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Correlation Between Peripheral Arterial Disease and Coronary Artery Disease Using the Ankle-Brachial Index: An Observational Study

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Abstracts

Objective: Atherosclerosis is associated with arterial stiffness and can cause acute cerebral stroke or myocardial infarction. It is the most prevalent and progressive disease of recent times. Coronary artery disease (CAD) is the leading cause of morbidity and mortality in India. The objective of our study was to use the ankle-brachial index (ABI)in a high-risk populationto find out the prevalence of previously unrecognized peripheral arterial disease in the lower limbs and its correlation with coronary artery disease.

Methods: We analyzed data from 100 consecutive patients with coronary arterial disease, as confirmed by coronary angiography. We measured the ankle-brachial index after coronary angiography. Patients were divided into two groups. Group A had ankle-brachial index (ABI) <0.9 and group B had ABI >0.9. ABI <0.9 was used to diagnose peripheral arterial disease.

Results: We have diagnosed asymptomatic peripheral arterial disease in 74% of the patients who were subjected to a coronary angiogram and had significant coronary artery disease. In Group A, we found that 62.1% of patients had multi-vessel coronary artery disease and 12.1% had left main coronary artery disease.

Conclusion: There is a significant correlation between peripheral arterial disease and coronary artery disease. Early diagnosis and treatment of the patient with PAD are important for preventing local progression of the disease and effective secondary prevention of future coronary and cerebrovascular events.

Keywords: Atherosclerosis, coronary artery disease, peripheral arterial disease, ankle-brachial index

1. INTRODUCTION

Lobstein introduced the term arteriosclerosis in 1772.Atherosclerosis is aninflammatory disease where atheromatous or fatty plaques are deposited on the wall of the affected arteries and make them stiff. Its common clinical manifestations are coronary artery disease (CAD), stroke, and peripheral arterial disease (PAD). Evidence of atherosclerosis in all vascular beds was found in mummies dating as far backas 3300 BCE and across various geographic regions, cultures, and lifestyles (1,2).Epidemiological studies show that coronary artery disease (CAD) is one of the most important causes of morbidity and mortality in India. All studies conducted in the last twenty years show a two to four times increase in the number of coronary artery

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diseases. The mortality due to CAD from 2000 to 2015, increased from 1.3 to >2.9 million. The concept of prevention of coronary artery disease was pioneered by Paul Dudley White in 1940. He recognized that familial history, high-fat/cholesterol diet, arterial hypertension, tobacco use, diabetes mellitus, and physical inactivity as risk factors for atherosclerosis (3). Since then,lots of efforts are being taken by the World health organization (WHO), different governmental and social organizations to prevent CAD by creating awareness among the general public, making an impact on their lifestyle modifications, changing in dietary patterns, and encouraging them to do regular exercise.

Newer and more effective drugs are also available in the market to prevent atherosclerosis. All concerned are trying to diagnose CAD early to prevent mortality. It was found that patients with asymptomaticPAD have a higher risk of CAD and are at a higher risk of cardiovascular events when compared with healthy controls (4).Hoyer C et al described that more than 50% of patients with coronary artery disease were associated with peripheral vascular disease butwerenot diagnosed as they were not symptomatic(5).The peripheral manifestations of systemic atherosclerotic disease can provide important prognostic clues on the burden of CAD. As we know PAD affects the lower extremities more commonly than the upper extremity vessels, and the ankle-brachial index (ABI) is an indicator of atherosclerosis and can serve as a prognostic marker for cardiovascular events, even in the absence of symptoms (6,7).So, if we can diagnose PAD early by measuring ankle-brachial index (ABI) then patients can be treated for local progression of the disease and take secondary preventive measures for future CAD.

The ankle-brachial index is a simple, easily available, and cheap tool for diagnosing peripheral artery disease. It can be performed in a primary care setting. But it is not used regularly for the diagnosis and predicament of coronary artery disease. The objective of our study was to use the ankle-brachial index (ABI) in a high-risk population to find out the prevalence of peripheral arterial disease in the lower limbs and its correlation with coronary artery disease. The study focused only on patients having significant coronary artery disease in angiography, without any clinical manifestations of lower limb peripheral arterial disease. We have evaluated and correlated the ability of the ankle-brachial index to predict coronary artery disease.

2. MATERIAL AND METHODS

After obtaining the Ethical committee's approval and written informed consent one hundred consecutive patients who were diagnosed with significant coronary artery disease after angiography have been included in the study. Significant coronary artery disease was defined as the presence of stenosis > 70% of at least one major epicardial coronary artery or any of its major branches. They should not have any clinical manifestations of lower limb peripheral arterial disease. Symptoms of peripheral artery disease (PAD) include, intermittent claudication (the thigh or calf muscles may feel pain when walking or climbing stairs), legs weakness, one foot or the lower leg may feel cold, numbness in the legs, hair loss on the feet and legs. Patients with previous coronary angiography, severe valvular heart disease, acute coronary syndrome, and those who did not agree to sign the informed consent were excluded from this study.

This was anobservational study, where we analyzed the data ofone hundred consecutive patients with significant coronary artery disease. The ankle-brachial index was measured after coronary angiography. Limb pressure measurements were done as recommended by American Heart Association (6). The patients were told not to smoke at least two hours before the ABI measurement. Then patients were put to rest for five minutes in the supine position and instructed to stay still during the measurement. The size of the blood pressure cuff was selected to cover at least 40% of the limb circumference. The cuff was positioned around the ankle with the straight wrapping method. And the lower edge should be 2 cm above the superior aspect of

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the medial malleolus. A 10-MHz Doppler probe (HadecoMinidop ES-100VX) was used to detect blood flow during limb pressure measurement. The same sequence of limb pressure measurement was used for all patients; beginning with the right arm and using the counter-clockwise sequence (i.e., right arm, right posterior tibial, right dorsalis pedis, left posterior tibial, left dorsalis pedis, left arm). In ABI calculation, the brachial systolic pressure the denominator, and ankle pressure were the numerator. For brachial systolic pressure, an average of right and left brachial pressure was used. In the case of differing values of more than 10 mm Hg, the higher value was used. For ankle pressure the dorsalis pedis and/or posterior tibial artery pressure, the highest value was considered. An ABI of 0.9 or less is the threshold for confirming lower-extremity PAD. After the angiogram and measurement of ABI, all patients were divided into two groups A (ABI < 0.9) group B (ABI > 0.9), and then data were analyzed using MCSS software and Chi-square test. The P-value <0.05 was considered statistical significance.

Statistical analysis:

As reported by a previous study by Fowkes FG et al 30.9% of patients with cardiovascular risk factors had ABIs of ≤ 0.90 and 27.6% of these patients had involvement in both arterial beds. Thus, estimating the rate of an event (ABI ≤ 0.90) of 30%, alpha error of 0.05, power of 80%, and error of 6% with a 95% confidence interval (CI) the sample size was calculated as 85. To account for a missing data probability of 10%, we enrolled 100 patients in this observational prospective cohort study.

Categorical data were compared by using Chi-square ($\chi 2$) and Fischer's exact test. Data are expressed as means ± standard deviations (SDs) or as percent (%) and 95% CI where appropriate. A p-value less than 0.05 was considered statistically significant. SPSS version 19.0 (Chicago, Illinois, United States) was used for the statistical analysis.

3. RESULTS:

In our sample (n=100) we have diagnosed peripheral vascular disease in 74% of the patient whose ABI was <0.9 and only 26% had negative ABI. The mean age was high in both groups, in group A 58.8 $\pm$ 11.45 years, and in group B it was 62.8 $\pm$ 9.74years. Men were also predominant in both the groups 78.4%, and 73.1% respectively in groups A and B. The risk factor with the highest prevalence was hypertension (72%). Differences in the number of patients having hypertension, diabetes, and smoking in both groups were not statistically significant. The demographic characteristics of the population studied are presented in Table

Table:1 Demography characteristics

	Group A (ABI <0.9)	Group B(ABI>=0.9)	P-Value*
Number	74	26	0.581
Age (mean, SD#)	58.8 $\pm$ 11.45	62.8 $\pm$ 9.74	0.112
Male N (%)	58(78.4%)	19(73.1%)	
Female N (%)	16(21.6%)	7(26.9%)	
Smoker N (%)	26(35.13%)	10(38.46%)	0.761
Hypertension N (%)	51(68.91%0	21(80.76%)	0.247
Diabetes (N%)	49(66.21%)	16(61.53%)	0.667

*p<0.05 significant # SD= standard deviation

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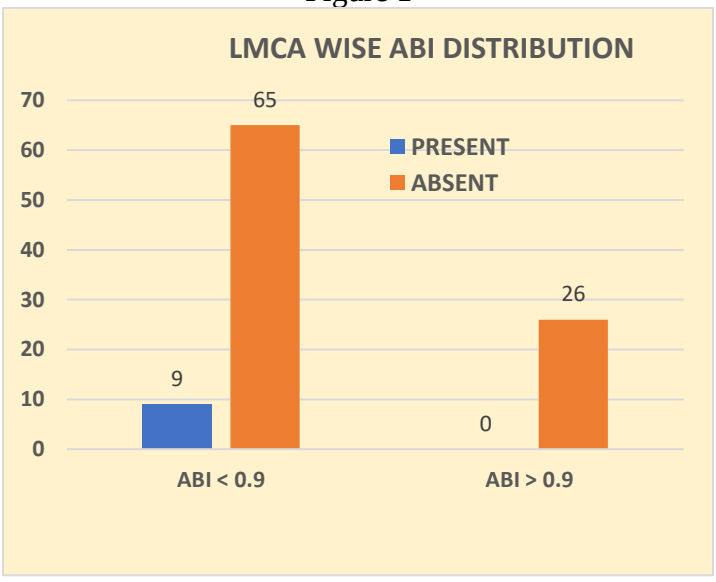
The extent and severity of CAD were evaluated according to the number of coronary arteries involved and the involvement of the left main coronary artery (LMCA). In this study, we have found that nine patients from group A had LMCA disease(12.1%) whereas no one from group B had positive for LMCAdisease (figure 1). Single vessels disease (SVD) was more prevalent in group B than in group A (figure2) and it was statistically significant (p=0.044). The distribution of multi-vessel coronary artery diseases was (62.1%) in group A and (42.3%) in group B which was statistically not significant(P=0.078). Table 2).

Table: 2

	Group A (ABI <0.9)	Group B (ABI >=0.9)	P-value
Target vessel location			
Left main coronary artery	9(12.1%)	0	0.107*
Left anterior descending artery	54	19	0.992
Left circumflex artery	40	9	0.088
Right coronary artery	45	12	0.194
Number of vessels involved			
Single vessel disease	26(35.1%)	15(57.69%)	0.044**
Multivessel disease	46(62.1%)	11(42.3%)	0.078

*Fisher's exact **Significant@alpha 5%

Figure 1



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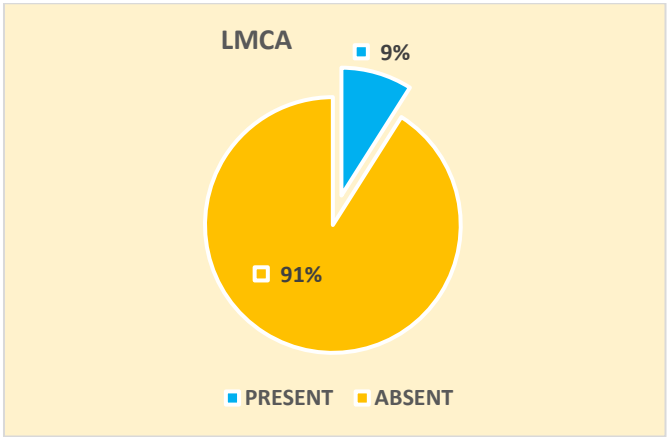
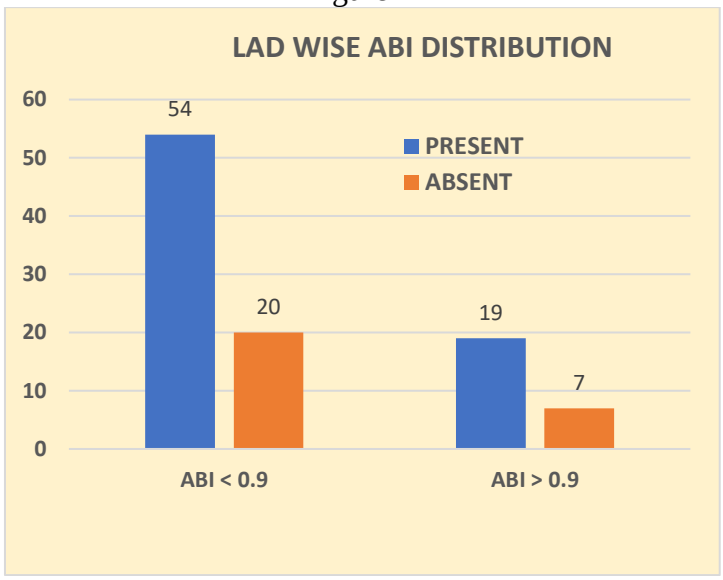
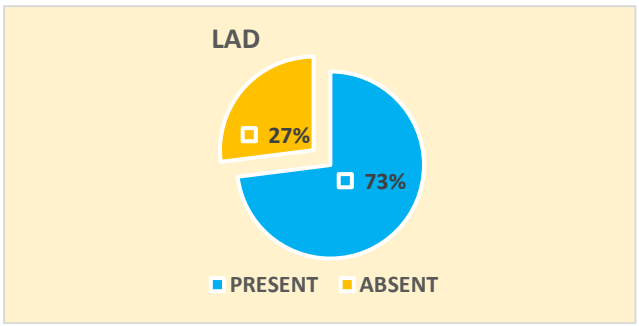


figure 2





4. DISCUSSION

Coronary artery disease (CAD) and peripheral arterial disease (PAD) are serious manifestations of systemic atherosclerosis andreflect overlapping disease states with similar underlying pathophysiologic mechanisms.A significant proportion of patients with CAD have associated PAD,many of them are asymptomatic and underdiagnosed.The measurement of ABI is the single most useful diagnostic tool in the evaluation of PAD. Some of the landmark studies like the 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 (9).

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In the present study, we have found the risk factors for CAD in both the groups were male sex, old age, diabetes, smoking, and hypertension which were consistent with the previous studies(10,11). The strength of association between smoking, hypertension, dyslipidemia, and coronary artery disease did not change over time. AsDoobay et al In 2004 have alsoreported by combining data from 28,679 individuals from the 7population-based cohort studies, the mean age was68.1years, 48.0% were women, 29.4% had tobacco exposure,10.8% had diabetes, and 32.1% had hypertension which was similar to our study. This emphasizes the need to put more effortinto early diagnosis and prevention of cardiovascular disease in those risk populations.

We have found thatthere was an association between asymptomatic peripheral vascular disease (ABI<0.9) and coronary artery disease in 74% of the total study population. In 2013 Papa ED et alin a study found,that an ABI<0.9 was independently related to the extent of CAD, as measured by the number of coronary arteries with obstructive CAD that were detected in the coronary angiography (12). Additionally, they have found that patients with a low ABI (<0.9) had a higher prevalence of multi-vessel coronary disease (83%) compared to single-vesseldisease (17%)patients. In our study, the prevalence of multi-vessel coronary artery diseases was 62.15% and single-vessel disease was 35.1% in groupA.The high average age (>65 years) of the patients in the described series may partially explain the high prevalence of multi-vessel disease in the coronary angiogram.Similarly, Sukhija et alanalyzed patients with an average age of 71 years and found a high prevalence of multi-vessels CAD (63%) in the PAD group and 11% of multi-vessels CAD in patients without PAD (p<0.001) (13).

Kim EKet al 2013 published in their studythat patients with PAD had a more severe form of CAD manifested by a higher frequency of left main coronary disease and multivessel disease (14). In 2018Akram Saleh et al reported that the prevalence of undiagnosed PAD in patients undergoing coronary angiography was14.7%and among them,57.4% of patients had a multivessel disease and 3.1% had left main disease (15). In our study, we have found nine patients (12.1%) fromgroup A had left main coronary artery disease whereas no one from group B had positive for LMCA disease.

Ourstudy has some limitations. Patient inclusion criteria might have biased thestudy results toward a higher prevalence of PAD as we have included patients with significant CAD only.However recentlyMihatov N et al have clearly shown that peripheral and coronary artery disease aretwo sides of the same coin (16).Other recent studiesfrom Japan (17), China (18), Iran(19), and Brazil (20) also concluded that ABI can be a surrogate marker of coronary artery disease.

5. CONCLUSION

The present study showed that there is a significant correlation between asymptomatic peripheral arterial disease and coronary artery disease. The ABI is a good predictor of subsequent cardiovascular events and theirseverity.Individuals with a low ankle-brachial pressure index require additional monitoring and might benefit from secondary preventive measures.Further studies in large sample sizes of the general population can makemore accurate decisions for using ABIasa diagnostic tool for CAD.

6. REFERENCE

[1] Thompson RC, Allam AH, Lombardi GP, Wann LS, Sutherland ML, Sutherland JD, et al. Atherosclerosis across 4000 years of human history: The Horus study of four ancient populations. Lancet 2013; 381: 1211-22.

ISSN:0975-3583,1906-1913 VOL12, ISSUE 06, 2021

[2] Zink A, Wann LS, Thompson RC, Keller A, Maixner F, Allam AH, et al. Genomic correlates of atherosclerosis in ancient humans. Glob Heart 2014; 9: 203-9.}

[3] Ndrepepa G. Atherosclerosis &ischaemic heart disease: Here to stay or gone tomorrow. Indian J Med Res. 2017 Sep;146(3):293-297. DOI: 10.4103/ijmr.IJMR_1668_17

[4] Grenon SM, Vittinghoff E, Owens CD, Conte MS, Whooley M, Cohen BE. Peripheral artery disease and risk of cardiovascular events in patients with coronary artery disease: insights from the Heart and Soul Study. Vasc Med. 2013 Aug;18(4):176-84. DOI: 10.1177/1358863X13493825.

[5] Hoyer C, Sandermann J, Petersen LJ. The toe-brachial index in the diagnosis of peripheral arterial disease. J Vasc Surg. 2013 Jul;58(1):231-8. DOI: 10.1016/j.jvs.2013.03.044

[6] Aboyans V, Criqui MH, Abraham P, Allison MA, Creager MA, Diehm C et al. Measurement and Interpretation of the Ankle-Brachial Index. *Circulation* 2012; 126(24):2890-909. DOI: 10.1161/CIR.0b013e318276fbcb.

[7] Leng GC, Fowkes FG, Lee AJ, Dunbar J, Housley E, Ruckley CV. Use of ankle-brachial pressure index to predict cardiovascular events and death: a cohort study. BMJ. 1996 Dec 7;313(7070):1440-4. DOI: 10.1136/bmj.313.7070.1440.

[8] Fowkes FG, Low LP, Tuta S, Kozak J; AGATHA Investigators. Ankle-brachial index and extent of atherothrombosis in 8891 patients with or at risk of vascular disease: results of the international AGATHA study. Eur Heart J. 2006 Aug;27(15):1861-7. DOI: 10.1093/eurheartj/ehl114.

[9] Sarangi S, Srikant B, Rao DV, Joshi L, Usha G. Correlation between peripheral arterial disease and coronary artery disease using ankle-brachial index-a study in Indian population. Indian Heart J. 2012 Jan-Feb;64(1):2-6. DOI: 10.1016/S0019-4832(12)60002-9.

[10] Gardner AW, Afaq A. Management of lower extremity peripheral arterial disease. J CardiopulmRehabil Prev. 2008 Nov-Dec;28(6):349-57. DOI: 10.1097/HCR.0b013e31818c3b96.

[11] Doobay AV, Anand SS. Sensitivity and specificity of the ankle-brachial index to predict future cardiovascular outcomes: a systematic review. ArterioscIerThrombVasc Biol. 2005 Jul;25(7):1463-9. DOI: 10.1161/01.ATV.0000168911.78624.b7.

[12] Papa ED, Helber I, Ehrlichmann MR, Alves CM, Makdisse M, Matos LN, Borges JL, Lopes RD, Stefanini E, Carvalho AC. Ankle-brachial index as a predictor of coronary disease events in elderly patients submitted to coronary angiography. Clinics (Sao Paulo). 2013 Dec;68(12):1481-7. DOI: 10.6061/clinics/2013(12)02.

[13] Sukhija R, Yalamanchili K, Aronow WS. Prevalence of left main coronary artery disease, three- or four-vessel coronary artery disease, and obstructive coronary artery disease in patients with and without peripheral arterial disease undergoing coronary angiography for suspected coronary artery disease. Am J Cardiol. 2003 Aug 1;92(3):304-5. DOI: 10.1016/s0002-9149(03)00632-5.

[14] Kim EK, Song PS, Yang JH, et al. Peripheral artery disease in Korean patients undergoing percutaneous coronary intervention: prevalence and association with coronary artery disease severity. Journal of Korean Medical Science. 2013 Jan;28(1):87-92. DOI: 10.3346/jkms.2013.28.1.87.

[15] Saleh A, Makhamreh H, Qoussoos T, Alawwa I, Alsmady M, Salah ZA, Shakhatreh A, Alhazaymeh L, Jabber M. Prevalence of previously unrecognized peripheral arterial

ISSN:0975-3583,1906-1913 VOL12, ISSUE 06, 2021

disease in patients undergoing coronary angiography. Medicine (Baltimore). 2018 Jul;97(29):e11519. DOI: 10.1097/MD.0000000000011519.

[16] Mihatov N, Secemsky EA, Peripheral Matters, Peripheral and Coronary Artery Disease: Two Sides of the Same Coin. American college of cardiology. 2019 Sep; 20, 2019

[17] Saiki A, Sato Y, Watanabe R, Watanabe Y, Imamura H, Yamaguchi T, Ban N, Kawana H, Nagumo A, Nagayama D, Ohira M, Endo K, Tatsuno I. The Role of a Novel Arterial Stiffness Parameter, Cardio-Ankle Vascular Index (CAVI), as a Surrogate Marker for Cardiovascular Diseases. J AtherosclerThromb. 2016;23(2):155-68. DOI: 10.5551/jat.32797

[18] Pang XH, Han J, Ye WL, Sun X, Ding Y, Huang WJ, Zhao YM, Lou HY, Shan LZ, Kang YX, Song XX, Zhang SZ, Gu W, Shan PF. Lower Extremity Peripheral Arterial Disease Is an Independent Predictor of Coronary Heart Disease and Stroke Risks in Patients with Type 2 Diabetes Mellitus in China. Int J Endocrinol. 2017;2017:9620513. DOI: 10.1155/2017/9620513

[19] Sadeghi M, Heidari R, Mostanfar B, Tavassoli A, Roghani F, Yazdekhasti S. The Relation Between Ankle-Brachial Index (ABI) and Coronary Artery Disease Severity and Risk Factors: An Angiographic Study. ARYA Atheroscler. 2011 Summer;7(2):68-73.

[20] de Oliveira DC, Correia A, Nascimento Neto J, Gurgel M, Sarinho FW, Victor EG. Association Between Ankle-Brachial Index and Coronary Lesions Assessed by Coronary Angiography. Cardiol Res. 2015 Feb;6(1):216-220. DOI: 10.14740/cr376w.