

openheart Inter-arm blood pressure difference as a tool for predicting coronary artery disease severity

Somen Das,¹ Mohammad Azmain Iktidar ,^{1,2} Joyanti Das,¹ Faisal Chowdhury,¹ Simanta Roy^{1,2}

To cite: Das S, Iktidar MA, Das J, *et al*. Inter-arm blood pressure difference as a tool for predicting severity of coronary artery disease. *Open Heart* 2022;**9**:e002063. doi:10.1136/openhrt-2022-002063

Received 24 May 2022
Accepted 6 July 2022

ABSTRACT

Background Patients with severe atherosclerosis have been found to exhibit considerable changes in blood pressure (BP) between arms. The objective of our study was to investigate the predictive value of interarm blood pressure difference (IABPD) for coronary artery disease (CAD) severity.

Methods It was a cross-sectional study conducted in the Department of Cardiology, Chittagong Medical College Hospital, Chattogram from May 2020 to November 2020. The study conveniently selected 110 individuals who visited the department for a coronary angiography during the study period. The BP of both arms were synchronously measured 1–2 days before the coronary angiography and IABPD were calculated. After coronary angiography, two blinded interventional cardiologists visually estimated the amount of coronary artery obstruction and determined the Gensini score.

Results Among the participants, more than three-fourths of the patients were above 50 years of age (64.66%), and the majority were male (86.67%). 14.7% of participants had no occlusion in their coronary artery, 38.0% of participants had insignificant occlusion, 26.7% participants had mild occlusion, 10.3% participants had moderate occlusion, 3.3% participants had significant occlusion and 6.0% participants had total occlusion. Corrected pulse IABPD (cIABPDpulse) showed the greatest area under the receiver operating characteristic curve (0.73) for predicting a high Gensini score (>median). Multiple regression analysis revealed a significant relationship between corrected systolic IABPD (cIABPDsys) and the Gensini score ($B=0.057$, $p<0.001$).

Conclusion The differences in BP between the arms were found to be having a strong positive correlation with CAD severity.

INTRODUCTION

Osler initially defined the interarm blood pressure difference (IABPD) in 1915,¹ since then this easily obtained noninvasive parameter is being practised all over the globe.^{2,3} In contrast to the right artery, the left subclavian artery forms an acute angle at its origin from the aorta, resulting in decreased blood flow. Consequently, right arm blood pressure (BP) is typically greater than left arm BP, leading

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Significant inter-arm blood pressure (BP) difference is present in patients with advanced atherosclerosis.

WHAT THIS STUDY ADDS

⇒ Corrected inter-arm pulse pressure difference and corrected inter-arm systolic BP difference are better in predicting coronary artery disease severity.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Results from our study should help raise awareness among the physicians to practise simultaneous BP measurement in both arms, especially in the coronary artery disease patients.

in IABPD.⁴ As a clinical recommendation for hypertensive condition, an IABPD less than 10 mm Hg is regarded to be normal.⁵ In patients with advanced atherosclerosis, however, significant arm-to-arm changes in BP have been found.⁶

Ischaemic heart illnesses are among the leading causes of death on a global scale, although the relationship between IABPD and coronary artery disease (CAD) remains poorly understood.⁷ IABPD with systolic BP (SBP) more than 5 or 10 mm Hg was an independent factor of unfavourable cardiovascular outcome and all-cause mortality, according to a cohort analysis of people without a history of cardiovascular disease.⁸ Patients with a higher IABPD SBP seemed to have a greater rate of CAD and cerebrovascular disease, as well as a higher 10-year cardiovascular risk, according to a different prospective study (CoCoNet) involving 3699 participants.⁹ Sixty-three per cent of patients with IABPD of 15 mm Hg or higher had CAD involving at least one coronary artery, and 83% of those patients with CAD had multivessel CAD, according to a study that examined the association between IABPD and CAD in 283 patients who had coronary angiography.¹⁰ However, seven further investigations found no significant



© Author(s) (or their employer(s)) 2022. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

¹Department of Medicine, Chittagong Medical College Hospital, Chittagong, Bangladesh

²Department of Public Health, North South University, Dhaka, Bangladesh

Correspondence to

Dr Mohammad Azmain Iktidar; sazmain@gmail.com

relationship between pre-existing CAD and IABPD, while other prospective studies found that an IABPD of 10 mm Hg or above increased the development of CAD (despite the fact that these investigations were restricted by the use of non-invasive methods of diagnosis).^{9 11 12}

The purpose of this study was to evaluate the link between IABPD and CAD severity in order to establish IABPD as a predictor of CAD severity. Findings from our research can help establish the role of IABPD as a tool for assessing atherosclerotic severity of CAD and thus help prevent the progression of atherosclerosis by aggressive risk factor interventions and reduce cardiovascular mortality.

MATERIALS AND METHODS

Study design and study participants

This cross-sectional investigation was carried out between May 2020 to November 2020 at the Department of Cardiology, Chittagong Medical College Hospital. All the patients (213) visiting the department for coronary angiography during the study period were conveniently approached for enrollment in the study. Since this study was conducted during the COVID-19 pandemic, patients attending the department were lower compared with the pre-pandemic period. Sixty-six patients did not consent to enter the study, and 37 patients with a history of revascularisation, congenital heart disease, significant valvular heart disease, peripheral artery disease, atrial fibrillation, cardiomyopathy and aortic coarctation were excluded from the study (figure 1).

Operational definitions

Patients were diagnosed with hypertension if they had a 'persistent rise in SBP ≥ 140 mm Hg and/or diastolic BP (DBP) ≥ 90 mm Hg for at least two occasions, or if they were using antihypertensive medication or had a history

of hypertension'.¹³ Patients were diagnosed with diabetes if they had a 'history of diabetes or used antidiabetic medications, or if their fasting plasma glucose was ≥ 126 mg/dL or 2 hours after fasting plasma glucose was ≥ 200 mg/dL, or if their glycated hemoglobin (HbA1c) was $\geq 6.5\%$, or if they exhibited classic symptoms of hyperglycaemic or hyperglycaemic crisis, and their random plasma glucose was ≥ 200 mg/dL (≥ 11.1 mmol/L)'.¹⁴ Dyslipidaemia was diagnosed if the patient had 'total cholesterol above 200 mg/dL, low-density lipoprotein (LDL) cholesterol above 130 mg/dL, high-density lipoprotein (HDL) cholesterol below 40 mg/dL (>1.0 mmol/L) in males and 50 mg/dL (>1.3 mmol/L) in women, triglycerides above 150 mg/dL (>1.7 mmol/L), or was taking lipid-lowering therapy'.¹⁵ Unstable angina is chest discomfort or pain resulting from inadequate blood and oxygen supply to the heart.¹⁶ Non-ST-elevation myocardial infarction (NSTEMI) is diagnosed in patients with acute coronary syndrome-like symptoms and elevated troponin levels, but no STEMI-like ECG abnormalities.¹⁶ STEMI is clinically diagnosed when there is new (or increased) and sustained ST-segment elevation in at least two contiguous leads of >1 mm in all leads, excluding leads V2–V3 for which the following cut-off points apply.¹⁷ Current smoker, smoking cigarettes within 1 month of this admission; recent smoker, quit between 1 month and 1 year before this admission; past smoker, quit greater than 1 year before this admission; non-smoker, never smoked cigarettes.¹⁸

Measurement of arm BP and IABPD

BP were measured 1–2 days prior to coronary angiography. Patients rested for at least 5 min prior to having their BP taken with an aneroid sphygmomanometer (ALPK2 500 V, Japan) in both arms simultaneously, which was valid and properly calibrated. The bladder cuff was an appropriate size and can encompass more than two-thirds of the arm. Before the procedure, tight clothes were removed, and the arm was sustained at the heart level. Two measurements were recorded at 2 min intervals. Mean pressure was calculated as, one-third times SBP added with two-thirds times DBP and pulse pressure was calculated as the difference between SBP and DBP. In order to account for the significance of baseline BP, the IABPD was measured as the change in BP between the two arms and corrected (cIABPD) by calculating the proportion arm with the higher BP.

Assessment of CAD severity

With the aid of coronary angiography data, two interventional cardiologists visually estimated the extent of coronary artery obstruction in each patient. The interventional cardiologists were approached conveniently from the same department. After informing about the aims and objectives of the study, they voluntarily contributed to the study. The profiles of the patients were concealed from the cardiologists. Using the data, they subsequently evaluated the Gensini score. The Gensini score was devised

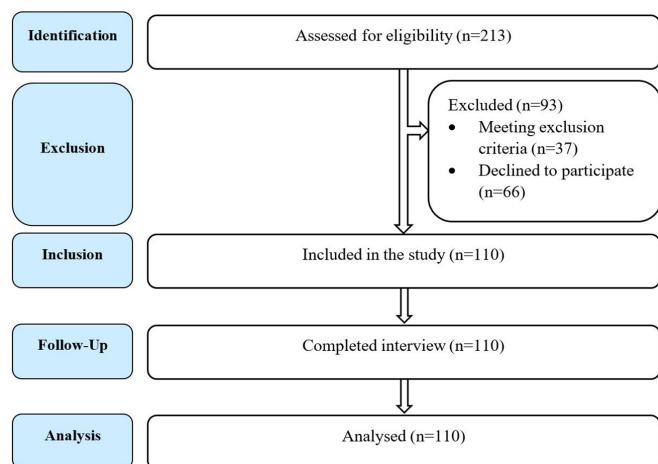


Figure 1 Strengthening the Reporting of Observational Studies in Epidemiology flow chart of study participants. A total of 213 individuals were approached for enrolment. Ninety-three individuals were eliminated because they did not match the inclusion requirements, leaving 110 as the final sample size.

in 1975 to quantify the severity of CAD by considering the geometrical severity of a lesion as assessed by angiography, the cumulative effect of several blockages, and the significance of the myocardium at risk.¹⁹ Each lesion was assigned a value based on the proportion of stenosis: 25% stenosis was ranked 1, 50% stenosis was ranked 2, 75% stenosis was ranked 4, 90% stenosis was ranked 8, 99.9% stenosis was ranked 16 and 32 was assigned for total occlusion. This score was then multiplied by a value based on the site of the affected section (ie, the lowest value 0.5 was assigned left circumflex arterial artery, posterolateral branch and second diagonal artery, 1 was assigned for right coronary artery, obtuse marginal branches as well as first diagonal branch, 1.5 assigned for middle left descending artery, 2.5 for left circumflex artery and proximal left anterior descending branch, the highest point 5 was assigned for left main coronary artery). The Gensini score is then determined by adding the scores for coronary stenosis degree and lesion site.

Statistical analysis

For data analysis, we used Stata (V.16; StataCorp). Using a histogram, a normal Q-Q plot and the Kolmogorov-Smirnov test, the normality of continuous data was determined. Due to the positively skewed distribution of the Gensini score, the original score was transformed as $\ln(\text{original Gensini score} + 1)$ in order to be included in the study. As a measure of the centre of quantitative data, the arithmetic mean was used, while the SD was used as a measure of dispersion. We summarised qualitative data using frequency and relative frequency. Student's t-test was performed to determine the significance of the difference between the two arms' mean BP values. Pearson's correlation analysis was used to analyse the association between the Gensini score and IABPD parameters. We also computed receiver operating characteristic (ROC) curves to predict a high Gensini score, and then used the DeLong method to determine differences between ROC curves for various IABPD. Simple and multiple linear regression model was fit using the Gensini score as the outcome variable to investigate the role of IABPD parameters and other associated factors. A two-tailed $p < 0.05$ was regarded as statistically significant. Our dataset did not have any missing data. All reporting conformed to the Strengthening the Reporting of Observational Studies in Epidemiology standards.²⁰

RESULTS

Most respondents were males (94%), aged between 51 and 60 years (36.36%), living predominately in the urban areas (60.91%). Almost all of the respondents demonstrated a right-hand dominance (95.45%). The majority of responders had no history of CAD (69.09%). The majority of the responders were currently smoking (34.55%) or had a history of smoking (29.09%). Most of the respondents did not have a history of diagnosed comorbidities including diabetes mellitus (76.36%), hypertension

(57.27%) and dyslipidaemia (70%). The respondents' diagnosis during the study revealed that the majority had unstable angina 52.72%, with NSTEMI being the second common (28.18%). An abnormality of fasting blood glucose was found to be in most of the respondents, with impaired glucose (30.00%) and diabetes (24.55%). The distribution of lipid profiles of the respondents revealed majority portion of the respondents had a normal level of cholesterol (72.73%), LDL (69.09%), HDL (91.00%) and triglyceride (57.27%). Most of the respondents had some level of CAD, with a majority having an insignificant block (40.00%). More than half the patients had elevated SBP in the right arm (50.91%) and SBP in the left arm was normal in most of the patients (51.82%). DBP was mostly normal in both hands (56.36%) (table 1).

Moreover, a statistically significant difference was discovered between the right and left hand in diastolic ($p=0.04$) and pulse pressures (0.01) (figure 2).

Between normotensive and hypertensive participants, the correlation between IABPD measures and Gensini score was studied (table 2).

All the IABPD parameters positively correlated with the Gensini score (figure 3); all of them were found to be highly statistically significant in case of normotensive patients ($p < 0.05$). However, in case of hypertensive patients $\text{cIABPD}_{\text{sys}}$ ($p < 0.01$), $\text{cIABPD}_{\text{pulse}}$ ($p < 0.011$), $\text{IABPD}_{\text{sys}}$ ($p < 0.013$) and $\text{IABPD}_{\text{mean}}$ ($p < 0.008$) constituted statistical significance.

To investigate the factors related with Gensini score, a linear regression model was used (table 3). The univariate model revealed significant association between gender ($p < 0.01$), diabetes mellitus ($p < 0.004$), hypertension ($p < 0.001$), dyslipidaemia ($p < 0.007$), $\text{cIABPD}_{\text{sys}}$ ($p < 0.001$), $\text{cIABPD}_{\text{mean}}$ ($p < 0.07$) and $\text{cIABPD}_{\text{pulse}}$ ($p < 0.001$). The model showed that males tend to score 3.2% higher than females, hypertensive 31.5% than normotensive, diabetic 4.9% than non-diabetic, dyslipidaemic 17.2% than normal lipid level, higher $\text{cIABPD}_{\text{sys}}$ 95% than lower, higher $\text{cIABPD}_{\text{mean}}$ 96% than lower and higher $\text{cIABPD}_{\text{pulse}}$ 94% than lower. However, in a multivariate model only hypertension ($p < 0.001$) and $\text{cIABPD}_{\text{sys}}$ ($p < 0.001$) retained their significance. The model demonstrated that hypertensive respondents had 12.2% chance higher than normotensive and increased $\text{cIABPD}_{\text{dia}}$ had 94.3% higher chance of having higher value in Gensini score.

DISCUSSION

This was one of the first studies, to the best of the researchers' knowledge, to attempt to explore the relationship between the risk of developing CAD and the Gensini score in the setting of Bangladesh. While the prevalence of CAD has increased significantly among the Bangladeshi population in recent years, few studies have been undertaken to create or apply a system for disease identification earlier.²¹

Table 1 Background information on study participants (n=110)

Variables		Frequency	
Age distribution (in years)	≤40	14(12.72%)	
	41–50	24(21.81%)	
	51–60	42(36.36%)	
	>60	30(27.27%)	
Sex	Male	94(85.45%)	
	Female	16(16.55%)	
Residential status	Urban	67(60.91%)	
	Rural	43(39.09%)	
Hand dominance	Right	105(95.45%)	
	Left	5(4.55%)	
History of coronary artery disease	Yes	34(30.9%)	
	No	76(69.09%)	
Smoking history	Current smokers	38(34.55%)	
	Ex-smokers	32(29.09%)	
	Never	40(36.36%)	
Comorbidities	Diabetes mellitus	Yes	26(23.64%)
		No	84(76.36%)
	Hypertension	Yes	47(42.73%)
		No	63(57.27%)
Dyslipidaemia	Yes	33(30%)	
	No	77(70%)	
Systolic blood pressure	Right sided	Normal	54(49.09%)
		Raised	56(50.91%)
	Left sided	Normal	57(51.82%)
		Raised	53(48.18%)
Diastolic blood pressure	Right sided	Normal	62(56.36%)
		Raised	48(43.64%)
	Left sided	Normal	62(23.64%)
		Raised	48(76.36%)
Fasting blood sugar difference	Normal	50(45.45%)	
	Impaired glucose tolerance	33(30%)	
	Diabetes	27(24.55%)	
Lipid profile of the participants	Cholesterol	Normal	80(72.73%)
		Borderline	15(13.64%)
		Raised	15(13.64%)
	LDL	Normal	76(69.09%)
		Borderline	10(9.09%)
		Raised	24(21.82%)
HDL	Normal	1(0.91%)	

Continued

Table 1 Continued

Variables	Frequency	
Triglyceride	Borderline	83(75.45%)
	Raised	26(23.64%)
	Normal	63(57.27%)
Diagnosis	Borderline	19(17.27%)
	Raised	28(25.45%)
	Unstable Angina	58(52.72%)
Presence and extent of coronary artery disease	STEMI	11(10%)
	NSTEMI	31(28.18%)
	Stable angina	10(9.09%)
	No block	17(15.45%)
	Insignificant	44(40%)
	Mild	30(27.27%)
	Moderate	12(10.9%)
	Significant	3(2.73%)
	Critical	1(0.91%)
	Total block	3(2.73%)

STEMI, ST-elevation myocardial infarction; NSTEMI, non-ST-elevation myocardial infarction; LDL, low-density lipoprotein; HDL, high-density lipoprotein.

The difference between arms' BP is one such critical diagnostic and prognostic factor. Our study discovered a significant difference in diastolic and pulse pressures between the two arms. Among the participants in our study, 57 (51.82%) participants had normal IABPD and 53 (48.18%) participants had raised (>10 mm Hg) IABPD. Extensive research has been undertaken to gain a better understanding of the clinical importance of interarm BP, both systolic and diastolic, with the difference generally being greater in the right than in the left.²² This was mostly owing to the acute angle formed by the left subclavian artery, which reduced blood flow

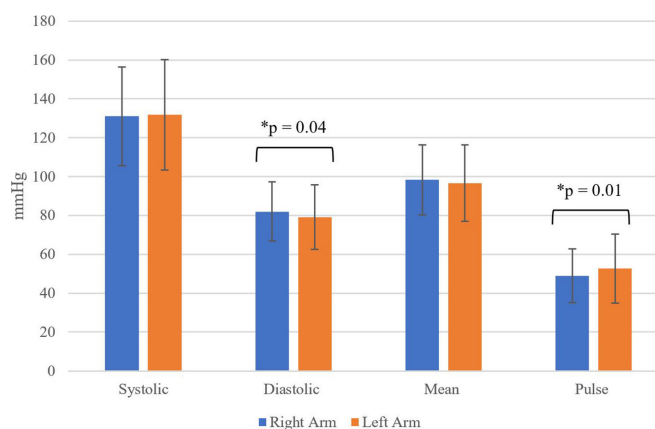
**Figure 2** Blood pressure measurements of study participants. Significant difference between the both arms ($p < 0.05$) is highlighted with an asterisk (*).

Table 2 Correlation of Gensini score and IABPD parameters

	Normotensive (n=63)		Hypertensive (n=47)	
	R	P value	R	P value
cIABPD _{sys}	0.467	<0.001*	0.374	.010*
cIABPD _{dia}	0.364	0.003*	0.131	0.381
cIABPD _{mean}	0.415	<0.001*	0.119	0.426
cIABPD _{pulse}	0.489	0.000*	0.370	.011*
IABPD _{sys}	0.485	<0.001*	0.358	.013*
IABPD _{dia}	0.404	0.001*	0.113	0.451
IABPD _{mean}	0.511	<0.001*	0.384	.008*
IABPD _{pulse}	0.447	<0.001*	0.104	0.487

*P<0.05

cIABPD_{dia}, corrected diastolic IABPD; cIABPD_{mean}, corrected mean IABPD; cIABPD_{pulse}, corrected pulse IABPD; cIABPD_{sys}, corrected systolic IABPD; IABPD, interarm blood pressure difference; IABPD_{dia}, interarm blood pressure difference; IABPD_{dia}, diastolic IABPD; IABPD_{mean}, mean IABPD; IABPD_{pulse}, pulse IABPD; IABPD_{sys}, systolic IABPD.

and, consequently, BP, in comparison to the right.²³ Consistently, research has revealed that an increase in IAD difference is associated with an increase in cardiovascular morbidity and mortality,^{8 24 25} as well as a possible prognostic factor.²² A greater difference of 5–10 mm Hg was particularly consistent with a greater risk for the patients.⁸

Further analysis of the relationship between the Gensini Score and IABPD parameters between the normotensive and hypertensive respondents revealed a significant correlation of all IABPD parameters among the normotensive patients. However, cIABPD_{sys}, cIABPD_{pulse}, IABPD_{sys} and IABPD_{mean} was found to

be significant for both groups. These results align with those of a previous study done by Park *et al*, who recognised cIABPD_{sys} had significant correlation with severity of coronary diseases.²⁵ This correlation can help physicians identify and manage the vulnerable risk groups.

Lastly, a regression analysis was conducted to determine the impact of various variables on the Gensini score. The univariate model predicted that those of female gender, hypertensive, diabetic, dyslipidaemic, had higher values of cIABPD_{mean} and cIABPD_{pulse} were in higher risk compared with their counterparts. This correlation can be explained by the fact that the Gensini score was developed to measure the risk of CAD based on arterial stenosis.¹⁹ The factors mentioned above are usually associated with increased incidence of vascular insults in various mechanisms and increases the risk of CADs. For example, whereas CAD has historically been regarded as a male-prevalent disease, accumulating data indicates that women, particularly after menopause, are at an increased risk of getting CAD.²⁶ Hypertension is one of the strongest risk factors that may be modified for CAD, being the strongest predictor in childhood and adolescence. Hypertension harms the blood vessels in a variety of ways, including acting as a physical force for the development of atherosclerosis, which may lead directly to the development of late-onset obstruction, hence raising the risk of CAD.²⁷ Diabetes mellitus is significantly related to CAD, with a twofold to fourfold increase in risk compared with non-diabetic controls. Through metabolic disorders such as hyperglycaemic and dyslipidaemia, DM may directly harm endothelial cells and smooth muscles.²⁸ On the other hand, dyslipidaemia has long been recognised as a primary and independent risk factor for CAD, even as a necessary condition for developing CAD. It has been established that dyslipidaemia is the initial risk factor contributing to the onset of CAD before other risk factors take action.²⁹ As each component independently or in combination increases the likelihood of having CAD, they are associated with a higher Gensini Score.

However, in a multivariate model, only hypertension (p<0.001) and cIABPD_{sys} (p<0.001) exhibited statistically significant results. According to the model, hypertensive respondents had 12.2% higher chance than normotensive and increased cIABPD_{dia} had 94.3% higher chance of having a higher value in the Gensini score. Park *et al* also found Hypertension to be a significant predictor of Gensini score.²⁵ The variation in the results might be attributed to the variation in sample size.

The precise mechanism of IABPD is unknown, however, the link between IABPD and CAD suggests that atypical alterations like luminal constriction (atherosclerosis) and vascular rigidity (arteriosclerosis) are related.^{9 30}

The study has some limitations. BP were only tested once, however, data showing repeated BP measures lower the variance in IABPD by 30%³¹ and boost repeatability.³²

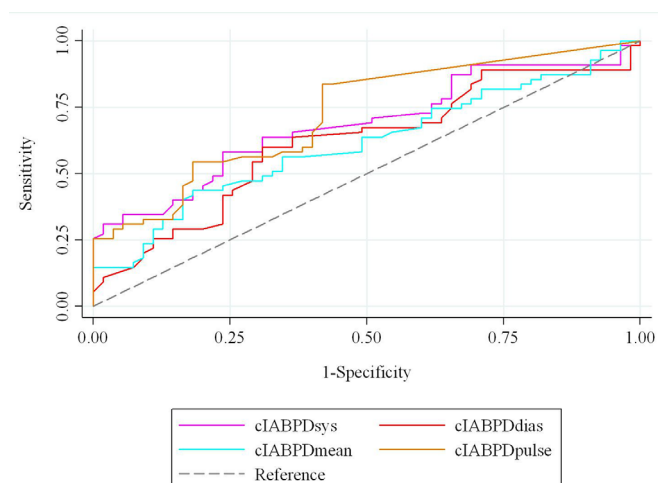


Figure 3 Comparison of receiver operating characteristic (ROC) curve for cIABPD_{sys}: cIABPD_{dia}, cIABPD_{mean} and cIABPD_{pulse} to predict high (>median (25.25)) Gensini Score. Area under the ROC curves for cIABPD_{sys}: 0.69, cIABPD_{dia}:0.62, cIABPD_{mean}: 0.61, and cIABPD_{pulse}: 0.73. cIABPD_{pulse}, corrected pulse interarm blood pressure difference.

Table 3 Univariate and multivariate analysis of factors associated with the Gensini score

Variables	Univariate model			Multivariate model*		
	Coeff.	95% CI	P value	Coeff.	95% CI	P value
Age	0.015	−0.012 to 0.043	0.26			
Gender			.01			.047
Female	Ref.			Ref.		
Male	1.032	0.257 to 1.808		−0.808	−1.606 to −0.01	
BMI	0.043	−0.007 to 0.094	.09	0.013	−0.031 to 0.057	0.57
DM	0.951	0.312 to 1.59	.004	−0.075	−0.751 to 0.601	0.826
Hypertension	1.315	0.803 to 1.828	<0.001	1.122	0.604 to 1.641	<0.001
Dyslipidaemia	0.828	0.233 to 1.423	.007	0.237	−0.381 to 0.855	0.449
Smoking						.
Never	Ref.					
Past smoker	0.115	−0.588 to 0.818	0.74			
Current smoker	0.277	−0.394 to 0.949	0.41			
clABPD _{sys}	0.05	0.032 to 0.085	<0.001	0.057	0.032 to 0.083	<0.001
clABPD _{dia}	0.034	−0.014 to 0.084	0.03			
clABPD _{mean}	0.040	−0.003 to 0.084	0.07			
clABPD _{pulse}	0.06	0.032 to 0.078	<0.001			

*In the multivariate model, we entered variables with a p value of ≤ 0.2 in the univariate analysis.

BP, blood pressure; clABPD, corrected interarm blood pressure difference; clABPD_{dia}, corrected diastolic IABPD; clABPD_{mean}, corrected mean IABPD; clABPD_{pulse}, corrected pulse IABPD; clABPD_{sys}, corrected systolic IABPD; DM, diabetes mellitus.

Since this was a cross-sectional study, we couldn't establish causality for the associations that we presented in this study. We performed multiple linear regression to adjust for the possible confounders. In future prospective investigations, the measurement of central BP via cardiac catheterisation, which is more clinically relevant to cardiovascular illness, may be required to validate our findings. Nonetheless, according to a number of studies, numerous measures were not always reproducible, and a single reading is sufficient for IABPD screening. Standard simultaneous and automated measurement of BP in both arms mitigates the potential impacts of BP variations, cuff-response bias (white coat effect), observer bias, and digit preference. Consequently, despite various limitations, our findings continue to support the notion that IABPD may be a useful therapeutic measure. Additionally, the study sample should be diversified and increased in future studies to ensure that the conclusions are generalisable.

CONCLUSION

IABPD was found to correlate significantly with the severity of CAD in our study. However, the guideline of measuring both arms during the initial assessment of high BP is not commonly practised by the general

practitioners.³³ Therefore, results from our study should help raise awareness among the physicians to practise simultaneous BP measurement in both arms, especially in the CAD patients. Future studies with a more diverse population can aid in the development of methods for the clinical implementation of these findings.

Acknowledgements We gratefully acknowledge all the patients and the interventional cardiologists who participated in this study.

Contributors SD, MAI, JD, FC and SR contributed to conception and design. SD, MAI and FC drafted the manuscript. SD and JD contributed to data acquisition. MAI contributed to analysis, and MAI and FC contributed to interpretation and critically revising the manuscript. All authors gave final approval and agreed to be accountable for all aspects of work ensuring integrity and accuracy. SD accepts as guarantor full responsibility for the finished work, had access to the data, and controlled the decision to publish.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was approved by the Institutional Review Board (IRB) of Chittagong Medical College (Approval number: CMC/PG/2019/611). Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to the study are included in the article or uploaded as online supplemental information. The data that support the

findings of this study are available from the corresponding author on reasonable request.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

ORCID iD

Mohammad Azmain Iktidar <http://orcid.org/0000-0002-9073-5451>

REFERENCES

- Osler W. *Modern medicine*. Vol 4.. Lea & Febiger, 1915.
- Orme S, Ralph SG, Birchall A, et al. The normal range for inter-arm differences in blood pressure. *Age Ageing* 1999;28:537–42.
- Singh S, Sethi A, Singh M, et al. Prevalence of simultaneously measured interarm systolic blood pressure difference and its clinical and demographic predictors: a systemic review and meta-analysis. *Blood Press Monit* 2015;20:178–85.
- O'Shea JC, Murphy MB. Ambulatory blood pressure monitoring: which arm? *J Hum Hypertens* 2000;14:227–30.
- National Institute for Health and Care Excellence (NICE). Hypertension in adults: diagnosis and management, 2019. Available: <https://www.nice.org.uk/guidance/ng136> [Accessed 23 April 2022].
- Thompson JF, Kinsella DC. Vascular disorders of the upper limb. In: *Vascular and Endovascular Surgery*. London: WB Saunders, 2001: 199–216.
- National Center for Health Statistics (US). Health, United States, 2016: with special feature on racial and ethnic health disparities, 2016. Available: <https://pubmed.ncbi.nlm.nih.gov/27308685/> [Accessed 23 April 2022].
- Clark CE, Taylor RS, Butcher I, et al. Inter-arm blood pressure difference and mortality: a cohort study in an asymptomatic primary care population at elevated cardiovascular risk. *Br J Gen Pract* 2016;66:e297–308.
- Kim S-A, Kim JY, Park JB. Significant interarm blood pressure difference predicts cardiovascular risk in hypertensive patients: CoCoNet study. *Medicine* 2016;95:e3888.
- Igarashi Y, Chikamori T, Tomiyama H, et al. Clinical significance of inter-arm pressure difference and Ankle-brachial pressure index in patients with suspected coronary artery disease. *J Cardiol* 2007;50:281–9 <http://www.ncbi.nlm.nih.gov/pubmed/18044457>
- Clark CE, Taylor RS, Shore AC, et al. Association of a difference in systolic blood pressure between arms with vascular disease and mortality: a systematic review and meta-analysis. *Lancet* 2012;379:905–14.
- Weinberg I, Gona P, O'Donnell CJ, et al. The systolic blood pressure difference between arms and cardiovascular disease in the Framingham heart study. *Am J Med* 2014;127:209–15.
- Williams B, Mancia G, Spiering W. ESC/ESH guidelines for the management of arterial hypertensionThe Task force for the management of arterial hypertension of the European Society of cardiology (ESC) and the European Society of hypertension (ESH). *European Heart Journal* 2018;39:3021–104.
- American Diabetes Association. 2. Classification and Diagnosis of Diabetes: *Standards of Medical Care in Diabetes-2020*. *Diabetes Care* 2020;43:S14–31.
- National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). Third report of the National cholesterol education program (NCEP) expert panel on detection, evaluation, and treatment of high blood cholesterol in adults (adult treatment panel III) final report. *Circulation* 2002;106:3143–421 <http://www.ncbi.nlm.nih.gov/pubmed/12485966>
- Braunwald E, Antman EM, Beasley JW, et al. ACC/AHA guidelines for the management of patients with unstable angina and Non-ST-Segment elevation myocardial infarction: Executive summary and recommendations. *Circulation* 2000;102:1193–209.
- Alpert JS, Thygesen K, Antman E, et al. Myocardial infarction redefined--a consensus document of The Joint European Society of Cardiology/American College of Cardiology Committee for the redefinition of myocardial infarction. *J Am Coll Cardiol* 2000;36:959–69.
- NHIS - Adult Tobacco Use - Smoking Status Recodes. Available: https://www.cdc.gov/nchs/nhis/tobacco/tobacco_recodes.htm [Accessed 24 Apr 2022].
- Gensini GG. A more meaningful scoring system for determining the severity of coronary heart disease. *Am J Cardiol* 1983;51:606.
- von Elm E, Altman DG, Egger M, et al. The strengthening of reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. *The Lancet* 2007;370:1453–7.
- Islam AKMM, Majumder AAS. Coronary artery disease in Bangladesh: a review. *Indian Heart J* 2013;65:424–35.
- Agarwal R, Bunaye Z, Bekele DM. Prognostic significance of between-arm blood pressure differences. *Hypertension* 2008;51:657–62.
- Cay S, Cagirci G, Demir AD, et al. Ambulatory blood pressure variability is associated with restenosis after percutaneous coronary intervention in normotensive patients. *Atherosclerosis* 2011;219:951–7.
- Sharma B, Ramawat P. Prevalence of inter-arm blood pressure difference among clinical out-patients. *Int J Health Sci* 2016;10:217–25.
- Park S-J, Son J-W, Park S-M, et al. Relationship between inter-arm blood pressure difference and severity of coronary atherosclerosis. *Atherosclerosis* 2017;263:171–6.
- Pathak LA, Shirodkar S, Ruparelia R, et al. Coronary artery disease in women. *Indian Heart J* 2017;69:532–8.
- Weber T, Lang I, Zweiker R. Hypertension and coronary artery disease: epidemiology, physiology, effects of treatment, and recommendations : A joint scientific statement from the Austrian Society of Cardiology and the Austrian Society of Hypertension: A joint scientific statement from the Austrian Society of Cardiology and the Austrian Society of Hypertension. *Wien Klin Wochenschr* 2016;128:467–79.
- Al-Nozha MM, Ismail HM, Al Nozha OM. Coronary artery disease and diabetes mellitus. *J Taibah Univ Med Sci* 2016;11:330–8.
- Mahalle N, Garg MK, Naik SS, et al. Study of pattern of dyslipidemia and its correlation with cardiovascular risk factors in patients with proven coronary artery disease. *Indian J Endocrinol Metab* 2014;18:48–55.
- Song BM, Kim HC, Shim J-S, et al. Inter-Arm difference in brachial blood pressure in the general population of Koreans. *Korean Circ J* 2016;46:374–83.
- Verberk WJ, Kessels AGH, Thien T. Blood pressure measurement method and inter-arm differences: a meta-analysis. *Am J Hypertens* 2011;24:1201–8.
- Mancia G, Parati G. Home blood pressure monitoring. *Hypertension* 2011;57:21–3.
- Heneghan C, Perera R, Mant D, et al. Hypertension guideline recommendations in general practice: awareness, agreement, adoption, and adherence. *Br J Gen Pract* 2007;57:948–52.