**Original article:**

**Carotid Doppler assessment of CAD patients undergoing Off Pump CABG: A useful investigation or unnecessary burden**

**Dr. Ravi Kumar1, Dr. Lakshmi Sinha1 , Dr. Ahmed Ali1, Dr.Satyajit Samal1,**

**Dr. HS Minhas2, Dr. MA Geelani3**

1MCh Senior Resident , CTVS Department, G.B.Pant Institute of Postgraduate Medical Education and Research (GIPMER) University of Delhi, New Delhi, India

2Professor, CTVS Department, G.B.Pant Institute of Postgraduate Medical Education and Research (GIPMER) University of Delhi, New Delhi, India

3Director & Professor, Head of the CTVS Department, G.B.Pant Institute of Postgraduate Medical Education and Research (GIPMER) University of Delhi, New Delhi, India

Corresponding author- Dr Lakshmi Sinha ; Email- dr.sannu2010@gmail.com

**Abstract:**

Carotid artery ultrasound screening before Off Pump Coronary Artery Bypass Grafting (OP CABG) to identify carotid artery disease requiring revascularization before or during CABG, with the expectation of reducing perioperative neurologic events, is a routine in many institutes across the world. However this practice is contrary to guidelines recommending screening in selected patients only8,9. As carotid artery disease might be a surrogate marker for diffuse atherosclerotic disease rather than a direct etiologic factor for post CABG neurological event {Fig 1}. We conducted a prospective observational study to assess the perioperative neurological outcome in patients of Coronary Artery disease undergoing Off Pump CABG, having done preoperative carotid ultrasound Doppler study.

**Keywords**: Carotid artery ultrasound, Off Pump CABG

**Introduction:**

Anastasiadis K, et all and Naylor AR (1 ) showed that routine carotid assessment may not be cost effective in asymptomatic patients. Gerraty R et all and Naylor AR (2) found out that the benefit of prophylactic carotid revascularization in patients with asymptomatic unilateral carotid disease is controversial. Sheiman and colleagues, used 7 risk factors (history of carotid artery disease, prior cerebrovascular event, hypertension, diabetes, peripheral artery disease, smoking, left main coronary disease, and female gender) to predict which patients have carotid artery disease. The presence of any 1 of these factors was 100% sensitive, but only 30% specific, in detecting patients with ≥50% carotid stenosis. Similarly, Cornily and colleagues, found that risk factors including age >70 years, history of cerebrovascular disease, diabetes mellitus, peripheral artery disease, or carotid bruit on physical examination could have detected 11 of 12 patients with significant carotid artery stenosis.

**Material and methods:**

Study included hundred patients with coronary artery disease admitted at our institute. Study period was from October 19 to February 21 who underwent Off Pump CABG(OPCABG) and immediate post operative neurological outcome was assessed in terms of stroke, seizures and TIA.

**Inclusion criteria**

1. All patients with coronary Artery disease fit for OP CABG
2. Asymptomatic patients for any neurological event.
3. No previous history of stroke, seizure and TIA.

**Exclusion criteria**

1. Patients with coronary artery disease and valvular heart disease undergoing both procedures.
2. Patients with history of stroke, seizures and TIA.
3. Symptomatic patients for neurological event.
4. Patients with preoperative arrhythmias.

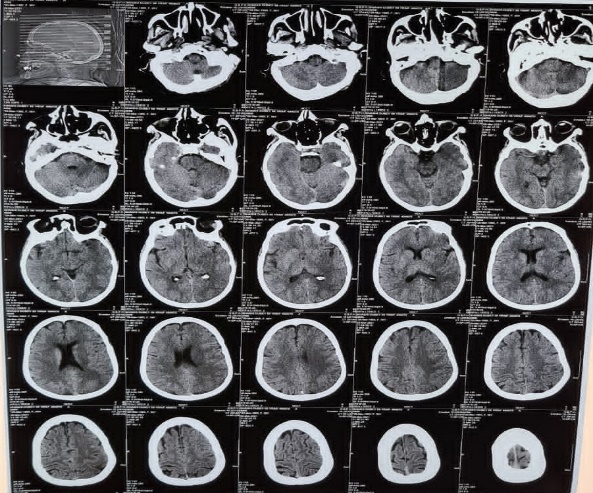


Fig 1 CT Picture showing left basal ganglia infarct in a 55 yr old female

following OPCABG with normal preoperative carotid doppler study

**Table 1:-Distribution of socio-demographic characteristics of study subjects.**

|  |  |  |
| --- | --- | --- |
| **Socio-demographic characteristics** |  |  |
| **Age(years)** | | |
| Mean ± SD | 53.16 ± 10.4 | |
| Median(25th-75th percentile) | 50(46-60) | |
| Range | 30-76 | |
| **Gender** | | |
| Female | 4 | 4.00% |
| Male | 96 | 96.00% |

**Table 2:-Distribution of single/double/triple vessel disease of study subjects.**

|  |  |  |
| --- | --- | --- |
| **Single/double/triple vessel disease** | **Frequency** | **Percentage** |
| Single vessel disease | 0 | 0.00% |
| Double vessel disease | 12 | 12.00% |
| Triple vessel disease | 88 | 88.00% |
| Total | 100 | 100.00% |

**Table 3:-Distribution of co-morbidities of study subjects.**

|  |  |  |
| --- | --- | --- |
| **Co-morbidities** | **Frequency** | **Percentage** |
| Diabetes mellitus | 40 | 40.00% |
| Hypertension | 16 | 16.00% |
| Smoking | 48 | 48.00% |

**Table 4:-Descriptive statistics of IMT of common carotid(mm) of study subjects.**

|  |  |  |  |
| --- | --- | --- | --- |
| **IMT of common carotid(mm)** | **Mean ± SD** | **Median(25th-75th percentile)** | **Range** |
| Right side | 0.91 ± 0.68 | 0.8(0.6-0.9) | 0.5-4 |
| Left side | 1.01 ± 0.57 | 0.9(0.6-1) | 0.5-3.3 |

**Table 5:-Distribution of common carotid luminal stenosis of study subjects.**

|  |  |  |
| --- | --- | --- |
| **Common carotid luminal stenosis** | **Frequency** | **Percentage** |
| **Right side** | | |
| Normal | 68 | 68.00% |
| <30% stenosis | 12 | 12.00% |
| 30-50% stenosis | 16 | 16.00% |
| >70 stenosis% | 4 | 4.00% |
| **Left side** | | |
| Normal | 40 | 40.00% |
| <30% stenosis | 20 | 20.00% |
| 30-50% stenosis | 32 | 32.00% |
| 50-70% stenosis | 4 | 4.00% |
| >70 stenosis% | 4 | 4.00% |

**Table 6:-Distribution of internal carotid stenosis of study subjects.**

|  |  |  |
| --- | --- | --- |
| **Internal carotid stenosis** | **Frequency** | **Percentage** |
| **Right side** | | |
| Normal | 80 | 80.00% |
| <30% stenosis | 12 | 12.00% |
| 30-50% stenosis | 8 | 8.00% |
| **Left side** | | |
| Normal | 56 | 56.00% |
| <30% stenosis | 16 | 16.00% |
| 30-50% stenosis | 24 | 24.00% |
| 50-70% stenosis | 4 | 4.00% |

**Table 7:-Distribution of external carotid stenosis of study subjects.**

|  |  |  |
| --- | --- | --- |
| **External carotid stenosis** | **Frequency** | **Percentage** |
| **Right side** | | |
| Normal | 84 | 84.00% |
| <30% stenosis | 8 | 8.00% |
| 30-50% stenosis | 8 | 8.00% |
| **Left side** | | |
| Normal | 68 | 68.00% |
| <30% stenosis | 12 | 12.00% |
| 30-50% stenosis | 16 | 16.00% |
| 50-70% stenosis | 4 | 4.00% |

**Table 8:-Distribution of carotid plaque of study subjects.**

|  |  |  |
| --- | --- | --- |
| **Carotid plaque** | **Frequency** | **Percentage** |
| **Right side** | | |
| Absent | 60 | 60.00% |
| Present | 40 | 40.00% |
| **Left side** | | |
| Absent | 36 | 36.00% |
| Present | 64 | 64.00% |

**Table 9:-Distribution of outcome of study subjects.**

|  |  |  |
| --- | --- | --- |
| **Outcome** | **Frequency** | **Percentage** |
| Stroke | 4 | 4.00% |
| Seizures | 0 | 0.00% |
| TIA | 0 | 0.00% |

**Results**

Demographic data of the study showed 96% were male patients and 4 % were female patients with mean age 53.16 ± 10.4. Triple vessel coronary artery disease was found in 88% of the patients with 12% of patients having double vessel disease. Among all patients co morbidities were very common 48% were smokers, 40% had diabetes and 16% were hypertensive. All patients underwent preoperative carotid Doppler ultrasound at our institute, it was found that mean IMT on right side common carotid artery was 0.91 ± 0.68 and mean IMT on left side was 1.01 ± 0.57. When it comes to luminal stenosis of common carotids, on right side 68% were normal, 12 % had < 30% stenosis, 16% had stenosis between 30 to 50% and only 4 % had significant stenosis of > 70%. On left side only 40% common carotids came out to be disease free, 20% had < 30% stenosis, 32% had stenosis between 30 to 50% , 4% patients had stenosis between 50 to 70% , with only 4 % having significant left sided common carotid stenosis of > 70%. Internal carotids on right side were normal in 80% of patients, with only 8% had luminal stenosis of < 30% and 8% had stenosis between 30 to 50%. Left sided internal carotids were more diseased with only 68% being normal , 12 % had luminal stenosis of 30 to 50% , 16% had stenosis between 50 to 70% and 4% had significant stenosis of > 70%. Carotid plaque was also more common on left side with 64 % of patients having plaque in left sided carotids where as on right side plaque was present only in 40% patients. 4% patients who had significant disease on ultrasound ( > 70% stenosis ) out of them 50 % came out to be normal On CT angiogram thus raising questions over effectiveness of carotid Doppler in picking up the disease and also points towards the subjective human error component associated with Doppler study. On follow up, only 4% patient had stroke in immediate post op period while no patient had seizures or TIA. Also, among the patients who had stroke, all of them had normal carotid Doppler study in preoperative period.

**Discussion**

Stroke is a grave complication of coronary artery bypass grafting (CABG)3. Stroke occurs in 1.3% to 2.0% of patients1,4-6, and results in acute mortality of up to 38%7,8. For this reason, various institutes routinely screen patients undergoing CABG9-14 .However this practice is contrary to guidelines recommending screening in selected patients only15,16. The causes of stroke in a post-CABG patient can be many, but because most strokes occur ≥24 hours of surgery, embolic events are mostly responsible17,18-21.The debris from the atherosclerotic aorta are strongly associated with postoperative stroke22,23-25.They may arise by manipulation of the ascending aorta during aortic clamping, cannulation, and proximal graft anastomosis20,26,27.Other risk factors for perioperative stroke include older age, prior stroke or transient ischemic attack, peripheral artery disease, hypertension, left ventricular dysfunction, preoperative atrial fibrillation3,23,2628-30, and carotid artery stenosis31,21,26,29,32. Since carotid artery stenosis is not a direct etiologic risk factor for perioperative stroke, routine nonselective screening may not be cost effective1,33. Data from Cleveland Clinic patients undergoing non cardiac surgery demonstrated no association between carotid artery stenosis and stroke (odds ratio 1.0, with a 95% confidence interval of 0.99–1.02) for a 10-unit increase in internal carotid artery peak systolic velocity, the variable used to quantify carotid artery stenosis34. Regardless of whether carotid artery stenosis is an etiologic factor for perioperative stroke, carotid artery ultrasound screening detects only a minority of patients who experience perioperative neurologic events. In the present study only 4% had significant carotid artery disease on routine preoperative carotid Doppler but when a CT Angiography was done to confirm the disease, 50% among them had no carotid disease. For rest 50 % preoperative carotid stenting was done and patients were taken up for OP CABG later on but none had neurological event in post operative period. Durand and colleagues5, by screening every patient undergoing CABG found that 13.4% had carotid artery stenosis of ≥70%. Among those who developed postoperative stroke after undergoing CABG, only 19% had carotid artery stenosis of ≥70% ipsilateral to the side of the stroke. In the present study also only 4% patients had stroke who underwent off pump CABG among them none had carotid artery disease on pre operative carotid ultrasound. An alternative to routine ultrasound screening is risk profiling. Several groups have identified risk factors associated with significant carotid artery stenosis in patients undergoing CABG like Peripheral artery disease, cerebrovascular disease (prior stroke or transient ischemic attack), and old age were the risk factors most consistently identified in these studies2-4,6,37,. Applying carotid disease–screening algorithms to cohorts of ultrasound-screened patients undergoing CABG showed that most who had significant carotid artery stenosis could be detected5,77,82.Thus, Durand and colleagues5 found that a risk-profiling algorithm based on a prior stroke or transient ischemic attack, carotid bruit on exam, or age >65 years would have missed significant carotid disease in only 2.3%of patients undergoing CABG (26 of 1138), although this represented 17% of 152 patients with significant carotid disease, and 582 had a false-positive result5. Thus, their selective screening algorithm had a sensitivity and specificity of 83% and 41%, respectively. Sheiman and colleagues, used 7 risk factors (history of carotid artery disease, prior cerebrovascular event, hypertension, diabetes, peripheral artery disease, smoking, left main coronary disease, and female gender) to predict which patients have carotid artery disease. The presence of any 1 of these factors was 100% sensitive, but only 30% specific, in detecting patients with ≥50% carotid stenosis. Similarly, Cornily and colleagues, found that risk factors including age >70 years, history of cerebrovascular disease, diabetes mellitus, peripheral artery disease, or carotid bruit on physical examination could have detected 11 of 12 patients with significant carotid artery stenosis. These studies suggest that clinical factors are sensitive in identifying patients with carotid disease, but that specificity is low, requiring more specific screening modalities, such as ultrasound, in more than half of patients. The Society of Thoracic Surgeons and the American College of Cardiology/American Heart Association recommend ultrasound screening for carotid artery stenosis in selected patients only (class IIa recommendation, level of evidence C)8,9,42. The guidelines document11 “2012 Appropriate Use Criteria for Peripheral Vascular Ultrasound and Physiological Testing” rated all clinical scenarios for cerebrovascular duplex scanning before cardiac surgery as uncertain (or “may be appropriate”)43. The Society of Vascular and Interventional Neurology recommends screening of selected patients undergoing CABG (grade B), but screening of all patients was considered a grade D recommendation44.

**Conclusion**

Stroke in post CABG patients is a serious complication with many etiological risk factors including carotid artery disease. But carotid disease might not be strongly related to neurological morbidity in immediate post operative period thus using carotid Doppler screening in selected patients after risk profiling might be cost effective reducing unnecessary burden on patient.

**References:**

1.Anastasiadis K, Karamitsos TD, Velissaris I, Makrygiannakis K, Kiskinis D. Preoperative screening and management of carotid artery disease in patients undergoing cardiac surgery. Perfusion. 2009; 24:257–62. [PubMed: 19755466]

2. Naylor AR. Managing patients with symptomatic coronary and carotid artery disease. Perspect Vasc Surg Endovasc Ther. 2010; 22:70–6. [PubMed: 20858607]

3. Tarakji KG, Sabik JF III, Bhudia SK, Batizy LH, Blackstone EH. Temporal onset, risk factors, and outcomes associated with stroke after coronary artery bypass grafting. JAMA. 2011; 305:381–90. [PubMed: 21266685]

4. Roach GW, Kanchuger M, Mangano CM, Newman M, Nussmeier N, Wolman R, et al. Adverse cerebral outcomes after coronary bypass surgery. Multicenter Study of Perioperative Ischemia Research Group and the Ischemia Research and Education Foundation Investigators. N Engl J Med. 1996; 335:1857–63. [PubMed: 8948560]

5. Brown PP, Kugelmass AD, Cohen DJ, Reynolds MR, Culler SD, Dee AD, et al. The frequency and cost of complications associated with coronary artery bypass grafting surgery: results from the United States Medicare program. Ann Thorac Surg. 2008; 85:1980–6. [PubMed: 18498806]

6. Frye RL, Kronmal R, Schaff HV, Myers WO, Gersh BJ. Stroke in coronary artery bypass graft surgery: an analysis of the CASS experience. The participants in the Coronary Artery Surgery Study. Int J Cardiol. 1992; 36:213–21. [PubMed: 1512060

7. McKhann GM, Grega MA, Borowicz LM Jr, Bechamps M, Selnes OA, Baumgartner WA, et al. Encephalopathy and stroke after coronary artery bypass grafting: incidence, consequences, and prediction. Arch Neurol. 2002; 59:1422–8. [PubMed: 12223028]

8. Salazar JD, Wityk RJ, Grega MA, Borowicz LM, Doty JR, Petrofski JA, et al. Stroke after cardiac surgery: short- and long-term outcomes. Ann Thorac Surg. 2001; 72:1195–201. discussion 1201–2. [PubMed: 11603436]

9. Salehiomran A, Shirani S, Karimi A, Ahmadi H, Marzban M, Movahedi N, et al. Screening of carotid artery stenosis in coronary artery bypass grafting patients. J Tehran Heart Cent. 2010; 5:25–8. [PubMed: 23074564]

10. Fukuda I, Gomi S, Watanabe K, Seita J. Carotid and aortic screening for coronary artery bypass grafting. Ann Thorac Surg. 2000; 70:2034–9. [PubMed: 11156116]

11. Anastasiadis K, Karamitsos TD, Velissaris I, Makrygiannakis K, Kiskinis D. Preoperative screening and management of carotid artery disease in patients undergoing cardiac surgery. Perfusion. 2009; 24:257–62. [PubMed: 19755466]

12. Durand DJ, Perler BA, Roseborough GS, Grega MA, Borowicz LM Jr, Baumgartner WA, et al. Mandatory versus selective preoperative carotid screening: a retrospective analysis. Ann Thorac Surg. 2004; 78:159–66. discussion 159–66. [PubMed: 15223422]

13. Shirani S, Boroumand MA, Abbasi SH, Maghsoodi N, Shakiba M, Karimi A, et al. Preoperative carotid artery screening in patients undergoing coronary artery bypass graft surgery. Arch Med Res. 2006; 37:987–90. [PubMed: 17045115]

14. Lee EJ, Choi KH, Ryu JS, Jeon SB, Lee SW, Park SW, et al. Stroke risk after coronary artery bypass graft surgery and extent of cerebral artery atherosclerosis. J Am Coll Cardiol. 2011; 57:1811–8. [PubMed: 21527154]

15. Hillis LD, Smith PK, Anderson JL, Bittl JA, Bridges CR, Byrne JG, et al. 2011 ACCF/AHA Guideline for Coronary Artery Bypass Graft Surgery. A report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. Developed in collaboration with the American Association for Thoracic Surgery, Society of Cardiovascular Anesthesiologists, and Society of Thoracic Surgeons. Executive summary. J Am Coll Cardiol. 2011; 58:2584–614.

16. The Society of Thoracic Surgeons. [Accessed September 4, 2013] Five things physicians and patients should question. Choosing wisely. An initiative of the ABIM Foundation. Available at: <http://www.choosingwisely.org/doctor-patient-lists/the-society-of-thoracic-surgeons/>

17. Naylor AR. Does the risk of post-CABG stroke merit staged or synchronous reconstruction in patients with symptomatic or asymptomatic carotid disease? J Cardiovasc Surg (Torino). 2009; 50:71–81.

18. Borger MA, Ivanov J, Weisel RD, Rao V, Peniston CM. Stroke during coronary bypass surgery: principal role of cerebral macroemboli. Eur J Cardiothorac Surg. 2001; 19:627–32. [PubMed: 11343943]

19. Schoof J, Lubahn W, Baeumer M, Kross R, Wallesch CW, Kozian A, et al. Impaired cerebral autoregulation distal to carotid stenosis/occlusion is associated with increased risk of stroke at cardiac surgery with cardiopulmonary bypass. J Thorac Cardiovasc Surg. 2007; 134:690–6. [PubMed: 17723819]

20. Hise JH, Nipper ML, Schnitker JC. Stroke associated with coronary artery bypass surgery. AJNR Am J Neuroradiol. 1991; 12:811–4. [PubMed: 1950901]

21. Naylor AR, Mehta Z, Rothwell PM, Bell PR. Carotid artery disease and stroke during coronary artery bypass: a critical review of the literature. Eur J Vasc Endovasc Surg. 2002; 23:283–94. [PubMed: 11991687]

22. Roach GW, Kanchuger M, Mangano CM, Newman M, Nussmeier N, Wolman R, et al. Adverse cerebral outcomes after coronary bypass surgery. Multicenter Study of Perioperative Ischemia Research Group and the Ischemia Research and Education Foundation Investigators. N Engl J Med. 1996; 335:1857–63. [PubMed: 8948560]

23. John R, Choudhri AF, Weinberg AD, Ting W, Rose EA, Smith CR, et al. Multi-center review of preoperative risk factors for stroke after coronary artery bypass grafting. Ann Thorac Surg. 2000; 69:30–5. discussion 5–6. [PubMed: 10654481]

24. Mickleborough LL, Walker PM, Takagi Y, Ohashi M, Ivanov J, Tamariz M. Risk factors for stroke in patients undergoing coronary artery bypass grafting. J Thorac Cardiovasc Surg. 1996; 112:1250–8. discussion 8–9. [PubMed: 8911321]

25. Lynn GM, Stefanko K, Reed JF III, Gee W, Nicholas G. Risk factors for stroke after coronary artery bypass. J Thorac Cardiovasc Surg. 1992; 104:1518–23. [PubMed: 1453715]

26. Stamou SC, Hill PC, Dangas G, Pfister AJ, Boyce SW, Dullum MK, et al. Stroke after coronary artery bypass: incidence, predictors, and clinical outcome. Stroke. 2001; 32:1508–13. [PubMed: 11441193]

27. Blauth CI, Cosgrove DM, Webb BW, Ratliff NB, Boylan M, Piedmonte MR, et al. Atheroembolism from the ascending aorta. An emerging problem in cardiac surgery. J Thorac Cardiovasc Surg. 1992; 103:1104–11. discussion 11–2. [PubMed: 1597974]

28. Newman MF, Wolman R, Kanchuger M, Marschall K, Mora-Mangano C, Roach G, et al. Multicenter preoperative stroke risk index for patients undergoing coronary artery bypass graft surgery. Multicenter Study of Perioperative Ischemia (McSPI) Research Group. Circulation. 1996; 94:II74–80. [PubMed: 8901723]

29. Hogue CW Jr, Murphy SF, Schechtman KB, Davila-Roman VG. Risk factors for early or delayed stroke after cardiac surgery. Circulation. 1999; 100:642–7. [PubMed: 10441102]

30. Filsoufi F, Rahmanian PB, Castillo JG, Bronster D, Adams DH. Incidence, topography, predictors and long-term survival after stroke in patients undergoing coronary artery bypass grafting. Ann Thorac Surg. 2008; 85:862–70. [PubMed: 18291158]

31 Gerraty RP, Gates PC, Doyle JC. Carotid stenosis and perioperative stroke risk in symptomatic and asymptomatic patients undergoing vascular or coronary surgery. Stroke. 1993; 24:1115–8. [PubMed: 8342182]

32. D’Agostino RS, Svensson LG, Neumann DJ, Balkhy HH, Williamson WA, Shahian DM. Screening carotid ultrasonography and risk factors for stroke in coronary artery surgery patients. Ann Thorac Surg. 1996; 62:1714–23. [PubMed: 8957376]

33. Naylor AR. Managing patients with symptomatic coronary and carotid artery disease. Perspect Vasc Surg Endovasc Ther. 2010; 22:70–6. [PubMed: 20858607]

34. Sonny A, Gornik HL, Yang D, Mascha EJ, Sessler DI. Lack of association between carotid artery stenosis and stroke or myocardial injury after noncardiac surgery in high-risk patients. Anesthesiology. 2014; 121:922–9. [PubMed: 25216396]

35. Berens ES, Kouchoukos NT, Murphy SF, Wareing TH. Preoperative carotid artery screening in elderly patients undergoing cardiac surgery. J Vasc Surg. 1992; 15:313–21. discussion 22–3. [PubMed: 1735892]

36. Sheiman RG, Janne d’Othee B. Screening carotid sonography before elective coronary artery bypass graft surgery: who needs it. AJR Am J Roentgenol. 2007; 188:W475–9. [PubMed: 17449747]

37. Salasidis GC, Latter DA, Steinmetz OK, Blair JF, Graham AM. Carotid artery duplex scanning in preoperative assessment for coronary artery revascularization: the association between peripheral vascular disease, carotid artery stenosis, and stroke. J Vasc Surg. 1995; 21:154–60. discussion 61–2. [PubMed: 7823354]

38. Kiernan TJ, Taqueti V, Crevensten G, Yan BP, Slovut DP, Jaff MR. Correlates of carotid stenosis in patients undergoing coronary artery bypass grafting–a case control study. Vasc Med. 2009; 14:233–7. [PubMed: 19651673]

39. Drohomirecka A, Koltowski L, Kwinecki P, Wronecki K, Cichon R. Risk factors for carotid artery disease in patients scheduled for coronary artery bypass grafting. Kardiol Pol. 2010; 68:789–94. [PubMed: 20648438]

40. Ansari S, Tan JY, Larcos GS, Paterson H. Low prevalence of significant carotid artery disease on ultrasound in patients proceeding to coronary artery bypass surgery. Intern Med J. 2011; 41:658–61. [PubMed: 20002852]

41. Cornily JC, Le Saux D, Vinsonneau U, Bezon E, Le Ven F, Le Gal G, et al. Assessment of carotid artery stenosis before coronary artery bypass surgery. Is it always necessary? Arch Cardiovasc Dis. 2011; 104:77–83. [PubMed: 21402341]

42. Brott TG, Halperin JL, Abbara S, Bacharach JM, Barr JD, Bush RL, et al. 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: executive summary: 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 Surgeons, Society of Atherosclerosis Imaging and Prevention, Society for Cardiovascular Angiography and Interventions, Society of Interventional Radiology, Society of NeuroInterventional Surgery, Society for Vascular Medicine, and Society for Vascular Surgery. J Am Coll Cardiol. 2011; 57:1002–44. [PubMed: 21288680]

43. Mohler ER III, Gornik HL, Gerhard-Herman M, Misra S, Olin JW, Zierler RE, et al. ACCF/ACR/AIUM/ASE/ASN/ICAVL/SCAI/SCCT/SIR/SVM/SVS/SVU [corrected] 2012 appropriate use criteria for peripheral vascular ultrasound and physiological testing part I: arterial ultrasound and physiological testing: a report of the American College of Cardiology Foundation appropriate use criteria task force, American College of Radiology, American Institute of Ultrasound in Medicine, American Society of Echocardiography, American Society of Nephrology, Intersocietal Commission for the Accreditation of Vascular Laboratories, Society for Cardiovascular Angiography and Interventions, Society of Cardiovascular Computed Tomography, Society for Interventional Radiology, Society for Vascular Medicine, Society for Vascular Surgery, [corrected] and Society for Vascular Ultrasound. [corrected]. J Am Coll Cardiol. 2012; 60:242–76. [PubMed: 22694840]

44. Qureshi AI, Alexandrov AV, Tegeler CH, Hobson RW II, Dennis Baker J, Hopkins LN. Guidelines for screening of extracranial carotid artery disease: a statement for healthcare professionals from the multidisciplinary practice guidelines committee of the American Society of Neuroimaging; cosponsored by the Society of Vascular and Interventional Neurology. J Neuroimaging. 2007; 17:19–47. [PubMed: 17238868]

45. Nishiyama K, Horiguchi M, Shizuta S, Doi T, Ehara N, Tanuguchi R, et al. Temporal pattern of strokes after on-pump and off-pump coronary artery bypass graft surgery. Ann Thorac Surg. 2009; 87:1839–44. [PubMed: 19463605]

Author Declaration: Source of support: Nil, Conflict of interest: Nil

Ethics Committee Approval obtained for this study?  YES

Was informed consent obtained from the subjects involved in the study?  YES

For any images presented appropriate consent has been obtained from the subjects: NA

Plagiarism Checked: Plagramme Software

Author work published under a Creative Commons Attribution 4.0 International License



DOI: 10.36848/IJBAMR/2020/26215.55652