ORIGINAL ARTICLE

EFFECT OF CORONARY ARTERY DOMINANCE IN-TERMS OF PRESENTATION AND IN-HOSPITAL OUTCOMES OF PATIENTS UNDERGOING PRIMARY PCI FOR CULPRIT PROXIMAL LEFT ANTERIOR DESCENDING ARTERY

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Objectives: Objective of this study was to assess the difference in terms of presentation and in-hospital course between patients with right vs. left dominant arterial circulation undergoing "primary percutaneous coronary intervention (PCI)" for culprit proximal left anterior descending artery (LAD).

Methodology: We included consecutive adult (≥18 years) patients diagnosed with STE-ACS undergoing primary PCI for culprit proximal LAD. Patients were categorized into right vs. left dominant circulation on left heart catheterization. Demographic, clinical characteristics, presentation, and hospital course were compared between the matched (propensity matched) and unmatched cohort of patients with right vs. left dominance.

Results: We included 775 patients, out of which 81.3% (630) were males and mean age was 54.59 ± 11.3 years. On coronary angiogram left dominance was observed in 14.3% (111). Single vessel disease was higher with left compared to right dominant system, 53.2% vs. 43.5%, respectively. The rate of slow flow/no-reflow (15.4% vs. 7.2%; p=0.0.230), heart failure (9.3% vs. 6.3%; p=0.299), and in-hospital mortality (5.1% vs. 3.6%, p=0.493) were not different between right vs. left dominance, respectively. In the matched cohorts, the frequency of slow flow/no-reflow (15.3% vs. 7.2%; p=0.056), heart failure (6.3% vs. 6.3%; p>0.999), and mortality (5.4% vs. 3.6%, p=0.493) were not different between right vs. left dominance, respectively.

Conclusion: No significant increase in complications and outcomes is witnessed among patients with left dominant arterial circulation undergoing primary PCI for culprit proximal LAD. However, careful handling of left main during intervention is warranted due lack of support from right system.

Keywords: Coronary Dominance, Proximal LAD, STE-ACS patients, Primary PCI

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INTRODUCTION

The cardiovascular diseases (CVD), characterized as diseases involves blood vessels and heart, are the leading cause of global morbidity and mortality.[1] According to estimates of the global burden of diseases (GBD) study, the prevalent case of CVD in Pakistan increased by 3.6% from 3717.5 to 3850.8 cases per 100,000 population with an incidence rate ratio of 1.001 [95% CI: 1.000 to 1.002] between the year 1990 to 2019, respectively.[2] The ischemic heart diseases (IHD) remained the main variant of CVD accounting for 49% of the total CVD burden at global level.[3] The "ST-segment elevation myocardial infarction (STEMI)" is reported to be the most common and most fatal manifestation of IHD.[4] However, significant improvements in survival and outcomes has been recorded in recent years the introduction of "primary percutaneous coronary intervention (PCI)" and other advancements in the therapeutic and nontherapeutic treatment and management modalities.[5] Even with the primary PCI, a substantial proportion of patients experiences

adverse outcomes. Hence, identification of high risk individuals is of paramount importance and multiple modalities have been developed and validated for this purpose.[6,7] In addition to the clinical factors, anatomical factors also plays a significant role in risk stratification of these patients.[7]

Coronary artery dominance is a common coronary artery variant which had shown a significant influence on outcomes. The left dominant circulation system has been reported to be associated a higher risk of post-PCI non-fatal myocardial infarction, immediate mortality, and re-infarciton.[8-10] The association of left dominant circulation with the adverse outcomes is hypothesized to be driven by the unbalanced supply of blood to the cardiac muscle, increased risk of failed intervention due to difficult course of the left circumflex artery, and absence of sufficient collateralized blood circulation.[7] In routine clinical practice, the stenosis of left anterior descending artery (LAD) is given attention due to its distinctive prognostic role. Hence, length and dominance are the two cardinal anatomical characteristics with significant clinical implications.[11] Thus, objective of this study was to assess the difference in terms of presentation and in-hospital course between patients with right vs. left dominant arterial circulation presenting with STE-ACS and undergoing primary percutaneous coronary intervention (PCI) for culprit proximal LAD.

METHODOLOGY

This was a single-center cross sectional study, conducted between January 2020 and June 2020 at the largest cardiac hospital in Karachi, Pakistan. Study was approved by the ethical review board of the "National Institute of Cardiovascular Diseases (NICVD), Karachi, Pakistan" and verbal consent for participation was obtained from all the study participants.

Study inclusion criteria were; consecutive adult (≥18 years) patients diagnosed with "ST-segment elevation acute coronary syndrome (STE-ACS)" undergoing primary PCI for culprit proximal LAD. Patients with consent refusal, patients with culprit segment other than proximal LAD, or patients with co-dominant circulation system were excluded.

A 12-lead electrocardiogram (ECG) was performed in all the patients and STE-ACS was diagnosed based on the ECG findings of "ST elevation in at least two contiguous leads >2mm in men or >1mm in women in leads V2 to V3 and/or >1mm in other contiguous chest leads or limb leads" along with history of "typical chest pain for at least 20 minutes" at the time of presentation in the emergency department.

All the diagnostic and primary PCI procedures were performed by the on call team of consultant cardiologists. As per the institutional policy all the procedures were performed free of cost. Pre-and post-procedure pharmacological and non-pharmacological care was uniform for all the patients. Culprit proximal LAD and coronary artery dominance were determined on the coronary angiogram. All the patients were observed for the development of post procedure complications and mortality during their hospital stay.

For the analysis, patients were categorized into two groups, the left and right dominance groups. Two groups were compared for the differences in demographic, clinical, and angiographic characteristics and post-procedure in-hospital morbidity was defined as either cerebrovascular accident (CVA)/stroke, heart failure, contrast-induced nephropathy (CIN), access site complications, major bleeding, or stent thrombosis. Data were analyzed using IBM SPSS version 21, for the comparison of categorical variables between the two groups, Chi-square test/Fisher's exact test was applied and independent sample t-test/Mann-Whitney U test was applied for comparison of continuous variables. In order to minimize the statistical bias a propensity matched cohort of right and left dominant patients was formed using software "R version 4.2.1" and library "MatchIt". The characteristics used in the matching algorithm included: the demographic variables (such as; gender and age), clinical variables (such as; total ischemic time (minutes), blood pressure (mmHg), heart rate (bpm), random blood sugar (mg/dL), height (cm), weight (kg), body mass index (kg/m^2), and Killip class), co-morbid conditions (obesity, hypertensions, smoking, diabetes, history of ischemic heart diseases, and CVA/stroke), and angiographic characteristics (pre-procedure "left ventricular end-diastolic pressure (LVEDP mmHg)", "left ventricular ejection fraction (LVEF %)", "thrombolysis in myocardial infarction (TIMI)" flow grade, and number of vessels involved). Criteria for statistical significance was p-value ≤0.05.

RESULTS

We included 775 patients, out of which 81.3% (630) were males and mean age was 54.59 ± 11.3 years. On coronary angiogram 14.3% (111) were found to have left dominant circulation. The clinical profile and distribution of risk factors were not statistically significant between the left vs. right dominant cohort (Table 1). However, comparatively higher proportion of patients with left dominant system had single vessel

disease (53.2% (59/111) vs. 43.5% (289/664)). The frequency of morbidity was higher, but insignificant, in right dominant as compared to left dominant system with slow flow (15.4% vs. 7.2%; p=0.0.230) and heart failure (9.3% vs. 6.3%; p=0.299), respectively. Overall in-hospital mortality rate was observed to be 4.9% (38) with 5.1% (34/664) in right system vs. 3.6% (4/111) in left system (p=0.493), Table 1.

In the propensity matched cohorts, the frequency of slow flow/no-reflow was higher, but insignificant, in right dominant as compared to left dominant system with rate of 15.3% vs. 7.2%; p=0.056, respectively. The mortality rate was 5.4% (6) in right system vs. 3.6% (4) in left system (p=0.518), Table 2.

Table 1: Comparison of clinical characteristics and hospital course of patients with left vs. right dominant circulation undergoing primary percutaneous coronary intervention for culprit proximal left anterior descending artery

	Total	Dominance		P-value
		Left	Right	
Total (N)	**775**	**111**	**664**	
Gender				
Male	81.3% (630)	80.2% (89)	81.5% (541)	0.746
Female	18.7% (145)	19.8% (22)	18.5% (123)	
Age (year)	54.59 ± 11.3	55.19 ± 11.79	54.49 ± 11.22	0.545
18 to 40 years	13.3% (103)	13.5% (15)	13.3% (88)	0.967
41 to 65 years	71.2% (552)	70.3% (78)	71.4% (474)	
>65 years	15.5% (120)	16.2% (18)	15.4% (102)	
Total ischemic time (min)	350 [240 - 499]	373 [240 - 486]	348.5 [240 - 500]	0.598
Systolic blood pressure (mmHg)	135.25 ± 23.91	138.38 ± 25.99	134.73 ± 23.52	0.136
Heart rate (bpm)	88.04 ± 17.81	87.03 ± 17.4	88.21 ± 17.88	0.516
Random blood sugar (mg/dL)	195 [163 - 235]	206 [165 - 240]	192 [163 - 231.5]	0.117
Killip Class				
I	83.6% (648)	83.8% (93)	83.6% (555)	0.925
II	9.2% (71)	9.9% (11)	9% (60)	
III	4.5% (35)	4.5% (5)	4.5% (30)	
IV	2.7% (21)	1.8% (2)	2.9% (19)	
Co-morbid conditions				
Hypertension	51.7% (401)	55% (61)	51.2% (340)	0.464
Diabetes	34.1% (264)	35.1% (39)	33.9% (225)	0.797
Smoking	20.4% (158)	17.1% (19)	20.9% (139)	0.356
Ischemic heart diseases	9% (70)	10.8% (12)	8.7% (58)	0.480
Cerebrovascular accident/stroke	0.8% (6)	0.9% (1)	0.8% (5)	0.868
Height (cm)	164.95 ± 7.58	164.04 ± 8.92	165.11 ± 7.32	0.168
Weight (kg)	73.54 ± 9.91	72.08 ± 9.27	73.78 ± 10	0.094
Body mass index (BMI kg/m^2)	27.12 ± 4.04	26.92 ± 3.92	27.16 ± 4.07	0.567
Obesity	20.9% (162)	19.8% (22)	21.1% (140)	0.762
Pre-procedure LVEDP (mmHg)	24.16 ± 9.51	24.15 ± 9.33	24.16 ± 9.55	0.993
Pre-procedure ejection fraction (%)	36.9 ± 7.91	36.85 ± 7.83	36.91 ± 7.93	0.935
Number of involved vessels				
Single vessel disease	44.9% (348)	53.2% (59)	43.5% (289)	0.070
Two vessel disease	31% (240)	30.6% (34)	31% (206)	
Three vessel disease	24.1% (187)	16.2% (18)	25.5% (169)	
Pre-TIMI flow				
0	38.3% (297)	47.7% (53)	36.7% (244)	0.177
I	9% (70)	8.1% (9)	9.2% (61)	
II	27.5% (213)	22.5% (25)	28.3% (188)	
III	25.2% (195)	21.6% (24)	25.8% (171)	
Complications and outcomes				
Slow flow/no-reflow	14.2% (110)	7.2% (8)	15.4% (102)	0.230
Heart failure	8.9% (69)	6.3% (7)	9.3% (62)	0.299
Contrast induced nephropathy	1.9% (15)	3.6% (4)	1.7% (11)	0.168
Major bleeding	0.3% (2)	0% (0)	0.3% (2)	0.563
Cerebrovascular accident/stroke	0.1% (1)	0% (0)	0.2% (1)	0.682
Access site complications	0.4% (3)	0% (0)	0.5% (3)	0.478
In-hospital mortality	4.9% (38)	3.6% (4)	5.1% (34)	0.493

LVEDP=left ventricular end-diastolic pressure, TIMI=thrombolysis in myocardial infarction

Table 2: Comparison of clinical characteristics and hospital course of propensity matched cohort of patients with left vs. right dominant circulation undergoing primary percutaneous coronary intervention for culprit proximal left anterior descending artery

	Dominance		P-value
	Left	Right	
Total (N)	**111**	**111**	
Gender			
Male	80.2% (89)	84.7% (94)	0.378
Female	19.8% (22)	15.3% (17)	
Age (year)	55.19 ± 11.79	56.05 ± 11.42	0.583
18 to 40 years	13.5% (15)	9.9% (11)	0.602
41 to 65 years	70.3% (78)	70.3% (78)	
>65 years	16.2% (18)	19.8% (22)	
Total ischemic time (min)	373 [240 - 486]	333 [210 - 510]	0.370
Systolic blood pressure (mmHg)	138.38 ± 25.99	134.58 ± 20.38	0.227
Heart rate (bpm)	87.03 ± 17.4	85.6 ± 17.85	0.548
Random blood sugar (mg/dL)	206 [165 - 240]	200 [173 - 248]	0.684
Killip Class			
I	83.8% (93)	84.7% (94)	0.997
II	9.9% (11)	9% (10)	
III	4.5% (5)	4.5% (5)	
IV	1.8% (2)	1.8% (2)	
Co-morbid conditions			
Hypertension	55% (61)	55% (61)	>0.999
Diabetes	35.1% (39)	36% (40)	0.889
Smoking	17.1% (19)	17.1% (19)	>0.999
Ischemic heart diseases	10.8% (12)	14.4% (16)	0.419
Cerebrovascular accident/stroke	0.9% (1)	0% (0)	0.316
Height (cm)	164.04 ± 8.92	163.56 ± 8.13	0.677
Weight (kg)	72.08 ± 9.27	72.86 ± 11.09	0.568
Body mass index (BMI kg/m^2)	26.92 ± 3.92	27.37 ± 4.68	0.435
Obesity	19.8% (22)	20.7% (23)	0.867
Pre-procedure LVEDP (mmHg)	24.15 ± 9.33	24.23 ± 10.06	0.950
Pre-procedure ejection fraction (%)	36.85 ± 7.83	36.17 ± 8.06	0.527
Number of involved vessels			
Single vessel disease	53.2% (59)	54.1% (60)	0.982
Two vessel disease	30.6% (34)	30.6% (34)	
Three vessel disease	16.2% (18)	15.3% (17)	
Pre-TIMI flow			
0	47.7% (53)	41.4% (46)	0.763
I	8.1% (9)	7.2% (8)	
II	22.5% (25)	26.1% (29)	
III	21.6% (24)	25.2% (28)	
Complications and outcomes			
Slow flow/no-reflow	7.2% (8)	15.3% (17)	0.056
Pump failure	6.3% (7)	6.3% (7)	>0.999
Contrast induced nephropathy	3.6% (4)	0.9% (1)	0.175
Major bleeding	0% (0)	0.9% (1)	0.316
Cerebrovascular accident/stroke	0% (0)	0.9% (1)	0.316
Access site complications	0% (0)	0% (0)	-
In-hospital mortality	3.6% (4)	5.4% (6)	0.518

LVEDP=left ventricular end-diastolic pressure, TIMI=thrombolysis in myocardial infarction

DISCUSSION

The stenosis of LAD has gained special attention to interventional cardiologists due to its distinctive prognostic role. Although, the left dominant circulation system is considered a normal entity but its prognostic role has been hypothesized mainly due to unbalanced supply of blood to the cardiac muscle.[10,11] Therefore, we conducted this study to evaluate the role of left dominant circulation system in determining the fate of STE-ACS patients with culprit proximal LAD. It has been observed that, in this particular sub-groups of STE-ACS patients, the clinical manifestation, risk factor distribution, most of the angiographic findings, and hospital course were not different between the left and right dominant groups. Contrary to the general perception, the rate of complications and in-hospital mortality were found to be relatively higher, but insignificant, for the patients with right dominant system compared to the left dominant circulation system. A single point of difference between the two groups was the proportion of single vessel disease, it has been observed that the 53.2% of the patients with

left dominant system had single vessels disease as compared to 43.5% for the patients with right dominant system. This could be one of the possible reasons for the relatively lower event rate among patients with the left dominant system but the difference between the two groups remained evident even after the propensity matching for the said difference.

To the best of our knowledge, no data are available regarding the differences in presentation and outcomes between the left vs. right dominant circulation for the patients particularly with culprit proximal LAD. Contrary to our findings of no difference, a study conducted by Abu-Assi E et al.[9] reported higher risk of mortality (hazard ratio: 1.76 [95% confidence interval: 1.11-2.79]) and re-infarction (hazard ratio: 2.06 [95% confidence interval: 1.15-3.69]) over 40.8 months follow-up among STE-ACS patients with left dominance. However, this study does not confer the uniformity of treatment among the groups and differences in baseline characteristics including distribution of culprit segment were not adjusted in the assessment of effect of coronary dominance on outcomes.[9] Another small study of 149 patients by Hossain MA et al.[12] reported in-hospital adverse event rate of 23.1% vs. 5.7% for patients with left vs. right or co-dominance. This study also suffer same technical issues including small sample size and lack of adjustment for differences in key clinical factors. A study conducted by Mikaeilvand A et al.[13] has similar observations as ours with no differences in success rate of procedure or complications and in-hospital as well as 1-year mortality rates between left and right dominance. However, patients with left dominant system had higher proportion of indicators of adverse outcomes such as TIMI ≤ 2 and lower left ventricular ejection fraction.[13] Multiple other studies have reported significant role of left dominance in determining the short and long term fate of patients with STE-ACS. In a study by He C et al.[10], left dominance was reported to be an independent predictor of long-term mortality with 2-year mortality rate of 2.58% against 1.23% mortality in right or co-dominance (p=0.024). Parikh NI et al.[14] in a large registry based study confers the modestly increase in in-hospital mortality after PCI of ACS patients with left dominant system. The prognostic role of left dominant coronary artery anatomy is also confirmed by the few recent studies and meat-analysis.[7,15]

In our study we observed a higher proportion of single vessel involvement among patients with left dominance circulation. A similar observations were made by the Peng L et al.[16] with a higher frequency of triple-vessel involvement, 36.6% vs. 27.3%, among patients with right coronary dominance compared to the left coronary dominance.[16] It has been further reported to be an independent predictor of incidence of acute inferior wall myocardial infarction with adjusted odds ratio of 2.396 [95% confidence interval: 1.328-4.321].[17] Yan B et al.[18] confirms these observation with conclusion of severity of coronary artery diseases associated with right dominance with a mean Gensini score of 36.3±29.0 vs. 42.3±33.6; p=0.033 for patients with left vs. right dominance, respectively. However, no effect of coronary dominance on burden of coronary artery calcification has been reported.[8]

Single center experience with relatively small sample size and lack are of follow-up are the key limitations of this study.

CONCLUSION

In conclusion, we observed no significant increase in complications and outcomes among patients with left dominant arterial circulation undergoing primary PCI for culprit proximal LAD. Left dominant system was found to be associated with a higher prevalence of single vessel involvement. However, careful handling of left main during intervention is warranted due lack of support from right system.

AUTHORS' CONTRIBUTION

LR and RK: Concept and design, data acquisition, interpretation, drafting, final approval, and agree to be accountable for all aspects of the work. SAR, MKB, ZIM, HI, MFA, AB, MNS, KR, MS, FF, ZUR, TS, and JAS: Data acquisition, interpretation, drafting, final approval and agree to be accountable for all aspects of the work.

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