The Ankle- Brachial Pressure Index AS A Predictor of Coronary Artery Disease Severity

Hilal B. Al Saffar* **MBChB, FRCP, FACC**
Haider J. Al Ghizzi** **MBChB, CABM, FICMS**
Shakir M. Muhammed** **MBChB, FICMS**

Summary:

Background*:* Atherosclerosis is a diffuse disease process, being present in one vascular bed predicts its presence in the others. Ankle –brachial pressure index (ABI) is a non invasive test proved to be sensitive and specific in detecting and assessing the severity of peripheral arterial disease.

Patients and Methods*:* One hundred fifty patients (150) were enrolled in this study, from January - June 2007; all were referred to the Iraqi Centre for Heart Diseases (I.C.H.D.) for further evaluation, with request for further assessment of CAD or lower extremity peripheral arterial disease.

Clinical data and physical examination were performed; ABI was calculated by measurement of systolic pressure on both ankles over both dorsalis pedis and posterior tibial arteries and on both arms over the brachial arteries by using a Doppler stethoscope. The Ankle –Brachial Pressure Index (ABI) calculation was made by taking the lowest value for the ankle pressure and the highest value for the brachial pressure. The normal value for the ABI range from (1-1.4), a cutoff value of < 0.90 was used to identify low ABI. All patients underwent diagnostic coronary angiography and quantitative coronary angiography (QCA) was used to identify the lesion length and severity of stenosis. The severity of CAD was quantified by GENSINI score, the number of diseased vessels and the number of significant lesions.

Results: The mean Ankle-Brachial Pressure index (ABI) for the sample was 0.908±0.31 (range 0-1.53), the mean GENSINI score was 44.02±40 (range 0-148), GENSINI score was zero in 30 (20%) patients, 40 (26%) were having no diseased vessel, 41(27%) having single, and 43 (28.7%) double and 26 (17%) triple vessel disease. ABI was inversely related to the extent of CAD assessed by GENSINI (p-value 0.015), number of diseased vessels (p-value 0.009), and number of significant lesions (p-value 0.021). ABI < 0.9 was recorded in 51 patients (34%) and a low ABI was an independent factor for a higher GENSINI scores (p-value 0.043) and a higher number of diseased vessels (p-value 0.0001). Patients who were referred with PAD were found to have significantly lower ABI than the rest of the sample (p=0.0001), and a coexisted CAD was detected in 15 out of 20 (75%) patients.

Conclusions: ABI was a useful bedside clinical test that predicts the severity of the CAD in patients who are already suffering from or suspected to have ischemic heart disease.

Keywords: IHD, Ankle-Brachial Pressure index, GENSINI score

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Introduction:

Cardiovascular disease is the leading cause of mortality in the United States and other developed countries, and it is also a cause of substantial morbidity and disability (1). The most important etiological factor for cardiovascular disease is atherosclerosis. Atherosclerotic cardiovascular disease is a diffuse disease and epidemiological studies have demonstrated that sub clinical cardiovascular disease in one vascular bed is associated with a clinical disease in another bed as well as with subsequent cardiovascular total mortality (1, 2). Atherosclerotic PAD affect nearly 10% of men >65 years of age, increasing to 20% of men and women >75 years (3). The prognosis of patient with lower extremity PAD is characterized by an increased risk for cardiovascular and ischemic events due to concomitant coronary artery disease (CAD) and cerebrovascular disease; These events are more frequent than the lower limb ischemic events in any given population (3). The PAD patients have two folds increased incidence of CAD and cerebrovascular disease than population without. Approximately 1/3rd to one half of them have CAD based on the clinical history and ECG, and in 2/3rd if the stress test is used as criterion for the diagnosis of CAD, angiographically significant CAD in at least one vessel detected in 60-80% of patients with lower extremity PAD, conversely there is approximately 1/3rd of men and 1/4th of women with a known CAD or cerebrovascular disease also have lower extremity PAD (3).

The Ankle Brachial Pressure Index (ABI): The ABI is a measurement that provides an objective data that serve as the standard for the diagnosis of the lower extremity PAD (3). For epidemiological purposes ABI was the most useful test to diagnose

* *Dept of Medicine, College of Medicine, Baghdad University.*
** *Baghdad Teaching Hospital*

PAD, the ABI correlates closely with intra arterial pressure recordings, it is inexpensive, non invasive, painless and rapid, and can be well standardized and show only minor inter-observer variability (3).A resting ABI < 0.9 is up to 95% sensitive in detecting angiogram positive disease, and almost 100% specific in identifying asymptomatic individuals (4). Prospective studies using the ABI have shown that a low ABI predicts fatal and non fatal cardiovascular events, and all cause mortality in people with and without clinical CAD and among people with existing PAD (5, 6, 7)**.**The epidemiological studies often define the normal range for ABI as from 0.9-1.5 or focus only on ABI that is <0.9 without defining the upper limit of normal (2), however the association of high ABI and mortality was similar to that of the low ABI highlighting the U shape association between the ABI and the mortality, so the cutoff value of high ABI was defined as >1.4 (2)**.** The abnormal ABI values represent a continuous variable that as the ABI value decreases below the threshold 0.9 the severity of PAD increases, with a figure between 0.4-0.9 considered to be a mild to moderate PAD and values below 0.4 is considered to have severe PAD with much higher chance to have future critical limb ischemia and resting limb pain (3).The unique value of ABI was observed in the epidemiological studies, of which many have demonstrated a significant predictive power of abnormal ABI regarding the presence of atherosclerotic process at other vascular beds (2, 8).

How to assess the severity of coronary artery disease? The anatomic extent and the severity of CAD is the second most important prognostic factor for CAD after the LV function and there are many classification systems for this purpose the most popular of them are: **According to the number of the diseased vessels:** This system popularized by the CLEVELAND CLINIC during 1970 (9) , The coronary artery jeopardy score (9) ,The DUKE S prognostic CAD index (9) , The GENSINI score: (fig 1) GOFFREDO G.GENSINI had suggested a fundamental concept forming the base of his scoring system for the severity of CAD stating that ((The severity of CAD must be regarded as a consequence of the functional significance of the vascular narrowing , the extent of the area perfused by the involved vessel(s), and the presence of effective collaterals)), in other words it takes into consideration the severity of the lesion ,the geographical location of the lesion and the influence of collaterals (10, 11)**.** Although this method is not ideal, it provides a more useful and reasonable information than simple division of the patients in to single, double and triple vessel disease

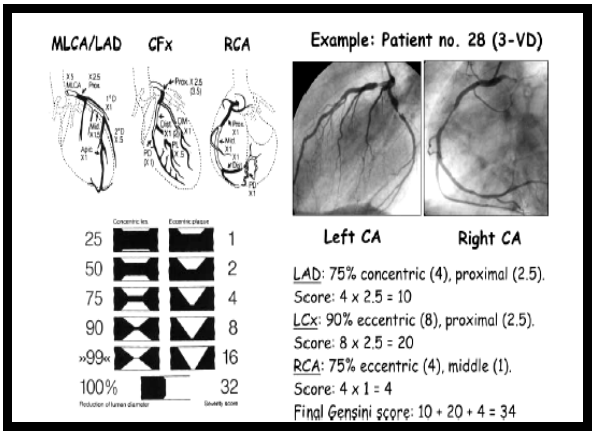

Figure (1): GENSINI score for the severity of CAD.

Methods:

One hundred fifty patients who were referred to the Iraqi Centre for Heart Disease (ICHD) for further evaluation with (stable angina, UA-NSEMI, STEMI, elective PCI , elective diagnostic angiography), lower extremity PAD and a variety of other indications., were enrolled in this study for the period from Jan 2007 to June 2007.

Demographic data were collected according to a pre specified information sheet; ABI was performed for all patients with a blood pressure cuff and the Doppler u/s stethoscope that magnifies the vascular sounds. the patients should have rested for at least 5 minutes in supine position, initially the systolic brachial pressure is recorded by inflating the cuff above the elbow and the Doppler probe held at 45 degrees angle over the brachial artery with the use of u/s gel then the cuff was slowly deflated and the value at which the vascular sounds appears recorded .the ankle recording is performed in a similar way but the site is approximately 5 cm above the medial malleolus, listening to the vascular sounds should be from both posterior tibial and the dorsalis pedis arteries. Both right and left sides (upper and lower limbs) were subjected to the measurement and the highest value of the upper limbs records, and the lowest value for the lower limb records were used for ABI calculation. Coronary angiography was carried out according to the planned decision , using QCA (quantitative coronary angiography) the extent of coronary artery disease was defined by the number of non significant lesions (<50% diameter stenosis),the number of significant lesions (>50% diameter stenosis), the total number of lesions ,the number of the diseased vessels with >75% diameter stenosis (non ,single ,double and triple vessel disease) ,and finally by calculating the GENSINI score. The score is assigned based on the degree of luminal obstruction, which may involve either concentric or eccentric lesions, Points are assigned starting at 25% occlusion, with values doubled for each increasing level of occlusion, The score for each segment is then multiplied by a weighting factor, which reflects the relative importance of that particular coronary segment.

Statistical Analysis: All data were coded and computerized analysis using the STATISTICAL PACKAGE FOR SOCIAL SIENCES (SPSS 14) program ,the associations between discrete variables were measured using (chi square test), the differences between continuous variables were measured using the (t test) and the analysis of variance (ANOVA) test. The Correlation coefficient was used to measure the association between the continuous variables, a logistic regression models were built to recognize the dependent and independent factors.P value <0.05 was considered as a cutoff value for the level of significance.

Results:

The mean Ankle-Brachial Pressure Index was 0.91 (0-153). The mean GENSINI Score was 44.02 ± 40 (0 – 148). The GENSINI Score was zero in 30 patients (30 %). Forty patients had normal coronary arteriogram (26%), 41 patients had single-vessel disease (27%), 43 patients had two-vessel disease (29%), and 26 patients had three-vessel disease (17%).(Table 1).ABI was inversely related to the extent of CAD assessed by GENSINI Score (P: 0.015), number of diseases vessels (P: 0.00009), and number of significant lesions (P: 0.012). A low ABI .Score of < 0.9 was reported in 51 patients (34%) and it was an independent risk factor for a higher GENSINI Score (P: 0.0001). Table 2 patients who were referred with peripheral vascular disease have significantly lower ABI than the rest (P: 0.0001). in this group coexisted CAD was detected in 15 out of 20 patients (75%).

Table (1): The general characteristics of the studied population

Variable	No. (%)
gender	Female 36(24%) Male 114(76%)
Mean ABI	0.908±0.31
U.A	36(24%)
Stable angina	31(20.7%)
Myocardial infraction	1(0.7%)
Claudication	20(13.3%)
Renal impairment	35(23.3%)
History of stroke	4(2.7%)
Perform angio 1st time	120(80%)
Elective PCI	7(4.7%)
Evaluation of chest pain	43(28.7%)
No. of diseased vessels 0 1 2 3	 40(26.7%) 41(27.3%) 43(28.7%) 26(17%)
Mean GENSINI score	44.02±40
D.M	51(34%)
H.T	73(48.6%)
BMI>25	89(59.3%)
smokers	66(44%)

Table (2): Comparison of the general characteristics according to the ABI groups.

variable	ABI<0.9		ABI>0.9		total	P value
	No.	%	No.	%		
Male	46	90	68	68.6	114	0.0034
Female	5	10	31	31.3	36	
H.T	20	39	53	53.5	73	0.09
D.M	23	45	28	28.2	51	0.03
B.M.I>25	26	50.9	63	63	89	0.13
Smoking	32	62	34	34	66	0.0009
U.A	17	33	19	19	36	0.054
Stable angina	8	15	23	23	31	0.27
Stroke/ TIA	2	3.9	1	1	3	0.27
Claudication	18	35	2	2	20	0.0001
Renal impairment	17	33	18	18	35	0.037
Gensini score	66.49±40		32.44±35		0.0001	

Table (3): multivariate regression analysis showing the dependent and the independent factors of the extent of the coronary artery disease assessed by GENSINI score and the number of the diseased vessels.

Variable	p-value in relation to	
	Gensini score	No. of diseased vessels
Age	0.06	0.045
Claudication	0.161	0.38
D.M	0.383	0.418
H.T	0.992	0.292
Smoking	0.059	0.616
Stable angina	0.017	0.00033
U.A	0.001	0.00012
ABI<0.9	0.0001	0.00028

Discussion:

Atherosclerotic cardiovascular disease is a diffuse disease and epidemiological studies have demonstrated that sub clinical cardiovascular disease in one vascular bed is associated with a clinical disease in another bed as well as with subsequent cardiovascular total mortality (1, 2). The ABI is a measurement that provides an objective data that serve as the standard for the diagnosis of the lower extremity PAD (3). A resting ABI of less than 0.9 is up to 95% sensitive in detecting coronary angiogram positive disease, and almost 100% specific in identifying asymptomatic individuals (4). The unique value of ABI was observed in the epidemiological studies, of which many have demonstrated a significant predictive power of abnormal ABI regarding the presence of atherosclerotic process at other vascular beds, and its significant correlation with the subsequent cardiovascular and cerebrovascular events.In this study the prevalence of low Ankle – Brachial index

(ABI<0.90) was 31 % which is higher than prevalence in Rotterdam study (20%), a
Finding that can be explained by the difference in the sample size (150 vs 6450 patients), the potential bias in this study (13.3% of the cases were referral cases of intermittent claudications of whom 90% were having an ABI <0.90 vs only 2.2 % in Rotterdam study) (12). The ABI was significantly and inversely related to the severity of CAD assessed by GENSINI score, the number of significant lesions and the number of diseased vessels) and this is in agreement with the Christos et al (5)**.**The ABI<0.90 was found to be an independent predictor of the extent of the CAD (assessed by the GENSINI score and by the number of the diseased vessels) unrelated to the vascular risk factors and this is in agreement with Christos et al (5)**.** Coexistent coronary artery disease in patient who presented to angiography with a lower extremity peripheral arterial disease was found in 75% of the cases, in agreement with others (3)**.** However the prevalence of angiographic lower extremity PAD in patients with established significant coronary artery disease was not assessed in this study because the practice of the institute where the study performed is to perform peripheral angiography only when there are strong clinical symptoms or a procedural evidence of extensive PAD.The mean GENSINI score was found to be significantly higher in patients with low ABI (<0.90) compared with those without (ABI >0.90), (p value 0.0001, Table 4). However the baseline characteristics of these two groups were significantly different and the real significance of the difference in GENSINI score between the two groups requires a more balance baseline data to accurately reflect reality. Comparison of the PAD patients with the rest of the sample revealed a significantly lower ABI in the PAD group (p value 0.0001), table (5), however there was no significant difference in the extent of coronary artery disease assessed by the GENSINI, and the number of diseased vessels, between the two groups despite the absence of a significant difference in the baseline characteristics of the two groups**.** The followings might have some potential to explain this discrepancy: Performance of peripheral angiogram in patient with extensive CAD is not a routine practice in this institute; this may lead to existence of many patients with subclinical PAD with only marginally low ABI but high markers of CAD severity in those without low ABI, Presenting with acute limb ischemia on the top of chronic one may lead to a lower ABI out of proportion of the real extent of the PAD (making them having lower ABI despite a less extensive PAD).

Limitation of the Study:
The sample of this study was obligated to selection bias because of most of the cases were a referred cases ,with advanced disease, hence, the milder forms of both coronary and peripheral arterial disease probably not enrolled in a balanced way to the studied sample , The lack of the angiographic study for the peripheral arteries for all patients included in the sample make the analysis of those with high ABI (>1.4) who are also proposed to be at a high risk of concomitant other cardiovascular disease impossible, The unavailability of sufficient number of patients with technically competent exercise stress test, and the lack of perfusion scans make the evaluation of the ABI to predict existence of CAD in symptomatic patient who are at intermediate or high risk for CAD impossible.

Table (4): shows the relation of a low ABI (<0.90) to the markers of severity of coronary artery disease in different sub groups (using Gensini Score)

Variable	No. of patients	p-value of relation of ABI<0.9 to		
		Gensini score	No. of significant lesions	No. of diseased vessels
D.M	51	0.008	0.237	0.016
H.T	73	0.001	0.072	0.005
Renal impairment	35	0.028	0.079	0.045
Stable angina	31	0.002	0.009	0.048
Smokers	66	0.001	0.161	0.015
Male	114	0.0001	0.022	0.001
Female	36	0.109	0,019	0.004
Patients with angio for the first time	120	0.0001	0.0001	0.0001

Table (5): comparison of the base line characteristics of PAD patients with those without PAD

Variable	PAD	NON PAD	P.VALUE
AGE (mean±SD)	55.9±10	56.4±9.5	o.82
ABI(mean±SD)	0.39±0.45	0.98±0.19	0.0001
GENSINI score (mean±SD)	44.7±40	39.±41	0.55
Chest pain	1 (5%)	42(32%)	0.007
DM	8(40%)	43(33%)	0.35
Hypertension	6(30%)	67(51%)	0.059
Male gender	17(85%)	97(74%)	0.23
Smoking	15(75%)	51(39%)	0.003
Low ABI(<0.90)	18(90%)	33(25%)	0.0001
Renal impairment	5(25%)	33(25.3%)	0.52

Conclusion: ABI was a useful bedside clinical test that predicts the severity of the CAD in patients who are already suffering from or suspected to have ischemic heart disease

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