

Association of Hypertension on Development of Coronary Collaterals in Severe Coronary Artery Disease

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Abstract:

Key Words :
Hypertension,
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collaterals.

Objectives: Coronary collaterals appear to play important role in coronary artery disease morbidity and mortality. In this study it was intended to determine whether hypertension is associated with development of coronary collaterals in patients with severe coronary artery disease.

Methods: This was an observational cross-sectional study carried out in the department of cardiology of National Institute of Cardiovascular Diseases, Dhaka, Bangladesh during the period from October 2010 to June 2011. A total of 334 patients were examined to include in the study. Among them 118 patient of severe coronary artery disease (CAD) were included who fulfilled the inclusion and exclusion criteria. From where 63 patients were CAD with hypertension (Group -I) and 55 patients were CAD without hypertension (Group -II). Based on Rentrop Grading the study patients were divided in two groups, patients with poor collaterals (Grade 0& 1) and good collaterals (Grade 2&3). Data compared the coronary collaterals in hypertensive patients with those without hypertension with severe coronary artery disease.

Results: The data showed that good collateral circulations were higher with duration of hypertension. The difference were statistically significant in duration <5 years and duration ≥ 10 years in both groups ($p < 0.05$). The pattern of vessel involvement in double vessel disease and triple vessel disease ($p < .001$) and dyslipidemia ($p < 0.004$) appeared to be significant predictor of hypertension controlling for other factors in the model. People with hypertension are around four times more likely to have good collateral circulation, multiple vessel disease and around 12 times more likely to have dyslipidemia.

Conclusion: It is concluded that the patients of hypertension develop higher grades of coronary collaterals which increases with duration of hypertension in patients of severe coronary artery disease. Involvements of coronary arteries were more extensive in patients of hypertension with coronary artery disease.

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Introduction:

Hypertension increases the risk of cardiovascular diseases by two folds, including coronary artery disease and is associated with an increased frequency of higher classes of angina pectoris and a higher probability of having severe atherosclerotic lesion in the major coronary arteries.¹

Coronary collateral vessels or 'natural bypasses' are anastomotic connections without an intervening capillary bed between portions of the same coronary artery or between different coronary arteries.² This collateral circulation is extensively

visible to an area of occlusive coronary artery disease.³ The prognosis of patients with an acute myocardial infarction may be beneficially affected by the presence of coronary collateral circulation.⁴

The patients with coronary artery disease (CAD) develop high degree collaterals and coronary collaterals are present in one fourth of patients with normal coronary arteries or non-obstructive CAD.^{5,6} There are significant associations between the prevalence and quality of collateral vessels with angiographically extensive coronary artery disease.⁷ In one study Barman RN found no significant presence and extent of coronary collaterals in

patients of chronic stable angina with hypertension.⁸ In another study with diabetic patients were found to develop less collateral in comparison to non-diabetic patients with coronary artery disease.⁹

There were poor development of coronary collateral vessels in patients with metabolic syndrome and incidence of development of coronary collaterals was significantly higher in patients with stable angina pectoris.^{10,11}

Coronary collaterals appear to play important role in coronary artery disease morbidity and mortality. But the conflicting results remain, and the exact mechanism of collateral formation is still unknown. In this study it was intended to determine whether hypertension is associated with development of coronary collaterals in patients with severe coronary artery disease. This may be helpful in management of the patients of severe coronary artery disease with hypertension.

Methods:

This cross-sectional study was conducted in the National Institute of Cardiovascular Diseases (NICVD), Dhaka from July 2010 to May 2011. A total of 334 patients were examined to include in the study among them 118 patient of severe coronary artery disease (luminal stenosis $\geq 90\%$ at least any one major coronary artery or $\geq 70\%$ stenosis in left main coronary artery) were included who fulfilled the inclusion and exclusion criteria. From where we got 63 patients were CAD with hypertension (Group- I) and 55 patients was CAD without hypertension (Group- II). Based on Rentrop Grading the studied patients were divided in two groups, patients with poor collaterals (collateral grade 0 and 1) and good collaterals (collateral grade 2 and 3).¹² Data were compared to the coronary collaterals in hypertensive patients with those without hypertension with severe CAD.

Group -I = CAD with hypertension

Group -II = CAD without hypertension.

Collateral circulations were analyzed according to Rentrop grading system of “0” to “3”.

Collateral grade ‘0’= Non-developed-no filling of any collateral vessels.

Collateral grade ‘1’= Less-developed-filling of the side branches of the artery, but no major trunk visualized through collaterals.

Collateral grade ‘2’= Well developed-partial filling of the epicardial segment of the stenosed artery through collaterals.

Collateral grade ‘3’= Complete filling of the epicardial segment.

- Two additional groups done:
 - Poor collaterals: Collateral grade 0 and 1.
 - Good collaterals: Collateral grade 2 and 3.
- Correlation of duration of hypertension was done with the grading of collaterals.

Results:

The study included 118 patient of severe coronary artery disease from where we got 63 patients were CAD with hypertension (Group- I) and 55 patients were CAD without hypertension (Group- II). Data were compared to the coronary collaterals in hypertensive patients with those without hypertension with severe CAD.

Table I showed the comparison of the risk factors for CAD between the two groups. Smoking and family history of IHD were more common in Group- II and dyslipidaemia more common in Group-I. The low physical activity was higher in Group- II than in Group- I.

Table-I
Distribution of risk factors between study groups (n=118).

Risk Factors for CAD	Group -I (n= 63)		Group- II(n =55)		p value
	Number	%	Number	%	
Smoking habit	38	60.3	46	83.7	0.005
Family history of IHD	24	38.1	37	67.3	0.001
Dyslipidaemia	9	14.3	2	3.6	0.04
Low physical activity	44	69.8	44	80.0	0.20

P values were obtained from Chi-square Test.

The table II showed 39.7% of Group- I and 34.5% of Group- II patients were admitted with STEMI. NSTEMI presentation was 6.3% in Group- I and 5.5% in Group- II. Chronic stable angina was 22.2% in Group- I and 20% in Group- II. Old MI was 23.8% in Group- I and 12.7% in Group- II. There were no statistically significant clinical presentations on admission between two groups ($p>0.05$). Unstable anginas were 7.9 in Group- I and 27.3% in Group- II. This was statistically significant ($p<0.05$).

The table III showed that 27% of the patients had single vessel disease (SVD) in Group- I and 61.1% in Group- II. Double vessel disease (DVD) had 58.7% of the patients in Group- I and 37% in Group- II. Triple vessel disease (TVD) had 14.3% in Group- I and 1.9% in Group- II. The patients of Group- I encountered significant higher DVD and TVD than those of Group- II ($p<0.01$). The patients of Group- II encountered significantly higher SVD than those of Group- I ($p<0.001$). The patients of without hypertension had more SVD and with hypertension had more DVD and TVD.

The table IV showed that in patients with duration of hypertension <5 years were 52.4% and 19.0% in poor and good collaterals group respectively. In 5-9 years were 23.8% and 28.6% in poor and good collateral respectively. In duration ≥ 10 years were 23.8% and 52.4% in poor and good collateral respectively. The difference were statistically

significant in duration <5 years and duration ≥ 10 years in both groups ($p<0.05$). So data showed that good collateral circulation were higher with duration of hypertension.

Table V showed that 14.3% in Group-I and 27.3% in Group-II had grading '0', 19% in Group-I and 38.2% in Group-II had grading '1', 41.3% in Group-I and 23.6% in Group-II had grading '2', 25.4% in Group-I and 10.9% in Group-II had grading '3'. The differences were significant between two groups ($p<0.05$).

The table VI showed that there were 33.3% in Group-I and 65.4% in Group-II had poor collateral supply. On the other hand 66.7% in Group-I and 34.6% in Group-II had good collateral circulation. Differences were statistically significant ($p<0.05$).

The logistic regression analysis for the relation of hypertension with coronary collateral circulation adjusting for possible confounders showed that the patients with hypertension had approximately 3.8 times more chance of developing good collaterals, which was statistically significant ($p=0.001$, OR 3.8, 95% CI 1.76 to 8.13). However the pattern of vessels involvement that was multiple vessel disease (DVD and TVD) appeared to be significant in patients with hypertension ($p=0.001$, OR 3.8, 95% CI 1.77 to 8.26). So, patients with hypertension were more likely to have good collateral circulation, multiple vessel disease.

Table-II

Distribution of patient by clinical presentation on admission (n=118).

Clinical presentation	Group -I (n=63)		Group- II (n=55)		p value
	Number	%	Number	%	
STEMI	25	39.7	19	34.5	0.56
NSTEMI	4	6.3	3	5.5	0.83
UA	5	7.9	15	27.3	0.005
CSA	14	22.2	11	20.0	0.76
OMI	15	23.8	7	12.7	0.12

p values were obtained from Chi-square Test.

Table-III

Distribution of number of coronary artery involvement between groups (n=118).

Vessels	Group -I (n=63)		Group- II (n=55)		p value
	Number	%	Number	%	
SVD	17	27.0	33	61.1	0.001
DVD	37	58.7	20	37.0	0.01
TVD	9	14.3	1	1.9	0.01

p values were obtained from Chi-square Test

Table-IV
Comparison of duration of hypertension with coronary collaterals (n= 63).

Hypertension duration in years	Poor collateral (Rentrop grade 0 and 1) (n= 21)		Good collateral (Rentrop grade 2 and 3) (n = 42)		p value
	Number	%	Number	%	
< 5	11	52.4	8	19.0	0.006
5 – 9	5	23.8	12	28.6	0.68
≥10	5	23.8	22	52.4	0.03

P values were obtained from Chi-square Test.

Table-V
Distribution of populations by Rentrop collateral grading (n=118).

Collateral grading	Group -I (n= 63)		Group- II(n =55)		p value
	Number	%	Number	%	
Grade – 0	9	14.3	15	27.3	0.08
Grade – 1	12	19.0	21	38.2	0.02
Grade – 2	26	41.3	13	23.6	0.04
Grade – 3	16	25.4	6	10.9	0.04

P values were obtained from Chi-square Test.

Table-VI
Distribution of mean Rentrop collateral grading of the study populations (n= 118).

Collaterals	Group -I (n= 63)		Group- II(n =55)		p value
	Number	%	Number	%	
Poor Collaterals (collateral grade 0 and 1)	21	33.3	36	65.4	0.001
Good collaterals (collateral grade 2 and 3)	42	66.7	19	34.6	

p values were obtained from Chi-square Test.

Table-VII
Multivariate logistic regression for the determinants of collateral circulation (n= 118).

Independent variables	B	Wald	OR	95.0% C.I. for OR		P- value
				Lower	Upper	
Age (>50 years)	0.345	0.870	1.412	0.684	2.917	0.35
Male sex	-0.830	1.726	0.436	0.126	1.504	0.18
BMI (Overweight)	0.241	0.266	1.273	0.509	3.185	0.61
Family history of IHD	-0.621	2.771	0.537	0.258	1.117	0.09
Smoking Habit	-0.929	4.727	0.395	0.171	0.913	0.06
HTN	1.332	11.609	3.789	1.766	8.133	0.001
Multiple Vessel Disease (DVD and TVD)	1.324	11.658	3.826	1.771	8.265	0.001

Dependent variables: (good collateral circulation/ poor collateral circulation)

Discussion:

The study of risk factors of CAD between the two groups the difference of smoking habit and family history in Group- II and dyslipidaemia in Group-I were statistically significant ($p < 0.05$). The low physical activity was higher in Group- II about 80% and 69.8% in Group- I, but not statistically significant ($p > 0.05$).

The mean total cholesterol of group-I was higher than Group-II that was found statistically significant. The mean high density lipoprotein of Group-I was lower than in Group- II that was statistically significant. These findings are consistent with Quayyum who found that mean total cholesterol were 189.1 ± 23.3 mg/dl and mean high density lipoprotein were 38.3 ± 2.3 mg/dl in patients with hypertension having coronary artery disease.¹

Coronary angiogram showed 50 patients had SVD, 57 patients had DVD and 10 patients had TVD. Patients with hypertension had 6 times more Multiple Vessel Disease than patients without hypertension. The patients of without hypertension were more SVD and with hypertension were more DVD and TVD. These findings are almost consistent with Quayyum, Hossain¹⁰ and Arzu, et al.^{1,10,11} Quasem, et al. stated that hypertension increases the risk of cardiovascular disease by two folds.¹³

In patients of hypertension good collaterals were associated with increased in duration of hypertension. The differences were statistically significant ($p < 0.05$) for the development of good collaterals in duration of hypertension > 10 years.

Study of coronary collaterals showed that 14.3% of patients in Group-I and 27.3% in Group-II had score '0', 19% of patients in Group-I and 38.2% in Group-II had score '1', 41.3% of patients in Group-I and 23.6% in Group-II had score '2', 25.4% in Group-I and 10.9% in Group-II had score '3'. The hypertensive patients developed more in collateral grade 1, 2 and 3 than patients of without hypertension. The differences were statistically significant ($p < 0.05$).

When compared with poor and good collaterals in between groups, there were 33.3% in Group-I and 65.4% in Group-II had poor collateral. On the other hand 66.7% in Group-I and 34.6% in Group-II had

good collaterals. The good collaterals were more in patients with hypertension. The differences were statistically significant ($p < 0.05$).

Kyriakides et al. found that the coronary collaterals were more extensive in the hypertensive patients.¹⁴ Heinle et al. found no effects of hypertension on development of coronary collaterals.¹⁵ Koerselman et al. found that there was an inverse association between high blood pressure with the presence and extent of coronary collaterals.⁴ Karpanou et al. showed that the patients of CAD with arterial hypertension developed coronary collaterals more frequently, especially high grade coronary collaterals.⁵ Kilian et al. found a positive relation between hypertension and Rentrop grade '3' collaterals.¹⁶

In multivariate logistic regression analysis for the relation of hypertension with coronary collateral circulation adjusting for possible confounders showed that the patients with hypertension had approximately 3.8 times more chance of developing good collaterals, which was statistically significant ($p = 0.001$). However the pattern of vessels involvement that was multiple vessel disease (DVD and TVD) appeared to be significant in patients with hypertension ($p = 0.001$).

So, the patients of hypertension with severe CAD were more likely to have good coronary collaterals with extensive involvements of coronary arteries.

Conclusion:

From this study it is concluded that the patients of hypertension developed higher grades of coronary collaterals which increases with duration of hypertension. But involvement of coronary arteries were more extensive that might be the cause of increased fatality in patients of hypertension with coronary artery disease.

Conflict of Interest - None.

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