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Original Article

Prevalence of peripheral arterial disease by ankle-brachial index and its correlation with carotid intimal thickness and coronary risk factors in Nepalese population over the age of forty years

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Abstract
Objectives: Noninvasive measures of subclinical atherosclerosis such as the ankle brachial index (ABI) and common carotid artery intima-media thickness (CCA IMT) could improve risk prediction and provide more focused primary prevention strategies. This report describes the prevalence of subclinical atherosclerotic vascular disease in a Nepalese population over the age of forty years as measured by ABI and CCA IMT and their association with established cardiovascular risk factors.
Materials and methods: Ultrasonic evaluation of ABI and CCA IMT was done in 195 individuals of age 40 years and above who had presented to an outpatient department. Patients with established diagnosis of coronary artery disease or symptomatic for peripheral arterial disease were excluded from the study.
Results: The prevalence of atherosclerotic disease as measured by ABI was 18.5% and there was a statistically significant correlation between ABI and CCA IMT and other established cardiovascular risk factors such as smoking, diabetes mellitus and hypertension.
Conclusions: We recommend that ABI as measured by sphygmomanometer be incorporated into routine cardiovascular screening and when found to be abnormal further confirmed by Doppler assessment of ABI and CCA IMT as surrogate markers of atherosclerotic vascular disease.

Key words: atherosclerosis, cardiovascular disease, peripheral vascular disease, carotid arteries

Peripheral arterial disease (PAD) is most commonly a manifestation of systemic atherosclerosis in which the arterial lumens of the lower extremities become progressively occluded by atherosclerotic plaque. It is associated with cardiovascular disease (CVD) and CVD risk factors[1-3]. It is also a surrogate risk marker for coronary artery disease, cerebrovascular disease and aneurismal diseases. Prospective studies using the ankle brachial index (ABI) have shown that a low ABI predicts fatal and nonfatal coronary heart disease (CHD) and all-cause mortality in people with and without existing clinical coronary artery disease and among people with existing peripheral vascular disease [4-10]. In patients with PAD, the prevalence of coronary artery disease ranges from 20% to 60% when based on medical history, physical examination, and electrocardiography and up to 90% in patients who have undergone coronary angiography[2], yet PAD is probably the most under diagnosed and least aggressively managed atherosclerotic disease.

The ABI is a simple, inexpensive and noninvasive tool that can be used to detect PAD in patients. Although quick and easy to perform with a high patient acceptability, the ABI was originally used to identify lower-limb atherosclerosis. However, it has subsequently been shown to be an accurate[11 12] and reliable[13] marker of generalized atherosclerosis. It has been reported that the 5-year incidence of total cardiovascular events in subjects with an ABI <=0.9 was almost twice that in subjects with an ABI >0.9 [14].

It has also been suggested that the intima-media thickness (IMT) of the common carotid artery (CCA) may be the most sensitive marker for the earliest stages of atherosclerosis [13]. The distribution of asymptomatic atherosclerosis could only be assessed at autopsy or by angiography of patients with severe disease. However, over the last decade, development of noninvasive ultrasound techniques has made the visualization and measurement of the layers of the arterial wall and plaques possible in large population samples.

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It has also been shown that atherosclerotic lesions in their earliest stages may progress without a reduction in lumen diameter because of simultaneous dilation of the arterial wall[15], making recognition of stenosis on arteriography difficult. Because ultrasonographic measurement of the IMT is not affected by lumen diameter, it may therefore be the most accurate method of assessing early development of atherosclerosis in large representative population samples.

With increasing incidence of Coronary Artery disease in developing countries, ABI and CCA IMT can be used to screen patients who are at increased risk of developing and suffering cardiovascular events. The main objectives of this study were (1) to study asymptomatic middle aged to elderly Nepalese population without documented coronary artery disease and without symptoms of typical angina for the presence of peripheral arterial disease as defined by ABI, and (2) to assess the relationship between ABI and CCA IMT, and ABI and other established cardiovascular risk factors.

Materials and methods

Study population

195 middle aged (40 years and above) patients were selected on consecutive basis from the outpatient of a general practice in urban Kathmandu. With estimated prevalence of 6%-10% PAD in general population, a study sample of this size will be able to estimate prevalence at 95% confidence interval. Demographic and risk factors (smoking, high blood pressure and diabetes mellitus) history were taken from the patients after the patients consented for participation. A history of smoking was established if patients had a history of 10 pack years of smoking. Diabetes was determined by clinical records. Separate measurement of blood glucose was not done. Patients were deemed hypertensive if they had systolic pressure more than 140 mm Hg and /or diastolic pressure more than 90 mm Hg or were on antihypertensive medications at the time of visit. Patients with symptomatic peripheral arterial disease were excluded from the study.

Materials

Echocardiography machine, Pro/Vivid 3 Expert technology from GE was used to measure the blood pressure and common carotid artery intima-media thickness (CCA IMT). 10L (739L) General Purpose Linear Probe with Image frequency of 5.7-10.0 and Doppler frequency of 4.4-6.7 was used to detect the resumption of blood flow by colour Doppler technique as the sphygmomanometer cuff pressure was gradually released. This was taken as the systolic blood pressure. A senior echocardiographer with 10 years of experience performed the procedure.

Ankle Brachial Index

With patients in supine position brachial artery systolic pressure was first measured by palpatory method and then by Doppler blood flow method in both the arms. Palpatory method of measuring blood pressure was used because auscultatory method of measuring blood pressure was not possible for dorsalis pedis due to bony prominence. The first wave seen during deflation of cuff was taken as systolic blood pressure. The higher reading was taken as brachial arterial systolic pressure. Similarly, ankle blood pressure was taken first by palpatory method with the cuff placed just above the ankle and then by measuring Doppler blood flow in dorsalis pedis artery or posterior tibial artery of both feet. Individual ABI were obtained for each leg by dividing corresponding ankle pressure by the brachial pressure. The lower of the values obtained for the two legs was used as the true ABI for that patient. A cut-off point of 0.9 was used to define a low ABI because this has been shown to be a highly sensitive and specific measure of peripheral vascular disease in a clinical setting [21]. Subjects with ABI > 1.5 were excluded from the study because this is associated with arterial calcification and stiffening giving a false high blood pressure.

Common Carotid Artery Intima-Media Thickness (CCA IMT)

The B-mode ultrasound scanning of the carotid arteries was performed using the same machine as mentioned above. The subject lay supine with the neck extended and the chin turned contralateral to the side being examined. The scanning protocol involved examination of the carotid arteries longitudinally. Measurement of IMT was made at a point 2cm proximal to the bifurcation, from a longitudinal scan plane that showed the intima-media boundaries most clearly. It was decided to measure the IMT at this section of the carotid artery because it is well documented that the accuracy of visualization of vessels, and particularly the intima-media boundary, on B-mode ultrasound images is related to depth and anatomic configuration of the vessel [16 17 18 19] . On the screen displaying the frozen magnified image of the far wall of the CCA, two cursors were positioned on the boundaries of the intima-media. The distance between these cursors was recorded to the nearest 0.1 mm (maximal axial resolution of the scanner) as the IMT. The procedure was repeated for each side of the neck.

Statistical analysis

Information on the questionnaire and recording forms was checked by the clinic staff, coded, and entered onto a DBASE IV database. Error rates were determined by dual entry of all data, and reference was made to original records in cases with any discrepancy. Data files were analyzed using the SPSS statistical package [20]. We used simple descriptive statistics and Chi square (*X2*) test to examine the association between ABI groups (ABI<=0.9 and ABI>0.9) and CCA IMT and other cardiovascular risk factors. Finally, a logistic regression analysis was done to find out independent association of cardiovascular risk factors and CCA IMT with ABI groups.

Results

The present analysis is based on 195 subjects after exclusion of 2 subjects with an ABI >1.5 as it is associated with arterial calcification and increase in wall stiffening. 113 (57.9%) of the subjects were male. Thirty-six subjects (18.5%) had an ABI <=0.9, thirty-nine (20%) were smokers, twenty-one (10.8%) hypertensive, fourteen (7.2%) diabetic, and fifty-eight (29.7%) subjects had a CIT of >0.8. After logistic regression analysis it was found that abnormal ABI (i.e. <=0.9) was significantly associated with the established cardiovascular risk factors, such as smoking, hypertension and diabetes mellitus, as well as CIT of more than 0.8 mm, which is another marker of atherosclerotic disease (Table 1).

Table 1. Demographics and the relationship between ankle-brachial index (ABI) and common carotid artery intima-media thickness (CCA IMT) and other cardiovascular risk factors

	ABI <=0.9 n (%)	**ABI > 0.9 n (%)**	**OR**	**95% CI**	**p**
Age group					
40-44	7 (3.6)	8 (4.1)			
45-49	12 (6.2)	52 (26.7)			
50-54	8 (4.1)	15 (7.7)			
>=55	9 (4.6)	11 (5.6)	-	-	NS
Sex					
Male	17 (8.7)	96 (49.2)			
Female	19 (9.7)	63 (32.3)	-	-	NS
CCA IMT					
<=0.8	14 (7.2)	123 (63.1)			
> 0.8	22 (11.3)	36 (18.5)	3.5	1.4-8.6	0.006
Smoking					
Non-smoker	28 (14.4)	128 (65.6)			
Smoker	8 (4.1)	31 (15.9)	2.1	1.9-5.6	0.003
Diabetes					
Non-diabetic	27 (13.8)	154 (78.9)			
Diabetic	9 (4.6)	5 (2.6)	7.6	1.6-34.9	0.009
Hypertension					
Non-hypertensive	23 (11.8)	151 (77.4)			
Hypertensive	13 (6.7)	8 (4.1)	5.8	1.8-19.1	0.004

Discussion

The prevalence of peripheral arterial disease (PAD) by the above study, based on ABI index of <=0.9, was 18.5% which is a reasonably high percentage of the population at risk for adverse cardiovascular events. This study also evaluates common carotid artery intima-media thickness (CCA IMT), and 29.7% were found to have a thickness of >0.8, which is another marker of PAD. It has recently been argued that ultrasonography of the peripheral vessels, rather than coronary angiography, is the most accurate measure of the extent of atherosclerosis [13]. B-mode ultrasonography allows accurate visualization of the arterial wall and measurement of IMT. There is mounting evidence to suggest that IMT is an indicator of the severity of atherosclerosis in its earliest stages [13 15 22]. Addition of the ABI significantly improves prediction of fatal myocardial infarction over and above that of conventional risk factors [23]. Moreover, in this study, ABI shows strong correlation between the established coronary heart disease risk factors such as smoking, hypertension and diabetes mellitus and the CCA IMT. Since the ACEP Treatment Panel 3 has classified PAD as a coronary risk equivalent, this sub-group of patients should be diagnosed early and treatment administered as per the guidelines.

Conclusion

To conclude, our results show a significant correlation between markers of peripheral arterial disease (ABI index and CCA IMT) and the cardiovascular risk factors. Since the screening of PAD patients can be done by the use of simple BP measurement of the brachial artery and dorsalis pedis/posterior tibial artery, this should be a routine examination in all patients above the age of 40 years. All suspected patients should be further confirmed by Doppler assessment of ABI and CCA IMT as surrogate markers for atherosclerotic vascular disease.

References

1. Curb JD, Masaki K, Rodriguez BL. Peripheral artery disease and cardiovascular risk factors in the elderly: the Honolulu Heart Program. Arterioscler Thromb Vasc Biol. 1996;16:1495–1500.
2. Murabito JM, Evans JC, Nieto K. Prevalence and clinical correlates of peripheral arterial disease in the Framingham Offspring Study. Am Heart J. 2002;143:961–965.
3. Fabsitz RR, Sidawy AN, Go O. Prevalence of peripheral arterial disease and associated risk factors in American Indians: the Strong Heart Study. Am J Epidemiol. 1999;149:330–338.
4. McKenna M, Wolfson S, Kuller L. The ratio of ankle and arm arterial pressure as an independent predictor of mortality. Atherosclerosis. 1991;87:119–128.
5. Vogt MT, McKenna M, Anderson SJ, et al. The relationship between ankle-arm index and mortality in older men and women. J Am Geriatr Soc. 1993;41:523–530.
6. McDermott MM, Feinglass J, Slavensky R. The ankle-brachial index as a predictor of survival in patients with peripheral vascular disease. J Gen Intern Med. 1994;9:445–449.
7. Newman AB, Tyrrell KS, Kuller LH. Mortality over four years in SHEP participants with a low ankle-arm index. J Am Geriatr Soc. 1997;45:1472–1478.
8. Leng GC, Fowkes FG, Lee AJ. Use of ankle brachial pressure index to predict cardiovascular events and death: a cohort study. BMJ. 1996;313:1440–1444.
9. Leng GC, Lee AJ, Fowkes GR. Incidence, natural history and cardiovascular events in symptomatic and asymptomatic peripheral arterial disease in the general population. Int J Epidemiol. 1996;25:1172–1181.
10. Newman AB, Shemanski L, Manolio TA. Ankle-arm index as a predictor of cardiovascular disease and mortality in the Cardiovascular Health Study: the Cardiovascular Health Study Group. Arterioscler Thromb Vasc Biol. 1999;19:538–545
11. Bird CE, Criqui MH, Fronek A. Quantitative and qualitative progression of peripheral arterial disease by non-invasive testing. Vasc Med. 1999;4;15-21
12. Fisher CM, Burnett A, Makeham V. Variation in measurement of ankle-brachial pressure index in routine clinical practice. J Vasc Surg. 1996;24;871-875.
13. Blankenhorn DH, Rooney JA, Curry PJ. Noninvasive assessment of atherosclerosis. Prog Cardiovasc Dis. 1984;26;295-307
14. Leng GC, Fowkes FGR, Lee AJ. Use of ankle brachial pressure index to predict cardiovascular events and death: a cohort study. BMJ.1996;313:1440-1444.
15. Howard G, Sharrett AR, Heiss G, Evans GW. Carotid artery intima-media thickness in general population as evaluated by B-mode ultrasound. Stroke. 1993;24:1297-1304 (Abstract)
16. Garth KE, Carroll BA, Sommer FG, Oppenheimer DA. Duplex ultrasound scanning of the carotid arteries with velocity spectrum analysis. Radiology. 1983;147:823-827. (Abstract)
17. Folger WN, Non-invasive studies. In: Sundt TM Jr, ed. Occlusive Cerebrovascular Disease: Diagnosis and Surgical Management. 1987: 77
18. Ginsberg MD, Cebul RD. Non-invasive diagnosis of carotid artery disease. In: Harrison MJG, Dyken ML, eds. Cerebral Vascular Disease. London, UK: Butterworth; 1983; chap 9: 226
19. Non-invasive dynamic and real time assessment of extracranial cerebrovasculature. In: Wood JH, ed. Cerebral Blood Flow: Physiologic and Clinical Aspects. New York, NY: McGraw-Hill Book Co; 1987; chap 6: 313
20. SPSS 13. Chicago, Ill: SPSS Inc
21. Ouriel K, McDonnell AE, Metz CE. A critical evaluation of stress testing in the diagnosis of peripheral vascular disease. Surgery. 1982; 91: 686-693.
22. O'Leary DH, Polak JF, Kronal RA, Kittner SJ, Bond MG, Wolfson SK Jr, Bommer W, Price TR, Gardin JM, Savage PJ, for the CHS Collaborative Research Group. Distribution and correlates of sonographically detected carotid artery disease in the cardiovascular Health Study. Stroke. 1992;23: 1752-1760. (Abstract)
23. Lee AJ, Price JF, Russel MJ, Smith FB, Wijk MCW van, Fowkes FGR. Improved prediction of fatal myocardial infarction using the ankle brachial index in addition to conventional risk factors. The Edinburg Artery Study. Circulation. 2004; 110:3075-3080