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Correlation between peripheral arterial disease and coronary artery disease using ankle brachial index—a study in Indian population

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KEYWORDS

Ankle brachial index
Coronary artery disease
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ABSTRACT

Objective: To study the prevalence of peripheral arterial disease (PAD) of the lower limbs in a high-risk population and its correlation with coronary artery disease (CAD), using the ankle brachial index (ABI).
Methods: The present study was conducted in randomly selected indoor patients >45 years of age with one or more risk factors for PAD admitted in the cardiology and medicine wards in a tertiary care institute.
Results: Based on ABI <0.9, PAD was diagnosed in 32 of the 182 (18%) patients. Coronary artery disease was present in 15 cases of PAD which was statistically significant.
Conclusion: There is a definite and strong correlation between PAD and CAD. Correct diagnosis and supervision of patients with PAD is important for preventing the local progression of the disease and effective secondary prevention of future coronary and cerebrovascular events.

Introduction

Peripheral arterial disease (PAD) is the occlusive disease of arteries distal to the aortic bifurcation.[1] The prevalence of PAD in the lower limbs in a general population >55 years of age is between 10% and 25% and it increases with age.[2] Majority of affected population have asymptomatic disease. Peripheral arterial disease, whether symptomatic or asymptomatic, is a risk factor for non-fatal and fatal coronary disease and cerebrovascular events.[3] Patients with PAD alone have the same relative risk of death from cardiovascular cause as those with coronary or cerebrovascular disease.[4] Risk of death in patients of PAD within 10 years is 4 times more than those without the disease.[5] Several studies have shown that the ankle brachial index (ABI), an index for occlusive vascular disease, is now considered an independent predictor of coronary and cerebrovascular morbidity and mortality.[6] Our study in an Indian population was carried out to correlate and substantiate the relation of PAD with coronary artery disease (CAD) using the ABI.

Methods

The present study was conducted in randomly selected in-patients admitted in the cardiology and medicine wards in a tertiary care institute between October 2004 and March 2005. The following inclusion criteria were followed:

1. Above 45 years of age.
2. History of one or more conventional risk factors of PAD like diabetes mellitus (DM), smoking, hypertension or dyslipidaemia and/or were on treatment for the same.
3. Angiographic confirmation of CAD in addition to clinical history and electrocardiogram (ECG) abnormalities in suspected cases.

A detailed clinical history of the patients was taken followed by a detailed clinical examination, which was recorded in a proforma sheet. The diagnosis of intermittent claudication (IC) was made based on the response to the questions in the proforma sheet.

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The measurement of ABI was done with the help of VP-1000 from Colins, Japan which works on the oscillometric principle. Blood pressure cuffs are tied to all four limbs and systolic pressure of all the limbs is measured at the same time and the ABI is calculated for each side.

Results

The present study consisted of a study population of 182 patients. Based on ABI <0.9, PAD was diagnosed in 32 patients and 150 patients had ABI >0.9 on both sides and hence were considered normal. The occurrence of PAD in the study population was 18% (Figure 1 and Table 1).

Of the study population 143 (78%) were males and 39 (22%) were females. Among males, 22 (15.38%) were detected as PAD-positive cases. Among females 10 (25.64%) out of the 39 cases had PAD (Table 2).

Nine (4.8%) patients among the 182 described symptoms of IC; of the 9, 7 patients had PAD. The overall occurrence of IC in the study population was 3.8%. Among the 32 cases who had PAD, 7 had IC. Twenty-five (13%) patients had PAD without symptoms of IC.

The minimum recorded ABI value on the right-side was 0.3 and the maximum was 1.29. The median value was 1.06. The minimum value on the left-side was 0.37 and the maximum was 1.39 with a median of 1.06. Of the ABI recordings 13.19% were abnormal on the right-side and 9.34% were abnormal on the left-side (Tables 3 and 4).

The presence of PAD in diabetics was significantly higher as shown in Table 5 (P=0.021; statistically significant).

As shown in Table 6, 14 (35.9%) out of the 39 smokers had PAD whereas 25 (16%) out of the 150 non-smokers had PAD. This proved the predominance of PAD amongst smokers. Amongst the PAD-positive patients 44% were smokers, i.e. 14 of the 32 patients (P=0.001; statistically significant).

Of the 182 patients in the study population, 102 had hypertension and 19 patients (18.63%) amongst them had PAD (Table 7). Occurrence in hypertensives and non-hypertensives was similar (P=0.676; statistically insignificant).

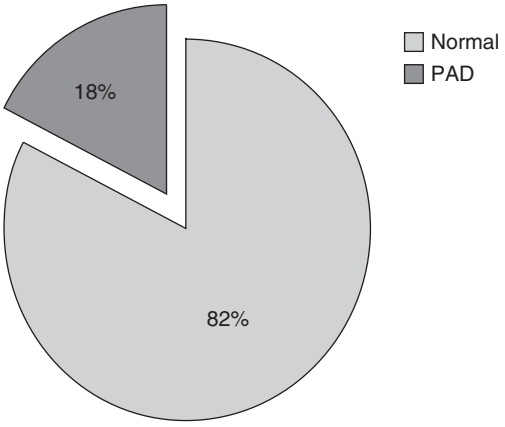

Figure 1 The pie graft distribution of normal and peripheral arterial disease patients in the study population. PAD: peripheral arterial disease.

Table 1
The number of normal and peripheral arterial disease patients in the study population.

Diagnosis	Total (%)
Normal	150 (82)
Peripheral arterial disease	32 (18)
Total	182 (100)

Table 2
The age wise occurrence of peripheral arterial disease.

Age (yr)	Normal	PAD (%)	Total
45–54	70	8 (10.2)	78
55–64	37	9 (18.7)	46
>65	43	15 (24.8)	58
Total	150	32 (18)	182

PAD: peripheral arterial disease.

Table 3
The variation of peripheral pulsations in the study population.

Peripheral pulse	Normal	PAD	Total
Abnormal	13	9	22
Normal	137	23	160
Total	150	32	182

PAD: peripheral arterial disease.

Table 4
The distribution of ankle brachial index values in both lower limbs and their relation to severity of peripheral arterial disease.

Severity (ABI value)	Left	Right	Total
Mild (0.89–0.7)	12	19	31
Moderate (0.69–0.4)	5	4	9
Severe (<0.4)	1	2	3
Normal (>0.9)	164	157	321
Total	182	182	364

ABI: ankle brachial index, PAD: peripheral arterial disease.

Table 5
The relation of peripheral arterial disease to diabetic status.

Diabetic status	Normal	PAD	Total
Non-diabetic	37 (22)*	2 (0)*	39 (22)*
Diabetic	113 (54)*	30 (24)*	143 (78)*
Total	150 (76)*	32 (24)*	182 (100)*

*Figures in brackets indicate patients >55 years of age. PAD: peripheral arterial disease.

Table 6
Relation of smoking to peripheral arterial disease.

Smoking status	Normal	PAD	Total
Non-smokers	125	18	143
Smokers	25	14	39
Total	150	32	182

PAD: peripheral arterial disease.

Table 7
The relation of hypertension to peripheral arterial disease.

Hypertension status	Normal	PAD	Total
Negative	67	13	80
Positive	83	19	102
Total	150	32	182

PAD: peripheral arterial disease.

Table 8
Relation of coronary artery disease to peripheral arterial disease.

CAD status	Normal	PAD	Total
Negative	120	17	137
Positive	30	15	45
Total	150	32	182

CAD: coronary artery disease; PAD: peripheral arterial disease.

As shown in Table 8, 45 patients (24.73%) in the study population had CAD. The occurrence of CAD in PAD-positive cases was 46.88% while in PAD-negative cases it was 20% ($P=0.001$; statistically significant).

Discussion

Peripheral arterial disease is the occlusive disease of arteries distal to the aortic bifurcation.[1] The term, however, is widely used to refer to chronic arterial disease of the legs of atherosclerotic origin. Atherosclerosis is by far the most common cause (>90%) of arterial problems in the legs.[7] The pathology was designated as arteriosclerosis obliterans by the World Health Organization (WHO) study group.[8] The ratio between systolic arterial pressure at the ankle and brachial artery, i.e. the ABI was established as a valid index to identify patients with asymptomatic PAD.[1] Some of the landmark studies like Edinburgh Artery Study (1992), Framingham Study (1970–1996), The San Diego Study (1992), and The Rotterdam Study (1998) using the ABI have shown that the prevalence of asymptomatic PAD is much higher than the symptomatic disease.[1] The measurement of ABI is the single most useful diagnostic tool in the evaluation of PAD.[6]

The San Diego Study found a high-risk of cardiovascular mortality among subjects with an abnormal ABI (<0.8).[6] Criqui et al. using multivariate analysis in a population investigated for carotid stenosis, ECG anomalies, and presence of PAD, diagnosed on the basis of the ABI, found that after 8 years of follow-up, ABI <0.9 was associated with total mortality 2.4 times higher than normal and double the risk of cardiovascular mortality.[9] The Cardiovascular Health Study and the Edinburgh Artery Study using multivariate analysis on prospective observations of a large series (5888 and 1592 subjects, respectively) with an adequate follow-up (6 and 5 years, respectively), showed that the risk of total and cardiovascular mortality was higher in patients with ABI <0.9, with a relative risk estimate between 1.5 and 1.8.[10,11] The risk of death and non-fatal vascular events was higher in patients who had a low ABI together with risk factors such as diabetes or high blood cholesterol. In Italian ADEP (Associazione Diaspora e Pace) Study, a low ABI was one of the predictors of vascular events—fatal or non-fatal in a population with IC.[4]

While the strength of the ABI as a negative prognostic indicator seems clear, it also appears that subclinical abnormalities in the index imply a prognosis as negative as in symptomatic patients.[6] In the Cardiovascular Health Study, subclinical vascular abnormalities detected instrumentally and with the ABI, involved a greater risk of developing the disease than in patients with no subclinical disorder.[10]

In this study, done on a defined population comprising inpatients >45 years of age with one or more conventional risk factors for PAD using the ABI as the diagnostic parameter, 18% of the subjects had PAD. The PARTNERS program which studied the population aged between 50 years and 69 years with diabetes or smoking and age >70 years found a prevalence of 29%.[12] The Rotterdam study with a study population <55 years of age had a prevalence of 19%.[13] The Edinburgh Artery Study studied the age stratified sample between 55 years and 74 years and found a prevalence of 9%.[11] However, the Swiss Atherothrombosis Survey carried out on a population >55 years of age with stroke, TIA, CAD or two or more risk factors found a prevalence of only 6.4%.[14] All the compared studies used ABI as the diagnostic parameter.

This study population when analysed age wise, the prevalence in age group of 45–54 years was only 10.2%. It increased to 18.7% in 55–64 years age group and was 24.8% in the age group >65 years. Peripheral arterial disease occurrence increased with age. Most studies have shown a linear relation between age and PAD. The Rotterdam Study showed a prevalence of 7.6% in age group of 55–59 years, which increased to 59.6% in age >85 years.[13] Newman et al. have shown a prevalence of 26% in a population aged ≥60 years.[10] This is comparable to the present study which has a prevalence of PAD of 24% of the patients in the study population >55 years of age.

In this study population, the male subjects comprised 78% and female subjects comprised 22%. The occurrence of PAD among males was 15.38% and among females was 25.64%. The impact of sex on PAD, however, did not reach statistical significance in this study. Most of the studies have shown a similar incidence of PAD with men to be slightly more than women. Schroll and Munk have shown an incidence of 16% in men and 13% in women.[1] The Cardiovascular Health Study has shown a prevalence of 14% for men and 11% for women.[10] Vogt et al. have shown the gap in prevalence narrows after 70 years of age.[15] However, Meijer et al. in the Rotterdam Study found a higher prevalence rate among women being at 20.5% and for men being at 16.9%.[13]

An important aspect of this study was assessing the occurrence of symptomatic and asymptomatic PAD based on the presence of IC. In this study, 4.8% of subjects described symptoms of IC. Of these 1% did not have PAD. The overall occurrence of IC in the study population was 3.8%. This is similar to most of the other studies. The Edinburgh Artery Study shows the prevalence of IC at 4.5%.[11] Reunanen et al. had shown the prevalence of IC at 2%.[16] Schroll and Munk have shown a prevalence of 3.5% for IC.[1] Though the prevalence of PAD in this study was 18%, the prevalence of symptomatic PAD is only 3.8%. The occurrence of IC has risen steeply with age.

Subjects <55 years of age had an occurrence of 1.2%, between 55 years and 64 years of age the occurrence was 6.5%, while in those subjects >65 years of age an occurrence of 9.6% was observed. This again corroborates the fact that progression of PAD occurs with increasing age. Ouriel et al. has reported that the incidence of symptomatic PAD increases with age from about 0.3% per year for men aged 40–55 years to about 1% per year for men aged over 75 years.[17] Reunanen et al. have shown a prevalence of IC of 2% in a population aged <60 years.[16] Newman et al. have shown that the prevalence of IC in population >60 years is 6.4% which is comparable to the figures discussed in this study.[10]

Another interesting fact observed was the presence of claudication seen more among subjects who also had associated CAD. Reunanen et al. had also made a similar observation in their study.[16] In this study, among the patients diagnosed to having PAD, 21% were symptomatic. Hence, screening with ABI detected 79% asymptomatic PAD subjects. Stoffers et al. have shown that among those diagnosed with PAD, only 22% had symptoms.[18] Meijer et al. have shown the prevalence of symptoms in 15% of PAD-positive cases.[13]

Taking into consideration the whole study population, 25 subjects (13%) out of 182 had asymptomatic PAD. Stoffers et al. have reported a prevalence of 6.9% of asymptomatic PAD.[18] In the Edinburgh Artery Study, 8% had major asymptomatic PAD.[11] The occurrence of both asymptomatic disease (13%) and diseased subjects being without symptoms (79%) suggests that screening the population at risk by a simple test like ABI measurement should be done in regular clinical practice. In the present study 28% of patients with PAD had an abnormal peripheral pulse examination. The remaining 72% had normal peripheral pulse. The PARTNERS program has highlighted that as many as 50% of cases may have a normal peripheral pulse.[12]

The spread of ABI showed a median value of 1.06 on each side. The maximum ABI value was 1.39. As none of the values were >1.5, which is indicative of non-compressible calcific arteries, no second method of evaluation was required in this study. Disease occurrence on the right-side was 13.19% and on the left-side was 9.34%. The Edinburgh Artery Study has also shown unilateral predisposition to disease, but it was to the left-side as opposed to the right-side in our study.[11]

Based on ABI, the study population was divided into mild, moderate, and severe disease and 72% of subjects were reported to have had mild disease (ABI 0.7–0.89). Doobay and Anand have shown that a low ABI between 0.8 and 0.9 has a high specificity of 92% to predict CAD and 87% for cardiovascular mortality.[19] Lee et al. have shown that ABI <0.9 can independently predict fatal myocardial infarction in addition to the conventional risk factors.[20] Majority of the study population have a low ABI but asymptomatic PAD. However, they are at a high-risk for coronary and cardiovascular events and hence should be the target for preventive measures.

This study showed that 20.98% of patients with DM had PAD and the *P* value for DM as a risk factor was statistically significant. A cross-sectional study by Adler et al. found a prevalence of 23.5% PAD among type 2 DM patients.[21] In the study by Beckman et al., 50% of patients with DM were found to have PAD.[22] In our study, the occurrence of PAD in diabetics >55 years of age went up to 24%. However, regardless of high prevalence and complication that can result from PAD, it is still not a common practice to routinely screen for the disease in diabetics.

In our study, 21% were smokers and all of them were males. Occurrence of PAD among smokers was around 36% which was significantly higher than among non-smokers (20%). Forty-four percent of the PAD-positive cases were smokers. Smoking as a risk factor had a statistically significant *P* value (0.001). Studies like Framingham Study, Cardiovascular Health Study, and Edinburgh Artery Study showed that amongst smokers PAD was 2–5 times higher.[10,11,23] Willingdael et al. have shown that PAD is 2.5 times more in smokers.[24] In our study, PAD was 2 times more in smokers than in non-smokers with a significant *P* value.

The present study had 55% of subjects as hypertensives; 18.63% had PAD whereas a similar proportion of 16% among non-hypertensives had PAD. The *P* value was not statistically significant (*P* value 0.676). According to the Framingham Heart Study, hypertension doubles the risk of PAD.[23] However, Reunanen et al. showed that hypertension was not significantly related to PAD.[16] In our study occurrence of PAD in both groups was similar.

The present study population of 182 patients had 45 patients (24.73%) who had CAD. However, the occurrence of CAD among patients who had PAD was 2 times more than those without PAD. Among PAD-positive cases, CAD was present in 46.88%. Only 20% of PAD-negative cases had CAD. A strong correlation was found to occur between PAD and CAD ($P=0.001$; statistically significant). The PARTNERS program showed that 16% of patients had PAD and CAD, 13% had only PAD, and 24% had only CAD.[12] In our study 10% had PAD and CAD, 12% had only PAD, and 16% had only CAD.

Another interesting observation in our study was that only 6 patients were subjected to ABI measurement previously comprising only about 3% of the study population. Among the 6 patients, 2 of them had symptomatic disease and 2 of them had associated CAD. Hence, it was observed that though ABI is a relatively simple test to conduct, it is still used very sparingly in clinical practice.

Conclusion

There is a definite and strong correlation between PAD and CAD. In view of the increasingly aging population and associated increase in atherosclerotic vascular disease, confrontation with patients of PAD will increase, which however, continues to be under diagnosed and under treated. The awareness and implementation of ABI in general clinical practice is poor. A simple, inexpensive test like ABI can improve the diagnosis of PAD in clinical practice and thus help in preventing CAD and consequent death by a range of medical therapies. Correct diagnosis and supervision of patients with these disorders is important for the prevention of local progression of the disease and effective secondary prevention of any future coronary and cerebrovascular events.

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