł, Kwinecki P, Wronecki K, Cichoń R. Risk factors for carotid artery disease in patients scheduled for coronary artery bypass grafting. *Polish Heart Journal (Kardiologia Polska)*. 2010;68(7):794-9.
5. Mahmoudi M, Hill PC, Xue Z, Torguson R, Ali G, Boyce SW, Bafi AS, Corso PJ, Waksman R. Patients with severe asymptomatic carotid artery stenosis do not have a higher risk of stroke and mortality after coronary artery bypass surgery. *Stroke*. 2011 Oct;42(10):2801-5.
6. Naylor AR, Bown MJ. Stroke after cardiac surgery and its association with asymptomatic carotid disease: an updated systematic review and meta-analysis. *European Journal of Vascular and Endovascular Surgery*. 2011 May 1;41(5):607-24.
7. Tanimoto S, Ikari Y, Tanabe K, Yachi S, Nakajima H, Nakayama T, Hatori M, Nakazawa G, Onuma Y, Higashikuni Y, Yamamoto H. Prevalence of carotid artery stenosis in patients with coronary artery disease in Japanese population. *Stroke*. 2005 Oct 1;36(10):2094-8.

8. Yoon BW, Bae HJ, Kang DW, Lee SH, Hong KS, Kim KB, Park BJ, Roh JK. Intracranial cerebral artery disease as a risk factor for central nervous system complications of coronary artery bypass graft surgery. *Stroke*. 2001 Jan;32(1):94-9.
9. Chen WH, Ho DS, Ho SL, Cheung RT, Cheng SW. Prevalence of extracranial carotid and vertebral artery disease in Chinese patients with coronary artery disease. *Stroke*. 1998 Mar;29(3):631-4.
10. Fukuda I, Gomi S, Watanabe K, Seita J. Carotid and aortic screening for coronary artery bypass grafting. *The Annals of thoracic surgery*. 2000 Dec 1;70(6):2034-9.
11. Brott TG, Halperin JL, Abbara S, Bacharach JM, Barr JD, Bush RL, Cates CU, Creager MA, Fowler SB, Friday G, Hertzberg VS. 2011 ASA/ACCF/AHA/AANN/AANS/ACR/ASNR/CNS/SAIP/SCAI/SIR/SNIS/SVM/SVS guideline on the management of patients with extracranial carotid and vertebral artery disease: a report of the American college of cardiology foundation/American heart association task force on practice guidelines, and the American stroke association, American association of neuroscience nurses, American association of neurological surgeons, American college of radiology, American society of neuroradiology, congress of neurological. *Journal of the American College of Cardiology*. 2011 Feb 22;57(8):e16-94.
12. Augoustides JG. Advances in the management of carotid artery disease: focus on recent evidence and guidelines. *Journal of Cardiothoracic and Vascular Anesthesia*. 2012 Feb 1;26(1):166-71.
13. Burgazli KM, Bilgin ME, Kavukcu E, Mericliler M, Bohl N, Atmaca N. Which is a better treatment for carotid artery stenosis: stenting or endarterectomy?. *European Review for Medical & Pharmacological Sciences*. 2013 Apr 15;17(8).
14. Shenoy AU, Aljutaili M, Stollenwerk B. Limited economic evidence of carotid artery stenosis diagnosis and treatment: a systematic review. *European Journal of Vascular and Endovascular Surgery*. 2012 Nov 1;44(5):505-13.
15. Siminelakis S, Kotsanti A, Siafakas M, Dimakopoulos G, Sismanidis S, Koutentakis M, Paziouros C, Papadopoulos G. Is there any difference in carotid stenosis between male and female patients undergoing coronary artery bypass grafting?. *Interactive cardiovascular and thoracic surgery*. 2009 Nov 1;9(5):823-6.
16. De Feo M, Renzulli A, Onorati F, Marmo J, Galdieri N, De Santo LS, Della Corte A, Cotrufo M. The risk of stroke following CABG: one possible strategy to reduce it?. *International journal of cardiology*. 2005 Feb 15;98(2):261-6.
17. Eagle KA, Guyton RA, Davidoff R, Edwards FH, Ewy GA, Gardner TJ, Hart JC, Herrmann HC, Hillis LD, Hutter Jr AM, Lytle BW. ACC/AHA 2004 guideline update for coronary artery bypass graft surgery: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (committee to update the 1999 guidelines for coronary artery bypass graft surgery). *Circulation*. 2004 Oct 5;110(14):e340-437.
18. Sugiishi M, Takatsu F. Cigarette smoking is a major risk factor for coronary spasm. *Circulation*. 1993 Jan;87(1):76-9.
19. Sato I, Tomita M, Ohe T, Haze K, Shimomura K. Age-related changes of clinical features and prevalences of coronary risk factors in Japanese patients with vasospastic angina. *Chest*. 1986 Jan 1;89(1):12-9.
20. Franczyk B, Dybiec J, Frąk W, Krzemińska J, Kućmierz J, Młynarska E, Szlagor M, Wronka M, Rysz J. Cellular mechanisms of coronary artery spasm. *Biomedicines*. 2022 Sep 21;10(10):2349.
21. Bourassa MG, Butnaru A, Lespérance J, Tardif JC. Symptomatic myocardial bridges: overview of ischemic mechanisms and current diagnostic and treatment strategies. *Journal of the American College of Cardiology*. 2003 Feb 5;41(3):351-9.
22. Al-Shudifat AE, Johannessen A, Azab M, Al-Shdaifat A, AbuMweis SS, Agraib LM, Tayyem RF. Risk factors for coronary artery disease in patients undergoing elective coronary angiography in Jordan. *BMC cardiovascular disorders*. 2017 Jul 11;17(1):183.