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Original Article

Association of Severity of Coronary Artery Disease With SYNTAX Score and Ankle Brachial Index

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ABSTRACT

Objective: To compare the Ankle Brachial Index and SYNTAX score in predicting Coronary Artery Disease severity and the variation of ABI with respect to SYNTAX score.

Study Design: Analytical cross-sectional study.

Place and Duration of Study: Armed Forces Institute of Cardiology/National Institute of Heart Diseases, Rawalpindi; from Jan-Jun 2023.

Methodology: Total 216 coronary angiographically confirmed cases of Coronary Artery Disease were consecutively enrolled in study and data was gathered prospectively on a pre-designed proforma containing patients' demographic details, risk factors and study's focal variables such as; Ankle Brachial Index, SYNTAX Score, coronary artery disease severity. Association of categorized data was found by Chi-square test and Fischer Exact test. Correlation analysis was done to find the relationship between Ankle Brachial Index and SYNTAX score with $p<0.05$ was taken as statistically significant.

Results: Out of 216 study participants, males were 180(83.3%) and females were 36(16.7%) having mean age 59.97±10.72 years. Majority of the patients had low SYNTAX score, 96(44.4%) and 95(43.9%) patients ranged in 0.91-1.0 ABI. A statistically significant and negative correlation between ABI and SYNTAX score (r=-0.879; $p<0.001$) and significant association of ABI and SYNTAX score with CAD severity ($p<0.001$) was found.

Conclusion: Although Ankle Brachial Index is an indicator of Peripheral Arterial Disease but it can also be used as an independent predictor and non-invasive and time saving indicator of complexity of Coronary Artery Disease prior to coronary angiography.

Keywords: Ankle Brachial Index, Coronary Angiography, Coronary Artery Disease, SYNTAX Score.

How to Cite This Article: *Khawaja AZ, Khalil M, Shahzad SK, Yousaf A, Anwar M, Ahmed I, Kamran J, Azad N. Association of Severity of Coronary Artery Disease with SYNTAX Score and Ankle Brachial Index. Pak Armed Forces Med J 2024; 74(Suppl-1): S12-S16. DOI: https://doi.org/10.51253/pafmj.v74i-SUPP-1-10579*

INTRODUCTION

Atherosclerosis is a systemic illness, that targets large and medium sized arteries and narrows them resulting in stenosed arteries. It stems from lipids and fibrosis accumulation in between the intima and media layer of artery.[1] As atherosclerosis is a systemic disease, therefore Peripheral Arterial Disease (PAD) presence (5-7% annual prevalence) acts as a strong causative factor of cardiovascular (CV) events. Among cardiovascular events, Coronary Artery Disease (CAD) is a common condition, resulting due to unusual buildup of atherosclerotic plaques which provokes luminal obstruction. Globally, the major risk factors are high fat and salt intake, smoking and lack of physical activity. [2,3] It has been reported that there is almost 40% co-existence of CAD with lower extremity artery disease (LEAD). Furthermore, co-existence of PAD with CAD increases the mortality chances.[4]

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Literature has demonstrated various ways to predict CAD such as complete blood count (CBC), C-reactive protein (CRP) levels,[5,6] genomic risk prediction,[7] Atherogenic index of plasma.[8] However, these are cost effective means which demands time as well as cost. The Ankle Brachial Index (ABI) i.e. ratio of ankle systolic blood pressure to brachial systolic blood pressure is generally accepted mean to detect PAD in whom increasing index significantly predicts PAD occurrence. In addition, CAD presence considerably promotes the CV events and deaths. The guidelines suggested duplex ultrasound to be the first line imaging for LEAD lesion along with ABI calculation because of its increased effectiveness, sensitivity and specificity at low expense.[9]

Moreover, SYNTAX Score (SS) is another popular predictor and is an anatomical risk score to determine CAD severity. It can provide prognostic information and guide non-invasive revascularization treatment protocol. It can also risk-stratify the CAD patients as well as to predict clinical outcomes in post Per-

Cutaneous Coronary Artery Intervention (PCI) patients.[10] SS takes into account various features like; total occlusion, bifurcation involvement, thrombus and calcifications. Each coronary lesion (≥50% stenosis) is detected, scored individually and summated to calculate the total SS.[1] However the literature is scarce, to compare the aforementioned tools as predictors of CAD severity and giving prognostic information. This study would be helpful for the practitioners, to detect CAD severity non-invasively with low cost and counsel the patients to adopt primordial or primary prevention. Current study was aimed at comparing both the tools (ABI and SYNTAX Score) in predicting CAD severity and the variation of ABI with respect to SYNTAX score grading in patients with angiographic confirmation of CAD.

METHODOLOGY

This study was an Analytical Cross-sectional, conducted on n=216 cardiac patients in Armed Forces Institute of Cardiology/National Institute of Heart Diseases, Rawalpindi, Pakistan, from Jan to Jun 2023. Data was collected through non-probability consecutive sampling technique after approval from Institutional Ethical Review Board (IERB Ltr#9/2/R&D/2023/238)

Sample size (n=162) was calculated by keeping confidence level 95%, margin of error 5% and taking prevalence of CAD (11.9%).[11] But we collected data from n=216 patients to increase the power of study.

Inclusion criteria: Patients with coronary angiographic confirmation of CAD, age between 20 to 80 years regardless of gender were taken as study participants.

Exclusion criteria: Those CAD patients having creatinine clearance <30mL/min, underwent cardiac surgery or intervention for lower extremity arterial disease, history of Coronary Artery Bypass Grafting (CABG) procedure, suffering from any malignancy, and patients taking anti-inflammatory drug apart from aspirin were excluded from study.

Both right and left ABI were calculated by using following formula followed by categorization;

$$\text{ABI} = \frac{\text{Highest Systolic Pressure at ankle}}{\text{Highest Systolic Pressure at arm}}$$

ABI less than 0.9 and greater than 1.4 indicates increased cardiovascular morbidity and mortality risk independently of cardiovascular risk factors and PAD symptoms presence. Therefore, the ABI was categorized in ranges [(≤0.5), (0.51-0.8), (0.81-0.9)]. ABI (0.91-1.0) was indicating borderline and 1.1-1.4 was normal ABI.[1] An angiographic tool, the SYNTAX score to grade the complexity of coronary artery lesions was graded as; Low (0-22), Intermediate (23-32), High (>32); predicting CAD severity as mild, moderate and severe respectively. [1]

Patients who were diagnosed and fulfilled the inclusion criteria; a written informed consent was taken from them or from their guardian. A detailed history and complete physical examination of all the patients was performed. Detailed history including age, smoking history, diabetes, hypertension, chronic kidney disease (CKD), claudication, and past surgery or intervention was taken. Anthropometric data such as height, weight and BMI were recorded. An experienced cardiologist analyzed the coronary angiogram after being performed using conventional techniques by radial artery, ulnar or femoral artery access. The lesions were described on the basis of location, number, extent of involvement, thrombus burden, extent of calcification, tortuosity of involved segments, bifurcation or trifurcation involvement and total occlusion. Scoring was done for each lesion. The SYNTAX Score Calculator software version 2.1.I was used to deduce the SS.[12] The Ankle Brachial Index (ABI) was also calculated for each patient via mercurial sphygmomanometer and stethoscope.

Gathered data was entered and analyzed by a software Statistical Package for Social Sciences (SPSS) Version-24:00. Categorical data such as gender, smoking history, diabetes and hypertension were expressed as frequencies and percentages, while continuous data such as age, height, weight, BMI, ABI and SYNTAX Score were expressed as Mean±SD. Comparison between categorical variables was done using Chi square or Fisher's exact test as appropriate. Pearson's and Spearman's Correlation (based upon parametric and non-parametric data) was applied to find the correlation of ABI with SS, and ABI & SYNTAX score with severity of CAD. *p*-value ≤0.05 was considered as statistically significant.

RESULTS

The given study was done on 216 patients enrolled for elective Coro angiography with mean age 59.97±10.72 years and male dominance 180(83.3%). A large pool of participants were diabetic and hypertensive 101(46.8) and 103(47.7%) respectively. Majority were non-smokers 177(81.9%). Mean LVEF noted was 45.6±11.4% and serum creatinine was 1.06±0.47 mg/dL. Maximum patients presented with NSTEMI

105(48.6%) and TVCAD 110(50.9%) and LMS was reported in 28(13.0%) patients. Mean ABI and SYNTAX score was (0.95±0.21; 22.33±12.02) res-pectively with majority of the patients had low SYNTAX grade 96(44.4%) and borderline ABI 95(43.9%) and severe CAD was noted in 38(17.5%) study participants as shown in (Table-I).

Majority of the patients were in the range of borderline ABI 95(43.9%). There can be seen a decreasing trend of SYNTAX score with increasing trend of ABI. In borderline and normal ABI range (0.91-1.0 and 1.1-1.4 respectively), SYNTAX score was also low in comparison to low ABI ranges. Hence, ABI was in negative and strongly significant correlation with SYNTAX score (r=-0.879; p<0.001) (Table-II & Figure-1).

Table-I: Demographics and Clinical Characteristics of Study Participants (n=216)

Variables		Frequency n(%)
Gender	Male	180(83.3)
	Female	36(16.7)
Age (years) (Mean ± SD)		59.97±10.72
Diabetes Mellitus	Yes	101(46.8)
	No	115(53.2)
Hypertension	Yes	103(47.7)
	No	113(52.3)
Smoking Status	Yes	39(18.1)
	No	177(81.9)
LVEF (%)(Mean±SD)		45.6±11.44
Serum Creatinine (mg/dL) (Mean ± SD)		1.06±0.47
Type of ACS	NSTEMI	105(48.6)
	STEMI	79(36.6)
	Unstable Angina	32(14.8)
Coronary Artery Disease	SVCAD	38(17.6)
	DVCAD	68(31.5)
	TVCAD	110(50.9)
Left Main Stem Disease	Yes	28(13.0)
	No	188(87.0)
Ankle Brachial Index (Mean±SD)		0.95±0.21
Ankle Brachial Index Ranges	≤0.5	10(4.6)
	0.51-0.80	33(15.3)
	0.81-0.90	23(10.6)
	0.91-1.0	95(43.9)
	1.1-1.4	55(25.5)
SYNTAX Score (Mean±SD)		22.33±12.02
SYNTAX Grade	Low	96(44.4)
	Intermediate	82(38.0)
	High	38(17.6)
Severity of CAD	Mild	96(44.4)
	Moderate	82(37.9)
	Severe	38(17.5)

LVEF=Left Ventricular Ejection Fraction; STEMI=ST Elevation Myocardial Infarction; NSTEMI=Non-ST Elevation Myocardial Infarction; CAD=Coronary Artery Disease; SVCAD=Single Vessel CAD; DVCAD=Double Vessel CAD; TVCAD=Triple Vessel CAD

Table-II: Correlation Between ABI and SYNTAX Score (n=216)

ABI Ranges	Frequency (%)	Pearson's Correlation with SYNTAX Score	
		Correlation Coefficient (r)	*p*-value
≤ 0.5	10(4.6)	-0.879	<0.001
0.51-0.80	33(15.27)		
0.81-0.90	23(10.65)		
0.91-1.0	95(43.98)		
1.1-1.4	55(25.46)		

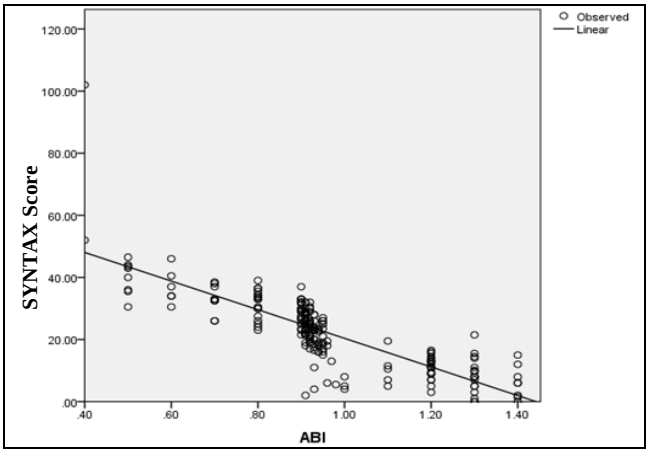

Figure-1: Correlation between Ankle Brachial Index (ABI) and SYNTAX Score (n=216).

Cross tabulation of ABI and SYNTAX score with severity of CAD revealed statistically significant association (p<0.001) (Table-III).

Table-III: Association of ABI and SYNTAX Score with Severity of Coronary Artery Disease (n=216)

Variables		Severity of Coronary Artery Disease Frequency (%)			*p*-value
		Mild (Total=96)	Moderate (Total=82)	Severe (Total=38)	
ABI Ranges	≤ 0.5	0(0.0)	1(1.2)	9(23.6)	<0.001
	0.51-0.80	0(0.0)	11(13.4)	22(57.8)	
	0.81-0.90	1(1.0)	16(19.5)	6(15.7)	
	0.91-1.0	40(41.7)	54(65.8)	1(2.6)	
	1.1-1.4	55(57.3)	-	-	
SYNTAX Score Grades	Low	96(100)	-	-	<0.001
	Intermediate	-	82(100)	-	
	High	-	-	38(100)	

DISCUSSION

Current study was an attempt to test and compare two tools (ABI and SS) to find out the severity of CAD through non-invasive method. Based on this objective, study revealed some interesting findings and showed statistically significant cor-relation between ABI, SYNTAX score and severity of CAD (p<0.001). It was found that ABI is negatively correlated with SYNTAX score and both are suitable to

find the risk of having CAD, non-invasively. Increasing trend of SYNTAX score due to decreasing trend of ABI was the predominant finding. This was being supported by various literatures on ABI and SYNTAX score with CAD severity.

Study's conducted by Mosatfa *et al*., and Sartore et al., evaluated the relationship of demographics with ABI and SYNTAX score and showed age and diabetes along with hypertension and dyslipidemia to be risk factors leading towards CAD.[1,13] Another study was conducted by Helaine E *et al*., on n=4393 American Indians to find out the all causes and CVD risk and mortality in relation to high (>1.4) and low ABI (<0.9). Analysis revealed low ABI in 216(4.9%) patients and high ABI was in 404(9.2%) patients. Diabetes, hypertension and albuminuria occurred in greater pool of patients having low ABI and high ABI (60.2%, 44.4%, and 50.1%; 67.8%, 49.9%, and 45.1% respectively) in comparison to normal ABI group (44.4%, 26.9%, and 36.5%), with significant correlation (p<0.001).[14] However, our study didn't add album-inuria while data collection due to certain limiting finances.

Study carried out by Mostafa et al., showed the findings consistent to ours that reported the mean value of SYNTAX score (28.97±12.03) in ABI <0.9 and in borderline ABI (0.91-0.99) patients, noted mean was (19.30±12.53), in normal ABI (>1.0) patients it was (5.69±6.09). Based upon such findings, there was negative trend between ABI and SS. Hence, there was statistically significant and negative relationship documented between ABI and SYNTAX score (p<0.001).1 Similarly, given study showed consistent results (ABI range=0.91-1.0; Mean SYNTAX score= 21.84±6.48). SYNTAX score in normal ABI range was (ABI range=1.1-1.4; Mean SYNTAX score=9.43±4.92) while in ABI <0.9, mean of SYNTAX score was above than low categorized SYNTAX score (>22). There exists a same negative and significant relationship between ABI and SYNTAX score (r= -.879; p<0.001) as it was determined by the afore-mentioned study. Similar findings were analyzed by Lin *et al*. [15]

A study on Asian patients (n=496) stated their participants' mean age of 69.2±11.4 years, and did comparison of ABI against SYNTAX score. They demonstrated that low ABI (≤0.9) is being more prevalent on high SYNTAX score and comparatively high ABI (>0.9) was significant (p<0.001) in patients with low SYNTAX score.16 Comparatively, our study's findings showed similar findings. Similarly, the same concept had been evaluated by Korkmaz *et al*., who had taken acute coronary syndrome patients to study and reported that higher SYNTAX score noted in patient with low ABI (≤0.9) compared to ABI ranging from 1.0 to 1.09 (17.8±9.1 vs 12.5±5.9; p<0.01).[17]

Number of other studies revealed results supporting our study's findings that ABI has significant association with higher risk of CAD and is indirectly related to SS. The lower the ABI, the higher the SYNTAX score and greater the risk of CAD in patients.[1,13,14,18] Current study revealed 38(17.6%) patients had severe CAD, out of which maximum patients (22; 57.8%) were in ABI range of 0.51-0.8 (Mean SYNTAX score =32.83±5.11) and 9(23.7%) had ABI≤0.05 (Mean SYNTAX score=47.30±20.16). These findings demonstrated significant and negative correlation of ABI with SYNTAX score and significant association with severity of CAD (p<0.001). Another compatible study was done by Amer MS *et al*., evaluated the same findings that there exists significant relationship between ABI and SYNTAX score [19] and significant association of ABI with CAD severity.[20] Similarly, various past researches have supported this concept and also found ABI as well as SYNTAX score to be an independent predictors of CAD.[15,21]

LIMITATIONS OF STUDY

Existing study had certain limitations such as; sample size was small and study was conducted in a single center, therefore the results can't be generalized on broad level. However, randomized studies with longer study duration involving greater number of participants can give much more generalized results.

CONCLUSION

Although ABI is an indicator of Peripheral Arterial Disease (PAD) but it can also be used as an independent predictor and non-invasive and timesaving indicator of complexity of CAD prior to coronary angiography. This ABI scoring can easily be applied to determine the CAD severity, at bed side of admitted patients with diagnosis of acute coronary syndrome.

ACKNOWLEDGEMENT

As it is one of my first ever publication so I want to take a moment to mention my beloved parents Mr. Khawaja Muhammad Zafar and Mrs. Jameela Zafar and thank them for their support throughout and always and I am thankful to Allah for having parents always by my side. I am also highly obliged to R&D department for providing me help and support to conduct this research.

Conflict of Interest: None

Authors' Contribution

Following authors have made substantial contributions to the manuscript:

AZK & MK: Data analysis, critical review, drafting the manuscript, approval of the final version to be published

SKS & AY: Concept, study design, critical review, approval of the final version to be published

MA & IA: Data acquisition, drafting the manuscript, approval of the final version to be published

JK & NA: Critical review, data interpretation, approval of the final version to be published

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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