Original Article

Disparity in Coronary Artery Diameter in Diabetic and Non-diabetic Subjects undergoing Percutaneous Coronary Intervention in Bangladesh: A 2-Year Retrospective Analysis

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Abstract:

Objective: Coronary arteries in diabetic patients were found to be narrower than in non-diabetic subjects. The aim of the study was to compare the coronary arteries diameter between diabetic and non-diabetic patients undergoing percutaneous coronary intervention (PCI) using stent diameter for greater accuracy.

Methods: This was a randomized observational study. From a dedicated database, we retrospectively analysed all consecutive patients of both gender who underwent PCI in the cardiac catheterization laboratory of Ibrahim Cardiac Hospital and Research Institute, Dhaka, Bangladesh, from January 2011 to December 2012. Patients who required left main coronary artery stenting were excluded from this study. Patients were divided into two groups; diabetics and non-diabetics. We calculated the coronary artery diameter according to the diameter of the stent, achieved at the final pressure at which the stent was deployed. The diameter which was achieved at a given atmospheric pressure was taken from the attached booklet provided with the stent packaging. If post dilatation was required then the diameter achieved by the non-compliant balloon after post dilatation was taken as the reference diameter of the artery.

Results: A total of 571 patients, 333 in diabetic and 238 in non-diabetic group were included in the study. Proximal segments of left anterior descending (LAD) coronary artery in diabetics and non-diabetics were 2.99±0.44 vs 3.14±0.50 mm (p=0.00) while mid and distal segments were 2.90±0.38 vs 3.10±0.42 mm (p=0.00) and 2.25±0.39 vs 2.42±0.45 mm (p=0.00) respectively. Various segments of proximal left Circumflex (LCx) coronary artery in diabetics and non-diabetics were 2.98±0.21 vs 3.01±0.25 mm (p=0.39) while distal circumflex were 2.35±0.40 vs 2.49±0.43 mm (p=0.00) respectively. Proximal segments of right coronary artery (RCA) in diabetic and non-diabetics were 3.0±0.28 vs 3.28±0.25 mm (p=0.00) while mid and distal segments were 2.97±0.26 vs 3.19±0.25 mm (p=0.00) and 2.43±0.51 vs 2.87±0.32 mm (p=0.00) respectively. The number of stents (1.34±0.87 vs 1.30±0.65; p=0.40) and type of stent utilized (DES & non DES: 87.3 & 12.7% vs 85.2 & 14.8%; p=0.50) between diabetic & non-diabetic groups were not significantly different; however the total stent length (23.1±13.3 vs 21.5±9.52 mm; p=0.03) in diabetic group was significantly longer.

Conclusions: The diameter of LAD, distal circumflex and right coronary arteries were significantly narrower in diabetic than non-diabetic subjects.

Key words: Diabetes mellitus, Coronary arteries, Percutaneous coronary intervention.

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Introduction:

The association between diabetes mellitus (DM) and cardiovascular disease is well-known, and DM is associated with a 2–4 fold increased incidence of Coronary Artery Disease (CAD).[1]. A world-wide non-communicable disease, DM has affected an estimated **387 million** people **globally in 2014,[2] with** Bangladesh having the second highest prevalence of diabetes in the South East Asia region at 10.6%.[3]

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It is estimated that more than 50% of adult diabetics have significant coronary atherosclerosis, a prevalence 10 times greater than that of the general population.[4] Diabetics have high prevalence of subclinical CAD with more diffuse lesions and accelerated progression in frequently smaller native vessels.[5,6]

Angiographic comparison of different segments of the coronary vessel tree has, in the vast majority of cases, revealed a tendency towards narrower coronary artery diameters among diabetic patients with CAD.[7] Most authors from different countries have found the Right coronary artery (RCA) to be significantly more frequently involved in diabetics, in terms of narrower diameter.[8-11.] There is also evidence of smaller luminal diameter of the Left anterior descending (LAD) artery among diabetics,[8,10-12] and distal left circumflex (LCx).[11] In contrast, some investigators have found similar angiographic profiles between non-insulin dependent diabetics (NIDDM) and non-diabetics.[13]

Most of these have been based on measurement of diameters by means of Quantitative Coronary Angiography (QCA). However QCA, which was developed to overcome the limitations of visual interpretation, is in turn limited in that observational variations can occur owing to the use of different frames. In the present study, we investigated diabetic patients undergoing PCI and applied a different method of measurement of coronary vessel diameter by means of the stent size, in order to avail a more objective measurement and overcome observer bias. We sought to study the disparity of vessel diameters among diabetics and non-diabetics, and in particular, the respective segments of vessels affected greatest among diabetics.

Materials and Methods:

This was a randomized observational study. From a dedicated database, we retrospectively analysed all consecutive patients of both gender who underwent PCI in the cardiac catheterization laboratory of Ibrahim Cardiac Hospital and Research Institute, Dhaka, Bangladesh from January 2011 to December 2012 for a total period of 2 years. The aim of the present study was to compare the coronary artery diameters between diabetic and non-diabetic patients undergoing PCI. Prior approval had been taken for the study protocol by the hospital ethical committee. Diabetes mellitus was defined as fasting plasma glucose of 7.0 mmol/L or above or random 2 hours post-prandial plasma glucose of 11.1 mmol/L or above following oral glucose tolerance test or A1C $\geq$6.5%.[14]

Informed written consent was taken from each patient prior to PCI. Patients who required left main coronary artery stenting were excluded from this study. Demographic data such as age, sex, height (cm), weight (kg), and BMI (kg/m^2) were noted. Risk factors were recorded for all patients. Patients were divided into two groups; diabetics and non-diabetics. All interventions were performed according to standard techniques. Unless contraindicated, all patients were given a pre-load of aspirin 300 mg & clopidogrel 600 mg prior to the procedure.

Angiographically, LAD is divided into 3 portions: Proximal, Mid and Distal. Proximal LAD is the portion from its origin from the LMCA to its first diagonal (D1) branch. Mid LAD is the portion between first diagonal (D1) and second diagonal (D2) branches. Distal LAD is the portion of the LAD beyond (D2) branch.[15]

Similarly, LCx is angiographically divided into 2 portions: Proximal and Distal. Proximal LCx is the portion from its origin from the LMCA to the origin of the first obtuse marginal (OM) branch. Distal LCx is the portion of the LCx beyond first OM branch.[15]

Angiographically, RCA is divided into 3 parts: Proximal, Mid and Distal. Proximal RCA is the portion of the RCA from its origin from the right anterior coronary sinus to the origin of its RV branch. Mid RCA is the portion of RCA between its RV branch and its PDA branch. Distal RCA includes PDA and PLV branches.[15]

We analyzed the coronary artery diameter according to the diameter the stent achieved at the final pressure at which the stent was deployed. The diameter which was achieved at a given atmospheric pressure was taken from the attached booklet given with stent packaging. If post dilatation was required then the diameter achieved by the non-compliant balloon after post dilatation was taken as the reference diameter of the artery.

Mean±standard deviation (SD) was calculated for numerical variables while categorical variables were presented as frequencies and percentages. Comparison between two groups was performed by using student's *t*-test for numerical variables and Chi-Square test for categorical variables. A p-value of <0.05 was considered significant. Data were analysed using computer based Statistical Programme for Social Science (SPSS) version 16.0.

Results:

A total of 571 consecutive patients who underwent PCI, 333 in diabetic and 238 in non-diabetic group were included in the study. Mean age in diabetic and non-diabetic groups was 58.6±7.5 vs 59.9±6.7 years (p=0.91) respectively (Table I). Male patients in diabetic and non-diabetic group were 260(78%) vs. 209(87.8%); p=0.00 respectively (Figure 1). Hypertension among diabetics and non- diabetics were 47% vs 42.4% (p=0.39)

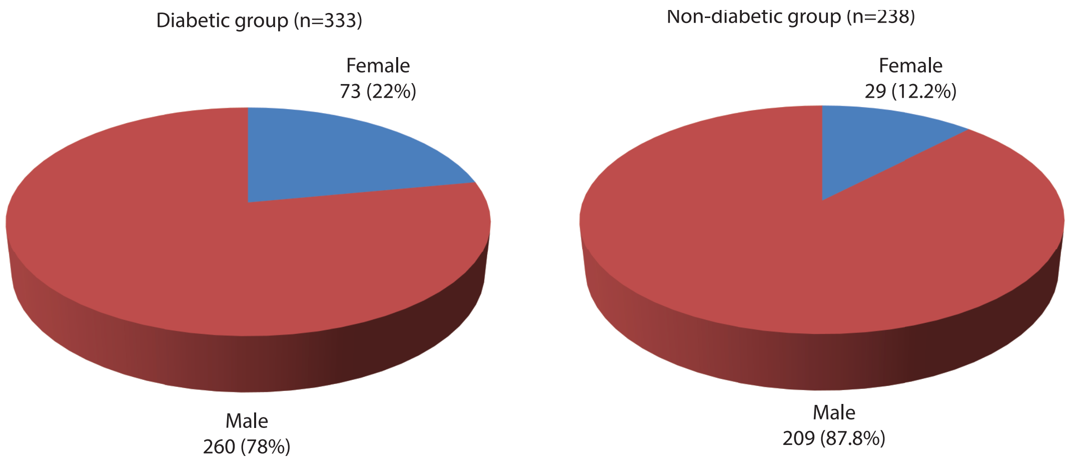

Fig.-1: *Sex distribution of the study population*

respectively. Mean BMI in diabetic and non-diabetic groups was 26.2±2.5 vs.26.8±2.7kg/m^2 (p=0.31) respectively. These baseline characteristics were shown in Table I.

Proximal segments of LAD coronary artery in diabetics and non-diabetics were 2.99±0.44 vs 3.14±0.50mm (p=0.00) while mid and distal segments were 2.90±0.38 vs 3.10±0.42 mm (p=0.00) and 2.25±0.39 vs 2.42±0.45 mm (p=0.00) respectively (Table II).

Various segments of proximal LCx coronary artery in diabetics and non-diabetics were 2.98±0.21 vs 3.01± 0.25mm (p=0.39) while distal circumflex were 2.35±0.40 vs 2.49±0.43mm (p=0.00) respectively (Table III).

Proximal segments of right coronary artery in diabetic and non-diabetics were 3.0±0.28 vs 3.28±0.25mm (p=0.00) while mid and distal segments were 2.97±0.26 vs 3.18±0.25 mm (p=0.00) and 2.43±0.51 vs 2.87±0.32 mm (p=0.00) respectively (Table IV).

Procedural data were presented in Table V. The mean number of stent deployed per patient (1.34±0.87 vs 1.30±0.65; p=0.40) and type of stent utilized (DES & non DES: 87.3 & 12.7% vs 85.2 & 14.8%; p=0.50) between diabetic & non-diabetic groups were not significantly different; however the total stent length (23.1±13.3 vs 21.5±9.52 mm; p=0.03) in non-diabetic group was significantly shorter than diabetic group.

Table-I

Baseline Characteristics of diabetic and non-diabetic patients

Characteristics	Diabetic Group (n=333)	Non-diabetic Group (n=238)	p-value
Mean age (y)	58.6±7.5	59.9±6.7	0.91
Hypertension	156(47%)	101(42.4%)	0.39
BMI (kg/m^2)	26.2±2.5	26.8±2.7	0.31

Table-II

Comparison of LAD artery diameters among diabetics and non-diabetics

	Diabetes	Mean±SD	p-value
Proximal LAD	Yes (n=101)	2.99±0.44	0.00
	No (n=75)	3.14±0.50	
Mid LAD	Yes (n=113)	2.90±0.38	0.00
	No (n=96)	3.10±0.42	
Distal LAD	Yes (n=126)	2.25±0.39	0.00
	No (n=111)	2.42±0.45	

Table-III

Comparison of LCx artery diameters among diabetics and non-diabetics

	Diabetes	Mean±SD	p-value
Proximal LCx	Yes (n=111)	2.98±0.21	0.39
	No (n=125)	3.01±0.25	
Distal LCx	Yes (n=133)	2.35±0.40	0.00
	No (n=118)	2.49±0.43	

Table-IV

Comparison of right coronary artery diameters among diabetics and non-diabetics

	Diabetes	Mean±SD	p-value
Proximal RCA	Yes (n=129)	3.0±0.28	0.00
	No (n=103)	3.28±0.25	
Mid RCA	Yes (n=123)	2.97±0.26	0.00
	No (n=100)	3.19±0.25	
Distal RCA	Yes (n=133)	2.43±0.51	0.00
	No (n=106)	2.87±0.32	

Table-V

Procedural characteristics of the study population

Characteristics	Diabetic Group (n=333)	Non-diabetic Group (n=238)	p-value
Mean number of stents per patient	1.34±0.87	1.30±0.65	0.40
Proportion of DES used (%)	87.3%	85.2%	0.50
Mean total length of stent(s) per lesion (mm)	23.1±13.3	21.5±9.52	0.03

Discussion:

There is a greater incidence of CAD among diabetic patients. CAD in diabetic patients is more severe and diffuse than non-diabetics.[8,9] This could be attributed to various pathophysiological mechanisms among diabetics, including hyperglycemia, hyperinsulinemia and insulin resistance.[8] In addition, a smaller coronary artery diameter should also be viewed as an important factor in the increased prevalence of CAD among diabetics.

Although a number of prior studies have concluded that the disparity in coronary artery diameters between diabetics are non-diabetics is significant, there have been contradictory opinions regarding this concept as well. Most of these studies have been QCA based. The alternative we adopted in this study was to measure the vessel diameters according to stent size.

Our study found no significant difference in the mean ages between the diabetic and non diabetic groups, being 58.6±7.5 vs 59.9±6.7 years (p=0.91) respectively. Melidonis et al. found that among their subjects, there was no statistical significance in the age of male versus female among diabetics.[8]

Male patients in diabetic and non-diabetic group were 260(78%) vs. 209(87.8%); p=0.00 respectively, indicating that the vast majority of patients diagnosed with CAD and undergoing PCI in both groups were male, with a significantly higher number of patients being from the diabetic group, a finding that was also statistically significant. This is consistent with the observations of other studies by Faridullah et al.[12] and Melidonis et al.[8] Hypertension among diabetics and non- diabetics were 47% vs 42.4% (p=0.39) respectively, indicating that it was an important risk factor for the development of CAD among both groups, a finding that has been established in studies done by Melidonis et al.[8] and Gui et al.[9] Mean BMI in diabetic and non-diabetic groups was 26.2±2.5 vs. 26.8±2.7kg/m^2 (p=0.31) respectively, which was also found to be insignificant statistically by Gui et al.[9]

This study found that the disparity in vessel diameters between the two groups of all segments of the LAD coronary artery were statistically significant. Proximal segments of LAD coronary artery in diabetics and non-diabetics were 2.99±0.44 vs 3.14±0.50 mm (p=0.00) while mid and distal segments were 2.90±0.38 vs

3.10±0.42 mm (p=0.00) and 2.25±0.39 vs 2.42±0.45 mm (p=0.00) respectively. In a QCA- based study, Faridullah et al and Adil et al. found very similar vessel diameters among Pakistani populations, all values of which were significant.[11,12] In contrast, however, in a Greek Caucasian population, Melidonis et al. found no statistically significant difference in vessel diameters between diabetics and non-diabetics for all segments of LAD.[8] It is notable to mention that the vessel diameters obtained in our study as well as the study by Faridullah et al. has found greater width for both diabetic and non-diabetic subjects in an Asian population, in comparison to the numbers obtained by Melidonis et al. among a Caucasian population.

As for LCx coronary artery, our study found that the measurements for the distal segment were statistically significant among diabetics and non-diabetics, being 2.35±0.40 vs 2.49±0.43 mm respectively. These findings were consistent with the findings of Faridullah et al.[12] The proximal LCx in diabetics and non-diabetics were 2.98±0.21 vs 3.01±0.25 mm (p=0.39); both Faridullah et al.[12] and Melidonis et al.[8] found no statistically significant difference among the diameters of the two groups for proximal LCx, as in our study.

Our study found that diameters of all segments of the right coronary artery were reduced among diabetic patients undergoing PCI, with statistical significance. Proximal segments of right coronary artery in diabetic and non-diabetics were 3.0±0.28 vs 3.28±0.25 mm (p=0.00) while mid and distal segments were 2.97±0.26 vs 3.19±0.25 mm (p=0.00) and 2.43±0.51 vs 2.87±0.32 mm (p=0.00) respectively. Coincidentally, a Pakistani study conducted by Adil et al.[11] found almost identical vessel diameters. Melidonis et al. however did not find a statistically significant difference in the sizes of the coronaries, although it found that the RCA was more affected with coronary disease in terms of stenosis.[8] Gui et al. who studied the angiographic profiles of diabetic and non-diabetic patients with CAD in a Chinese population, also found that the RCA was more frequently involved among diabetics than non-diabetics (66.4% vs. 52.6%, p=0.002).[9] They postulated this predominance of stenosis is RCA to the low blood flow which coexists in RCA in comparison to other vessels, and the increased plasma viscosity among diabetics.[8,9]

Reference data derived from the literature for standard luminal diameters of normal coronary arteries as derived from literature are as follows: LAD 2-5.0mm (mean 3.6mm), LCx 1.5-5.5 mm (mean 3 mm) and RCA 1.5-5.5mm (mean 3.2mm). LAD and LCx generally taper in diameter as they extend from the LMCA, while RCA maintains a fairly constant diameter till it gives rise to PDA.[16] In comparison to this data derived the diameters measured from our study for non-diabetic patients were similar albeit lesser than the diameters quoted above. Diabetic patients demonstrated significant lesser artery diameter. However, these reference data could not be applied for comparison totally, as they only gave a single average diameter for the whole vessel, as opposed to segments which we measured; in practice, the diameters of the coronary tree changes throughout its length giving rise to different vessel widths.

In summary, our study found that the artery diameters of specific segments of the coronary tree among diabetic patients undergoing PCI were significantly narrower than non-diabetic subjects, particularly the right coronary artery (all segments), proximal and mid LAD and distal LCx. These are consistent with the findings of QCA based measurements of vessel diameter, as well as other studies comparing angiographic profiles between diabetic and non-diabetic populations. Although the exact diameters of the vessels were not measured, these studies reiterate our findings, by showing similar segment and vessel involvement being more predominant among diabetics.

Thus, the smaller diameter of coronary artery segments comes with important therapeutic implications, especially in terms of revascularization, both CABG and PCI. A smaller coronary arterial diameter even after dilatation by PCI/balloon implies that a lower atheroma burden would be required to develop critical stenosis, leading to more frequent occurrence of CAD among diabetics. Consequently, this has an impact in both treatment options as well as outcome, with the incidence of PCI being more frequent among diabetics, as evidenced by our study and others.[4,6]

Due to the more diffuse coronary involvement, diabetics have also been known to require greater stent length due to longer and more diffuse lesions[1,5,6] as reflected in our study with the mean total stent length among diabetic subjects being significantly longer, i.e. 23.1±13.3 vs 21.5±9.52 mm; p=0.03 among diabetics and non-diabetics respectively. However, this study did not find any statistical significance in the number of stents used between the two groups (1.34±0.87 vs 1.30±0.65 mm; p=0.40 for diabetics and non-diabetics respectively).

Smaller vessel reference diameter before the procedure and greater stented length of the vessel have been found to be independent predictors of restenosis in patients with diabetes, leading to poor outcome following PCI.[17]

As restenosis is the major limitation of BMS use in patients with diabetes, DES are considered to be the standard of care for patients with diabetes undergoing PCI, and likely to significantly improve outcome after PCI.[4] DES reduce angiographic restenosis and need for repeat revascularization procedures amongst all patients, with similar benefit among diabetics.[6]

In terms of the type of stent used, our study found no difference in the frequency of the use of DES among diabetic and non-diabetic populations (87.3% vs 85.2%; p=0.50 respectively); given the increasing evidence of better outcome in diabetic following DES, further studies to assess the effects of stent implantation with BMS versus DES stent among diabetics may be warranted.

Conclusion:

Coronary arteries in diabetic patients were found to be narrower than in non-diabetic subjects. The diameter of LAD, distal circumflex and right coronary arteries were significantly narrower in diabetic than non-diabetic subjects. The diabetic subjects needed longer stent lengths than non diabetics.

Limitations:

This study is a retrospective analysis performed on a relatively small number of consecutive patients. Stent size may not reflect the vessel size. IVUS utilization has an additive effect on correcting the appropriate size. Our study also does not take into account potential differences between male and female patients.

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