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ROLE OF CAROTID DOPPLER ULTRASOUND IN DETECTING THE CAROTID ARTERY DISEASE RESULTING IN STROKE AFTER CABG SURGERY.

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Contribution

RT conceived, designed and did statistical analysis & manuscript writing. AK did data collection and manuscript writing. AN did review and final approval of manuscript

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ABSTRACT

Objective: To determine the role of Carotid doppler ultrasound in detecting the carotid artery disease resulting in stroke after coronary artery bypass graft (CABG) surgery in our population.

Methodology: We carried out a cross-sectional study at Department of Cardiac Surgery, Civil Hospital Karachi from 1st September 2015 to 31st January 2017. Data was collected for risk factors for stroke. Carotid doppler scanning was done in all patients undergoing CABG surgery. Post operative development of stroke was noted.

Results: Total number of patients was 120 and the age range was 35-60 years. The risk factors for stroke (hypertension, diabetes mellitus and smoking) were present in 104 (86.7%) patients. Of the 4 patients with significant (50%-69%) unilateral carotid artery stenosis 2 patients developed stroke and the patient with bilateral significant stenosis also developed stroke. In patients with significant (50-69%) unilateral carotid artery stenosis, out of the 3 patients who had risk factors for stroke one patient developed stroke postoperatively, while one patient in whom the risk factors were not present also developed stroke postoperatively. The patient with significant (50-69%) bilateral carotid artery stenosis who had risk factors for stroke also developed stroke

Conclusion: Carotid Doppler Ultrasound screening is an effective tool in detecting the carotid artery disease that may result in stroke after CABG.

Key Words: Carotid doppler ultrasound, CABG, Cardiac Surgery, Stroke.

INTRODUCTION

Ischemic heart disease is one of the most common cardiovascular diseases worldwide with significant mortality and morbidity. The morbidity and mortality is associated with the disease as well as with its complications both preoperatively and postoperatively.[1] CABG is one of the most common operations in the field of cardiovascular surgery. Excluding intra-operative death, stroke is the leadingperi-operative complication in patients undergoing coronary bypass surgery with incidence of 2.1–5.2% and mortality of 0–38%.[2] Advanced age, peripheral vascular disease, prior history of cerebral ischemia and atherosclerosis of the ascending aorta have been identified as risk factors for cerebral infarction after CABG. Stroke also increases costs and hospital length of stay.

Preoperative screening of stroke is effective in reducing its development postoperatively.[3] Doppler ultrasound scan is used for this purpose in addition to other modalities.[4] In spite of the proven efficacy of doppler ultrasound in detecting carotid plaques and perceive a possible stroke, it is not commonly employed. Pre-operative duplex carotid screening seems to be necessary in patients with risk factors such as hypertension, diabetes, smoking, peripheral vascular disease, female gender, and advanced age.[5-10] An association between carotid and coronary artery disease is well recognized. An adequate history, physical examination and duplex ultrasound scanning could identify patients at risk for the presence of significant carotid disease.[11] Somecenters tend to limit pre-operative investigations in patients with symptoms and/or clinical signs of associated vascular disease (e.g. carotid bruit or peripheral pulse losses), in spite of the proven efficacy of Doppler ultrasound in detecting carotid plaques and perceive a possible stroke. Others are liable to routinely opt for pre-operative doppler screening of carotid vessels.[12,13] Keeping in view all these points, we conducted this study to determine the role of Carotid Doppler Ultrasound in detecting the carotid artery disease resulting in stroke after CABG.

METHODOLOGY

It was a cross-sectional retrospective study, conducted at Department of Cardiac Surgery, Civil Hospital Karachi from 1st September 2015 to 31st January 2017. The sampling technique utilized was non probability consecutive. Both male & female patients undergoing isolated elective Coronary Artery Bypass Grafting, aged between 35-60 years were included in the study. Patients excluded from the study were those with: co-existing valvular or congenital heart diseases, left main coronary artery disease, peripheral artery disease, cerebrovascular disease (stroke, TIA), presence of clot in any chamber of the heart (detected on echocardiography), coagulation disorders, calcification of the ascending aorta, EF less than 40%, emergency and redo-CABG.

Data was collected of demographic factors, co-morbidities, pre, intra and post-operative variables and analyzed using SPSS version 16.0. After taking detail history, physical examination and routine investigations, carotid doppler scanning was done in all patients preoperatively. CABG was done with median sternotomy using standard cardiopulmonary bypass. Myocardial protection was achieved by anterograde cardioplegia. Left internal mammary artery and great saphenous vein were used as conduits.

After surgery patients were shifted in intensive care unit as per routine. Patients were extubated on the same day except three patients as those developed stroke and we could not wean them off the ventilator.

RESULTS

Total number of patients were 120 including 86 (71.6%) male and 34 (28.3%) female. Age range was 35-60 years with mean age of 51.7 ± 2.3 years. A total of 97 patients had hypertension including 60 males and 27 females. Diabetes mellitus was present in 80 patients of which 54 were males and 26 were females. Of the 60 patients who were smokers, 58 were males and 2 were females (Table 1).In our study the risk factors for stroke were hypertension, diabetes mellitus and smoking which were present in 104 (86.7%) patients, while risk factors were absent in 16 (13.3%) patients. Our study did not include patients with age greater than 65 years, peripheral artery disease, previous cerebrovascular disease (stroke, TIA, etc.), left main carotid artery disease as these are also risk factors for stroke.

Table 1: Comorbidities Present in Study Population

	Number of Patients	Co-morbidities present			No Co-morbidities
		Hypertension	Diabetes Mellitus	Smoking	
Male	86	60	54	58	16
Female	34	27	26	02	0
TOTAL	120(100%)	97(80.8%)	80(66.6%)	60(50%)	16 (13.3%)

In our study, Carotid artery duplex scanning showed that 106 (88.3%) patients had normal carotid arteries and 10(8.3%) patients had non significant(<50%) carotid artery stenosis (06 unilateral and 04 bilateral stenosis). None of the patients with non significant carotid artery stenosis had developed stroke. Five(4.2%) patients had significant (50%-69%) stenosis (with 4 unilateral and 1 bilateral), of whom three developed stroke after CABG surgery. Of the 4 patients with unilateral significant stenosis 2 patients developed stroke and the patient with bilateral significant stenosis also developed stroke. The incidence of stroke in our study was 2.50%.All the patients who developed stroke were preoperatively screened by carotid duplex scanning as having significant unilateral or bilateral carotid stenosis (Table 2). None of our patients had severe (70-99%) stenosis or carotid artery occlusion (Table 2).

Table 2: Results of Carotid Doppler Ultrasound and Incidence of Stroke (n=130)

Carotid ArteryStenosis	Number (%)	Stroke
Carotid Artery Stenosis < 50%	10 (8.33%)	0 (0%)
Unilateral	6 (5%)	0 (0%)
Bilateral	4 (3.33%)	0 (0%)
Significant Carotid Artery Stenosis (50-69%)	5 (4.17%)	3 (2.50%)
Unilateral	4 (3.33%)	2 (1.67%)
Bilateral	(0 .83%)	1 (0 .83%)
Severe Carotid Artery Stenosis (70 99%)	0 (0%)	0 (0%)
Unilateral	0 (0%)	0 (0%)
Bilateral	0 (0%)	0 (0%)
Carotid Artery Occlusion		
Unilateral	0 (0%)	0 (0%)
Bilateral	0 (0%)	0 (0%)
Total	15 (12.50%)	3 (2.50%)

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In four patients with less than 50% unilateral carotid stenosis risk factors for stroke were present, while in 2 patients with less than 50% unilateral carotid stenosis the risk factors were absent, none of these 6 patients developed stroke. In patients with significant (50-69%) unilateral carotid stenosis, out of the 3 patients who had risk factors for stroke one patient developed stroke postoperatively, while one patient in whom the risk factors were not present also developed stroke postoperatively. The patient with significant (50-69%) bilateral carotid artery stenosis who had risk factors for stroke also developed stroke (Table 3).

Table 3: Risk Factors for Stroke in Study Population (n=130)

Carotid Artery Stenosis		Risk Factors for Stroke *		Stroke	
		Present	Absent	Risk Factors Present	Risk Factors Absent
Carotid Artery Stenosis < 50%					
Unilateral	6	4	2	0	0
Bilateral	4	4	0	0	0
Significant Carotid Artery Stenosis (50-69%)					
Unilateral	4	3	1	1	1
Bilateral	1	1	0	1	0
Total	15	12	3	2	1

*Risk factors for stroke: Hypertension, Diabetes Mellitus, smoking

DISCUSSION

Ischemic heart disease is one of the most common cardiovascular diseases worldwide with significant mortality and morbidity. CABG is one of the most common operations in cardiovascular surgery. The operation itself has complications and postoperative stroke is the leading peri-operative complication in patients undergoing coronary bypass surgery with incidence of 2.1–5.2% and mortality of 0–38%.[1,2,14-17] Stroke is considered one of the most devastating complications following CABG due to its effects often being irreversible, lifelong and potentially debilitating.[17] In the CABG patients who developed stroke the mortality rate is 10 fold higher and the length of hospital stay and costs increased compared to those who did not develop stroke.[18] Morbidity after CABG remains relatively high due to advanced age, peripheral vascular disease, prior history of cerebral ischemia, atherosclerosis of the ascending aorta, hypoperfusion and embolization as thesehave been identified as risk factors for cerebral infarction after CABG.[6-10,19]

Preoperative screening of stroke is effective in reducing its development postoperatively. Doppler ultrasound scan is used for this purpose in addition to other modalities.[3,4,20,21] Duplex ultrasound is the most commonly used imaging modality for the pre-operative assessment of carotid artery disease as it is a non-invasive, accurate, cost effective and easily available method.[2,14,15,17]

Pre-operative duplex carotid screening seems to be necessary in patients with risk factors such as hypertension, peripheral vascular disease, female gender, and advanced age.[5] Diagnostic strategies to predict occurrence of stroke in high risk patients have shown a significant improvement in their clinical outcomes.[17] In our study the risk factors for stroke were hypertension, diabetes mellitus and smoking which were present in 104 (86.7%) patients, while risk factors were absent in 16 (13.3%) patients. Our study did not include patients with age greater than 65 years, peripheral artery disease, previous cerebrovascular disease (stroke, TIA, etc.), left main carotid artery disease as these are also risk factors for stroke.

In our study, 97 patients had hypertension including 60 male and 27 female, diabetes mellitus in 80 patients of which 54 were male and 26 were female and 60 patients were smokers including 58 male and 2 females.The literature data suggest that carotidduplex should be performedin all patients with a history of stroke or TIA, all patientswith a bruit, and all patients >65 years of age.[22]

Carotid and coronary artery disease share common risk factors and frequently coexist.[23] Various studies have evaluated carotid disease as a risk factor for postoperative stroke.[14,17,24] Carotid artery atherosclerosis is common and predisposes to cerebral infarction, the risk increasing with the degree of carotid artery stenosis (CAS).[23] In our study, Carotid artery duplex scanning showedt hat 106 patients had normal carotid arteries and 10(8.3%) patients had non significant(<50%) carotid artery stenosis (06 unilateral and 04 bilateral stenosis). None of the patients with non significant carotid artery stenosis had developed stroke. Five(4.2%) patients had significant (50%-69%) stenosis (with 4 unilateral and 1 bilateral), of whom three developed stroke after CABG surgery. Of the 4 patients with unilateral significant stenosis 2 patients developed stroke and the patient with bilateral significant stenosis also developed stroke. The incidence of stroke in our study was 2.50% None of our patients had severe (70-99%) stenosis or carotid artery occlusion.

In our study the risk factors for stroke were hypertension, diabetes mellitus and smoking. Our study did not include patients with age greater than 65 years, peripheral artery disease, previous cerebrovascular disease (stroke, TIA, etc.), left main carotid artery disease as these are also risk factors for stroke. In four patients with less than 50% unilateral carotid stenosis risk factors for stroke were present, while in 2 patients with less than 50% unilateral carotid stenosis the risk factors were absent, none of these 6 patients developed stroke.In patients with significant (50-69%) unilateral carotid stenosis, out of the 3 patients who had risk factors for stroke one patient developed stroke postoperatively, while one patient in whom the risk factors were not present also developed stroke postoperatively. The patient with significant (50-69%) bilateral carotid artery stenosis also developed stroke. The etiology of postoperative stroke is often multifactorial. The shedding of debris from carotid or aortic atherosclerotic plaques, embolization of the intra-cardiac clot, and decrease in perfusion pressure to < 60 mmHg are the etiologic causes of stroke associated with bypass surgery.[25]More than half of all post-CABG strokes occur after uneventful recovery from CABG and are believed to becaused by supraventricular arrhythmias, low cardiac output, or postoperative hypercoagulability.[26] In our study we selected non artheromatoussite for aortic cannulation and avoided aggressive manipulation of the aorta and use of side-biting clamp of the ascending aorta and maintained high perfusion pressure(> 60 mmHg) during surgery. None of our patient developed arrhythmias and low cardiac output postoperatively.We carried out on-pump CABG surgery in all patients. Although off-pump CABG was introduced in large part to reduce stroke and other adverse neurological outcomes associated with CPB, several randomized control trials (RCTs)comparing on-pump and off-pump CABG have shown no difference in stroke rates.[27-33]

The carotid duplex scan iseffective for identifying patients who may develop the complication of stroke following CABG surgery. Hence, screening of CABG patients with Carotid duplex may play an important role in identifying patients with

and without risk factors for stroke who may develop stroke after CABG. In spite of the proven efficacy of Duplex ultrasound in detecting carotid plaques and perceive a possible stroke, it is not commonly employed. Because the presence of extracranial disease of the internal carotid artery is a risk factor for adverse neurological events after CABG we can consider carotid noninvasive scanning in all patients scheduled for CABG.[34] The advantages of Duplex ultrasound are absence of its complications, relatively low costs, and its widespread availability.[35] The literature suggests that significant reduction in stroke rate could be achieved by screening the whole cardiac surgical population.[23] An association between carotid and coronary artery disease is well recognized so an adequate history, physical examination and routine pre-operative duplex carotid screening of all coronary surgery patients may be an effective strategy. Some centers routinely opt for pre-operative Doppler screening of carotid vessels12,13 in all patients undergoing CABG surgery while others do carotid ultrasound only in patients with symptoms and/or clinical signs of associated vascular disease (e.g. carotid bruit or peripheral pulse losses).According to some studies the identification of preoperative risk factors of carotid artery disease could be used to stratify patients into high- and low-riskcategories, thereby allowing for a more selective use of noninvasive carotid screening.[19,36] However our study showed that stroke may occur in CABG patient in whom risk factors were absent, hence employing a selective screening strategy may result in overlooking patients whom may develop stroke postoperatively. Such screeningis important because some patients benefit from combinedcarotid and cardiac surgery and, regardless of this, the informationgained puts the cardiac surgeon in a position to providean accurate assessment of surgical risk.[23] The limitation of our study was that it was a single center study.

CONCLUSION

Carotid Doppler Ultrasound screening is an effective tool in detecting the carotid artery disease that may result in stroke after CABG.

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