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Original Article

Carotid Angiographic Profile in Patients with Coronary Artery Disease

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ABSTRACT

Background: This study was conducted with an aim of assessing the angiographic incidence of carotid artery stenosis (CAS) in patients undergoing coronary angiography for the diagnosis of coronary artery disease (CAD). **Methods:** This single centre study included 50 patients with stable CAD or acute coronary syndromes, undergoing coronary angiography for diagnostic or therapeutic indications, who gave consent for concomitant carotid digital subtraction angiography (DSA). Significant CAD was defined as ≥ 50% diameter stenosis in at least one major coronary artery or its first order branches, and was categorized as single vessel disease (SVD), double vessel disease (DVD), or triple vessel disease (TVD) according to number of vessels involved. Significant CAS was defined as a diameter stenosis of ≥50% in the common carotid artery, the carotid bifurcation, or the internal carotid artery. For statistical analysis, patients were divided into two groups i.e. patients without or with CAS. Patient characteristics in these groups were then analysed and compared to each other. **Results:** The mean age of study group was 58.72 ± 9.03 years. Out of 50 patients studied 33 (66%) were males and 17 (34%) were females. Risk factors included hypertension, smoking, diabetes mellitus and dyslipidemia in 82%, 50%, 48% and 28% patients respectively. CAD was present in 62% patients; with 24%, 14% and 24% patients having SVD, DVD and TVD respectively. CAS was present in 10 (20%) patients, all of whom had TVD on coronary angiography (p≤0.0001). Patients with CAS were more likely to be older than those without CAS (p=0.065). Additionally, 80% of patients with CAS were males and all of them were hypertensive. **Conclusion:** Significant CAS is found in substantial proportion of patients with CAD, especially multi vessel disease. A strategy of concomitant carotid DSA at the time of coronary angiography may allow superior risk stratification and better planning of management in these patients.

Keywords: Carotid artery stenosis, Carotid angiography, Coronary Artery Disease.

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INTRODUCTION

Atherosclerotic vascular disease is the leading cause of death worldwide. Approximately 13 million deaths are caused by vascular diseases annually. Coronary artery disease (CAD) and stroke account for 12.2% and 9.7% of the total yearly deaths in the world respectively.[1] Myocardial infarction is the leading cause of long-term mortality in stroke surviving patients, although stroke is the leading cause of disability in the world.[2,3] Atherosclerosis is a systemic disease, with multifocal involvement not being an infrequent finding.[4]Coronary and carotid arteries are the most frequent sites of atherosclerotic involvement. The association between carotid artery stenosis (CAS) and CAD has been widely reported in literature.[5-7] In the western countries, approximately 8% to 14% of patients undergoing myocardial revascularization for CAD have significant CAS. Conversely, 28% of patients undergoing carotid endarterectomy for CAS have significant CAD.[8,9] The data from Asian countries is somewhat different, with some studies showing that more than 50% of patients with CAD have associated significant CAS and vice versa.[10,11] Additionally, the distribution and severity of carotid atherosclerosis, as well as cardiovascular risk factor profile has been shown to demonstrate racial differences.[12]The presence of concomitant CAS in patients with CAD not only increases their overall cardiovascular risk but also has a significant impact on the choice of management strategy. This study was conducted with an aim of assessing the angiographic incidence of hitherto undiagnosed CAS in patients undergoing coronary angiography for the diagnosis of CAD. We also studied the association of CAS with the angiographic extent of CAD and attempted to identify various clinic-demographic correlates of concomitant CAS in these patients. To the best of our knowledge, this is the first study of such nature conducted among Indian patients.

PATIENTS AND METHODS

Study design

This was a single centre non-randomized prospective observational study, conducted in the Department of Cardiology, Sher-i-Kashmir Institute of Medical Sciences, Srinagar, Jammu and Kashmir, between 2013 and 2015.

Study population

We included 50 consecutive patients with stable CAD or acute coronary syndromes, undergoing coronary angiography for diagnostic or therapeutic indications, who fulfilled the eligibility criteria as described below.

Inclusion criteria

i. Patients with chronic stable angina who had an indication for diagnostic coronary angiography according to ACC/AHA guidelines.[13]
ii. Patients with acute coronary syndromes [Unstable angina (UA), Non ST elevation myocardial infarction (NSTEMI) or ST elevation myocardial infarction (STEMI)], who were undergoing coronary angiography for diagnostic or therapeutic purpose.

iii. Patients who gave consent for the study.

Exclusion criteria

i. Patients who did not have an indication for invasive coronary angiography.
ii. Patients with history of allergy to contrast agents.
iii. Patients with documented history of cerebrovascular disease (CVD) i.e. stroke or transient ischemic attack (TIA).
iv. Patients with serious comorbidities like chronic renal failure (eGFR< 30 ml/min), sepsis, or malignancies and pregnant ladies.
v. Patients who refused to give consent for the study.

Methods

A detailed history including presenting symptoms, past history, family history of CAD or CVD, and drug history was taken from all patients. Conventional atherosclerotic risk factors (smoking, hypertension, diabetes mellitus, or dyslipidemia) were identified and recorded in each patient. Smoking was defined as if the patient smoked >1 cigarette per day regularly for more than 6 months or had quit smoking for less than 2 years. Diabetes Mellitus was diagnosed on the basis of fasting plasma glucose of ≥ 126 mg/dL or Hemoglobin A_1C greater than 6.5%or symptoms of diabetes plus random blood glucose concentration ≥ 200 mg/dL or patient on anti-diabetic medications.[14] Hypertension was considered to be present if the patient was taking any anti-hypertensive drugs at the time of presentation or if blood pressure recorded was ≥ 140mmHg systolic and/or ≥ 90mmHg diastolic, on at least two separate occasions.[15] Dyslipidemia was defined as total cholesterol ≥ 200 mg/dL, or LDL cholesterol ≥130 mg/dL, or triglycerides ≥ 150 mg/dL, or HDL cholesterol ≤40 mg/dL or any combination of these criteria.[16] Complete physical examination including cardiovascular examination was then performed. Base line investigations including electrocardiogram (ECG), chest X ray, complete blood count, kidney function tests, liver function tests, serum electrolytes, and coagulation profile were obtained. Echocardiography for the evaluation of regional wall motion abnormalities, left and right ventricular functions, and associated structural heart disease was also done in all the cases.

Coronary angiography was performed via trans-radial or trans-femoral approach using the standard Judkins technique in our cardiac catheterization laboratory (Axiom Artis, Seimens, Germany). For complete visualisation of the left coronary artery system at least four different projections were used. For complete visualisation of the right coronary artery at least standard left and right anterior oblique projections (LAO and RAO) were obtained. After completion of coronary angiography, a non-selective aortic arch angiogram in LAO 30 degree view was obtained using a 6 French pigtail catheter, to delineate aortic arch anatomy, locate origins of carotid arteries, and to rule out any ostial carotid artery stenosis. Next, selective carotid digital subtraction angiography (DSA) was performed in lateral and frontal views, using 5 French Judkins right (JR 4), Simmons sidewinder (SS) or Vitek (Cook) catheter, depending on the aortic arch anatomy. The angiograms were assessed by two independent interventional cardiologists, who were blinded to the clinical details of the patients. Significant CAD was defined as ≥ 50% diameter stenosis (visual estimation of lesion diameter compared with the adjacent normal segment) in at least one major coronary artery [left anterior descending (LAD), left circumflex (LCx), right coronary artery (RCA)] or their first order branches. CAD was categorized as single vessel disease (SVD), double vessel disease (DVD), or triple vessel disease (TVD) according to number of major branches with significant involvement. For carotid arteries, the view showing the maximum stenosis was selected for quantitative angiographic analysis. The lumen diameter at the point of maximum stenosis and the diameter of the normal distal internal carotid artery were measured; percent stenosis was then calculated using the method described in the North American Symptomatic Carotid Endarterectomy Trial (NASCET) study.[17] We defined significant CAS as a diameter stenosis of ≥ 50% in the common carotid artery, the carotid bifurcation, or the internal carotid artery. For statistical analysis, patients were divided into two groups: Group I – Patients without CAS; and Group II – Patients with CAS. Patient characteristics in these groups were then analysed and compared to each other.

Consent and ethical issues

The study protocol was approved by the Institutional Ethics Committee. All procedures were conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants prior to their enrolment in the study.

Statistical analysis

Statistical analysis was performed by SPSS software package (version 20.0, SPSS Inc, Chicago, Illinois, USA). All continuous variables were expressed as mean ± SD, and categorical variables were reported as frequency and percentages. Group comparisons were performed with Student t-test or crosstabs. The Chi-square test or Fisher exact test was used for categorical variables. A p-value of < 0.05 was considered statistically significant.

RESULTS

During the study period of 2 years, a total of 50 patients with stable CAD or acute coronary syndromes undergoing coronary angiography for diagnostic or therapeutic indications, who consented for concomitant carotid angiography,were enrolled in the study.

Patient characteristics

The mean age of study group was 58.72 ± 9.03 years with a range of 40 to 71 years. Out of 50 patients studied 33 (66%) were males and 17 (34%) were females; with male to female ratio of 1.9:1. Overall STEMI and stable angina were the most common modes of presentation (32%) each, followed by NSTEMI (22%) and UA (14%).In males STEMI was the most common indication for coronary angiography (36.3%), while in females stable angina was the major indication (35.2%). Among patients with STEMI, 54% had anterior wall myocardial infarction (AWMI) and 46% had inferior wall myocardial infarction (IWMI). The risk factor profile of study population is depicted in Table 1. As described, smoking was significantly more frequent in males ($p = 0.007$), while diabetes mellitus was more frequent in females ($p = 0.007$).

Coronary and carotid angiographic profile of the study population

Table 2 describes the coronary and carotid angiographic profile of the study population. Although 58.8% females had normal coronary angiogram compared to only 27.7% in males, we did not find any statistically significant difference between the coronary angiographic profile of males and females ($p = 0.170$). Among 10 patients (20%) who had CAS, 7 (70%) had bilateral CAS while 3 patients (30%) had unilateral CAS. Again, there was no significant difference between males and females vis a vis carotid angiographic profile ($p = 0.460$). All 10 patients with CAS had TVD on coronary angiography and none of the patients with normal coronary angiography, SVD or DVD had associated significant CAS ($p \leq 0.0001$). In other words, 32.26% patients with significant CAD and 83.3% patients with TVD had associated significant CAS.

Demographic and risk factor profile of patients with concomitant CAS and CAD

We compared the demographic characteristics and the risk factor status of the two groups i.e. patients without CAS (group I) and patients with CAS (group II). The results are shown in Table 3. Although we did not find any statistically significant differences between the two groups

Table 1: Risk factor profile of the study group

Risk Factor	Male		Female		Total		P value
	N=33	%	N=17	%	N=50	%	
Hypertension	27	81.8	14	82.4	41	82.0	0.96
Diabetes Mellitus	11	33.3	13	76.5	24	48.0	0.007
Dyslipidemia	9	27.3	5	29.4	14	28.0	0.87
Smoking	21	63.6	4	23.5	25	50.0	0.007

Note: N – Number; % - Percentage.

Table 2: Coronary and carotid angiographic profile of the study group

Angiographic Profile		Male		Female		Total		P value
		N=33	%	N=17	%	N=50	%	
Coronary Angiogram	Normal	9	27.7	10	58.8	19	38.0	0.170
	SVD	9	27.7	3	17.6	12	24.0	
	DVD	6	18.1	1	5.88	7	14.0	
	TVD	9	27.7	3	17.6	12	24.0	
Carotid Angiogram	CAS present	8	80.0	2	20.0	10	20.0	0.460
	CAS absent	25	62.5	15	37.5	40	80.0	

Note: N – Number, % - Percentage, SVD – Single Vessel Disease, DVD – Double Vessel Disease, TVD – Triple Vessel Disease, CAS – Carotid Artery Stenosis.

Table 3: Demographic and risk factor profile of patients with and without CAS

Variable		CAS		Total		P value
		Group 1 (Absent)	Group 2 (Present)	N (50)	%	
Age (years)	40 - 49	11	1	12	24.0	0.065
	50 - 59	9	0	9	18.0	
	60 - 69	16	6	22	44.0	
	≥ 70	4	3	7	14.0	
Gender	Male	25	8	33	66.0	0.460
	Female	15	2	17	34.0	
Hypertension	Absent	9	0	9	18.0	0.098
	Present	31	10	41	82.0	
Diabetes	Absent	21	5	26	52.0	0.880
	Present	19	5	24	48.0	
Dyslipidemia	Absent	28	8	36	72.0	0.529
	Present	12	2	14	28.0	
Smoking	Absent	20	5	25	50.0	1.000
	Present	20	5	25	50.0	

Note: CAS – Carotid Artery Stenosis, N – Number, % - Percentage.

in terms of their demographic or risk factor profile, it is pertinent to mention that patients with CAS were more likely to be older than those without CAS ($p = 0.065$). Additionally, 80% of patients with CAS were males and all of them were hypertensive. Smoking and diabetic status was equally distributed between the two groups.

DISCUSSION

The major findings of our study were:

i. Overall 20% patients with stable or unstable CAD, undergoing coronary angiography for diagnostic or therapeutic indications, have associated significant CAS.
ii. All patients with CAS had TVD on coronary angiography and none of the patients with normal coronary angiography, SVD or DVD had associated significant CAS ($p \leq 0.0001$).
iii. Patients with CAS were more likely to be older than those without CAS. Additionally, 80% of these patients were males and all of them were hypertensive.

To the best of our knowledge, this is the first Indian study evaluating the carotid angiographic profile in patients with suspected or proven CAD. Although patients with atherosclerotic vascular disease come to clinical attention due to symptoms related to one vascular territory, given its multifocal nature, concomitant subclinical involvement of other vascular beds is not an uncommon observation.[4] CAD and CVD are the most fearsome complications of atherosclerosis, presenting dramatically as acute myocardial infarction or stroke in more than 50% of previously asymptomatic patients.[18] The association between carotid artery disease and CAD is well documented.[5-7] In fact just increased carotid intimal medial thickness (CIMT), even without carotid stenosis, has been established as a surrogate marker of subclinical atherosclerosis and is independently associated with adverse cardiovascular outcomes.[6,9,18,19] In the western countries, approximately 8% to 14% of patients undergoing myocardial revascularization for CAD have significant CAS, and 28% of patients undergoing carotid endarterectomy for CAS have significant CAD.[8,9] The data from Asian countries is somewhat different, with studies showing that more than 50% of patients with CAD have associated significant CAS and vice versa.[10,11] In most of these studies carotid ultrasound/Doppler was used to identify and quantify CAS. Compared with selective intra-arterial DSA, color duplex sonography has an overall sensitivity of 91% to 95% and a specificity of 86% to 97% for diagnosing CAS, and therefore, false positive or negative results may be present in the data reported in these studies.[20]DSA has also been demonstrated to be more accurate than other non-invasive methods such as computerized tomographic angiography (CTA) and magnetic resonance angiography (MRA) in detecting CAS.[21,22] Our study demonstrated that 20% of patients undergoing coronary angiography, and one third of patients with angiographically documented CAD, have associated significant CAS on DSA. Thus, prevalence of CAS in Indian patients with CAD seems to be intermediate between Western and other Asian countries. The presence of coexistent carotid artery disease in patients with CAD has an adverse impact on their short term and long term prognosis.[18,23-26] Hence, knowledge of associated CAS aids in refining the cardiovascular risk stratification of these patients, and strongly calls for more aggressive management strategies. Another interesting fact vis a vis cerebrovascular disease is that in contrast to CAD where non-critical rupture prone plaques are responsible for majority of the serious clinical events, severity of stenosis plays a dominant role in dictating the clinical course of patients with CAS.[27,28] Furthermore, presence of concomitant CAS dramatically increases the risk of periprocedural stroke in patients undergoing coronary revascularization. Coronary artery bypass grafting (CABG) in patients without carotid atherosclerosis carries an approximate 1% to 2% risk of perioperative stroke, but in the presence of untreated major carotid stenosis, this risk rises exponentially to about 14%.[25,29] It is also clear that the risk of perioperative stroke highly correlates with the degree of CAS.[26]Hence early diagnosis of concomitant carotid stenosis may have a direct bearing on the choice of revascularisation strategy. Some patients may benefit from synchronous coronary and carotid operations.[30,31] Optionally, patients at high risk with advanced but stable CAD may require prior intervention in the carotid arteries followed by coronary intervention.[23,24,32]A few authors have also reported simultaneous stenting of the carotid artery and coronary arteries in patients with high operative risk.[33] As far as correlation between carotid and coronary artery disease is concerned, studies have also shown that presence of CAS has a significant positive correlation with the extent and severity of CAD.[5-7,10,11] Our study demonstrated that all the patients with significant CAS had associated TVD on coronary angiography. These findings are consistent with previously reported literature. As regards to the risk factor profile, although both CAD and CAS share common atherosclerotic risk factors, some studies have shown that carotid disease correlates more strongly with age, hypertension and body size; while CAD has a stronger association with smoking status, diabetes and dyslipidemia.[19] We found that patients with concomitant CAS and CAD were more likely to be older than those without CAS. Additionally, 80% of these patients were males and all of them were hypertensive. Smoking and diabetic status were equally distributed between the two groups. These differences were however not statistically significant. Whether the insignificance of these findings was due to small sample size or due to ethnic attributes of our population needs to be confirmed in larger prospective studies.

LIMITATIONS

The present study had some important limitations. First, this was a single centre study and the sample size was small. Therefore, these results require further validation from larger prospective studies. Second, we included only those patients who had a diagnostic or therapeutic indication for invasive coronary angiography and excluded patients with documented history of CVD. These selection biases could mean that our findings regarding the relationship between carotid stenosis and CAD are relevant only to this specific group and may not be applicable to the general population. Third, although DSA is the criterion standard for vascular examination, many patients do not undergo DSA as a routine examination, because it is an invasive method with large-dose radiation exposure. In recent years, the accuracy of non-invasive imaging techniques has significantly improved. Whether or not these imaging modalities can totally replace DSA in the era of constantly growing proportion of carotid stenting vis a vis carotid endarterectomy remains to be answered. Finally, we did not evaluate the effect of coronary and/or carotid intervention on the clinical outcomes of these patients. Long term follow up data needs to be collected to see whether or not the prognosis is different in patients who were intervened upon in comparison to those who were not.

CONCLUSION

Concomitant angiographic CAS is found in significant proportion of patients with CAD, especially multivessel disease. Therefore, it can be argued that the patients with multivessel CAD should undergo carotid DSA at the time of coronary angiography for diagnosing associated CAS. Given the grave consequences that the patients with this deadly combination face, this strategy may allow superior risk stratification and better planning in terms of choice and sequence of revascularization strategy in these patients.

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CONFLICT OF INTEREST

The author declare no conflict of interest.

ABBREVIATIONS

ACC: American College of Cardiology; AHA: American Heart Association; eGFR: Estimated Glomerular Filtration Rate; HDL: High Density Lipoprotein; LDL: Low Density Lipoprotein.

REFERENCES

1. Mathers C, Fat DM, Boerma JT. The global burden of disease: 2004 update. World Health Organization; 2008. http://dx.doi.org/10.1016/b978-012373960-5.00335-x.
2. Gongora-Rivera F, Labreuche J, Jaramillo A, Steg PG, Hauw JJ, Amarenco P. Autopsy prevalence of coronary atherosclerosis in patients with fatal stroke. Stroke. 2007; 38(4):1203-10. http://dx.doi.org/10.1161/01.STR.0000260091.13729.96;

PMid:17332452.

3. Lloyd-Jones D, Adams R, Carnethon M, De Simone G, Ferguson TB, Flegal K, *et al*. Heart disease and stroke statistic-2009 update a report from the American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Circulation. 2009;119(3):e21-181. http://dx.doi.org/10.1161/CIRCULATIONAHA.108.191261; PMid:19075105.
4. Ross R. Atherosclerosis—an inflammatory disease. New England journal of medicine. 1999; 340:115-26. http://dx.doi.org/10.1056/NEJM199901143400207; PMid:9887164.
5. Sanguigni V, Gallù M, Strano A. Incidence of carotid artery atherosclerosis in patients with coronary artery disease. Angiology. 1993;44(1):34-8. http://dx.doi.org/10.1177/000331979304400106; PMid:8424583.
6. Salasidis GC, Latter DA, Steinmetz OK, Blair JF, Graham AM. Carotid artery duplex scanning in perioperative assessment for coronary artery revascularization: the association between peripheral vascular disease, carotid artery stenosis, and stroke. Journal of Vascular Surgery. 1995; 21(1):154-62. http://dx.doi.org/10.1016/S0741-5214(95)70254-7;
7. Craven TE, Ryu JE, Espeland MA, Kahl FR, McKinney WM, Toole JF, *et al*. Evaluation of the associations between carotid artery atherosclerosis and coronary artery stenosis. A case-control study. Circulation. 1990;82:1230-42. http://dx.doi.org/10.1161/01.CIR.82.4.1230; PMid:2205416.
8. Borger MA, Fremes SE, Weisel RD, Cohen G, Rao V, Lindsay TF, *et al*. Coronary bypass and carotid endarterectomy: does a combined approach increase risk? A metaanalysis. The Annals of Thoracic Surgery. 1999; 68(1):14-20. http://dx.doi.org/10.1016/S0003-4975(99)00474-9.
9. Steinvil A, Sadeh B, Arbel Y, Justo D, Belei A,Borenstein N, *et al*. Prevalence and predictors of concomitant carotid and coronary artery atherosclerotic disease. Journal of the American College of Cardiology. 2011;57:779-83. http://dx.doi.org/10.1016/j.jacc.2010.09.047; PMid:21310312.
10. Zheng JH, Hu DQ, An GY, Ma WJ, Zhang JX, Zhang HR. The prevalence and risk factors for coronary stenosis in patients with cerebral infarction. Zhonghua-neikezazhi. 2008;47:658-60.
11. Li AH, Chu YT, Yang LH, Chen KC, Chu SH. More coronary artery stenosis, more cerebral artery stenosis? A simultaneous angiographic study discloses their strong correlation. Heart and Vessels. 2007;22(5):297-302. http://dx.doi.org/10.1007/s00380-006-0971-8; PMid:17879020
12. Wityk RJ, Lehman D, Klag M, Coresh J, Ahn H, Litt B. Race and sex differences in the distribution of cerebral atherosclerosis. Stroke. 1996;27:1974-80. http://dx.doi.org/10.1161/01.STR.27.11.1974; PMid:8898801.
13. Gibbons RJ, Abrams J, Chatterjee K, Daley J, Deedwania PC, Douglas JS, *et al*. ACC/AHA 2002 guideline update for the management of patients with chronic stable angina—summary article: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee on the Management of Patients With Chronic Stable Angina). Journal of the American College of Cardiology. 2003;41(1):159-68. http://dx.doi.org/10.1016/S0735-1097(02)02848-6.
14. American Diabetes Association. Standards of medical care in diabetes—2015 abridged for primary care providers. Clinical Diabetes. 2015;33:97-111. http://dx.doi.org/10.2337/diaclin.33.2.97; PMid:25897193 PMCid:PMC4398006
15. James PA, Oparil S, Carter BL, Cushman WC, Dennison-Himmelfarb C, Handler J, *et al*. 2014 evidence-based guideline for the management of high blood pressure in adults: report from the panel members appointed to the Eighth Joint National Committee (JNC 8). JAMA. 2014;311(5):507-20. http://dx.doi.org/10.1001/jama.2013.284427; PMid:24352797.
16. Grundy SM, Brewer HB, Cleeman JI, Smith SC, Lenfant C. Definition of metabolic syndrome report of the National Heart, Lung, and Blood Institute/American Heart Association Conference on scientific issues related to definition. Circulation. 2004;109(3):433-8. http://dx.doi.org/10.1161/01.CIR.0000112379.88385.67; http://dx.doi.org/10.1161/01.CIR.0000111245.75752.C6; PMid:14744958.
17. Ferguson GG, Eliasziw M, Barr HW, Clagett GP, Barnes RW, Wallace MC, *et al*. The North American symptomatic carotid endarterectomy trial surgical results in 1415 patients. Stroke. 1999;30(9):1751-8. http://dx.doi.org/10.1161/01.STR.30.9.1751; PMid:10471419.
18. Kablak-Ziembicka A, Tracz W, Przewlocki T, Pieniazek P, Sokolowski A, Konieczynska M. Association of increased carotid intima-media thickness with the extent of coronary artery disease. Heart. 2004;90(11):1286-90. http://dx.doi.org/10.1136/hrt.2003.025080; PMid:15486123 PMCid:PMC1768551.
19. Ramper saud E, Bielak LF, Parsa A, Shen H, Post W, Ryan KA, *et al*. The association of coronary artery calcification and carotid artery intima-media thickness with distinct, traditional coronary artery disease risk factors in asymptomatic adults. American Journal of Epidemiology. 2008;168(9):1016-23. http://dx.doi.org/10.1093/aje/kwn211; PMid:18805900 PMCid:PMC2720772.
20. Gaitini D, Soudack M. Diagnosing Carotid Stenosis by Doppler Sonography State of the Art. Journal of Ultrasound in Medicine. 2005;24(8):1127-36. PMid:16040828.
21. Tomanek AI, Coutts SB, Demchuk AM, Hudon ME, Morrish WF, Sevick RJ, *et al*. MR angiography compared to conventional selective angiography in acute stroke. Canadian Journal of Neurological Sciences. 2006;33(1):58-62. http://dx.doi.org/10.1017/S0317167100004704; PMid:16583723.
22. Bash S, Villablanca JP, Jahan R, Duckwiler G, Tillis M, Kidwell C, *et al*. Intracranial vascular stenosis and occlusive disease: evaluation with CT angiography, MR angiography, and digital subtraction angiography. American Journal of Neuroradiology. 2005;26(5):1012-21. PMid:15891154.
23. Kabłak-Ziembicka A, Hlawaty M, Sadowski J, Pieniazek P, Pasowicz M, Tracz W. Management of coexistent advanced coronary artery disease and internal carotid artery stenosis. Przegladlekarski. 2001;59(7):554-6.
24. Shawl F, Kadro W, Domanski MJ, Lapetina FL, Iqbal AA, Dougherty KG, *et al*. Safety and efficacy of elective carotid artery stenting in high-risk patients. Journal of the American College of Cardiology. 2000;35(7):1721-8. http://dx.doi.org/10.1016/S0735-1097(00)00618-5;
25. Faggioli GL, Curl GR, Ricotta JJ. The role of carotid screening before coronary artery bypass. Journal of Vascular Surgery. 1990;12(6):724-31. http://dx.doi.org/10.1067/mva.1990.24458; PMid:2243408.
26. 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. The Annals of Thoracic Surgery. 1996;62(6):1714-23. http://dx.doi.org/10.1016/S0003-4975(96)00885-5;
27. Falk E, Shah PK, Fuster V. Coronary plaque disruption. Circulation. 1995;92(3):657-71. http://dx.doi.org/10.1161/01.CIR.92.3.657 PMid:7634481.
28. Kolodgie FD, Burke AP, Skorija KS, Ladich E, Kutys R, Makuria AT, *et al*. Lipoprotein-associated phospholipase A2 protein expression in the natural progression of human coronary atherosclerosis. Arteriosclerosis, Thrombosis, and Vascular biology. 2006;26(11):2523-9. http://dx.doi.org/10.1161/01.ATV.0000244681.72738.bc; PMid:16960105.
29. Rizzo RJ, Whittemore AD, Couper GS, Donaldson MC, Aranki SF, Collins JJ, *et al*. Combined carotid and coronary revascularization: the preferred approach to the severe vasculopath. The Annals of Thoracic Surgery. 1992;54(6):1099-109. http://dx.doi.org/10.1016/0003-4975(92)90076-G.
30. Chang BB, Darling RC, Shah DM, Paty PS, Leather RP. Carotid endarterectomy can be safely performed with acceptable mortality and morbidity in patients requiring coronary artery bypass grafts. The American Journal of Surgery. 1994;168(2):94-6. http://dx.doi.org/10.1016/S0002-9610(94)80043-X.
31. Terramani TT, Rowe VL, Hood DB, Eton D. Combined carotid endarterectomy and coronary artery bypass grafting in asymptomatic carotid artery stenosis. The American Surgeon. 1998;64(10):993. PMid:9764710.
32. Babatasi G, Theron J, Massetti M,Payelle G, Rossi A, Khayat A. Value of percutaneous carotid angioplasty before cardiac surgery. Annales de cardiologie et d'angeiologie. 1996;45:24-9.
33. Hofmann R, Kerschner K, Kypta A, Steinwender C, Bibl D, Leisch F. Simultaneous stenting of the carotid artery and other coronary or extracoronary arteries: Does a combined procedure increase the risk of interventional therapy?. Catheterization and Cardiovascular Interventions. 2003;60(3):314-9. http://dx.doi.org/10.1002/ccd.10652; PMid:14571479

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