Value of three-dimensional echocardiography study of left ventricle function correlated to coronary arterial dominance in predicting the outcome of primary percutaneous coronary intervention

Noha Hassanin Hanboly [a,*], Yasser Mohamed Baghdady [a], Reda Huissen Diab [a], Sameeh Ramadan Lawend [b], Ahmed Abdelazim Kenawy [a]

[a] Cardiovascular Department , Cairo University, Cairo
[b] Cardiovascular Medicine King Saud University, Riyadh

[a] Egypt
[b] Saudi Arabia

Background: **Limited information is available regarding the relationship between coronary vessel dominance and outcome after ST-segment elevation myocardial infarction (STEMI).**

Objectives: **The study was designed to evaluate the prognostic value of coronary arterial dominance after primary percutaneous coronary intervention (PCI) during hospital stay and at 3 months follow-up regarding cardiac mortality, heart failure, nonfatal myocardial infarction, revascularization, and stroke.**

Patients and methods: **The study population consisted of 300 consecutive patients (mean age, 57.35 þ 13.41 years; 91% men) with STEMI who were admitted to Dallah Hospital (Riyadh, Saudi Arabia) from January 2015 to December 2016. These patients underwent successful primary PCI with thrombolysis in myocardial infarction (TIMI) III flow. They were divided into three groups according to angiographic coronary dominance: 227 (75.7%) in the right coronary dominant group, 40 (13.3%) in the left coronary dominant group, and 33 (11%) in the balanced coronary dominant group. They were evaluated with two- (2D) and three-dimensional (3D) echocardiography within 48 hours of admission and at 3 months follow-up after STEMI.**

Results: **Right dominance was present in 75.6%, left dominance in 13.3%, and balanced dominance was present in 11% of patients. The main finding of this study was that a left dominant system was associated with increased risk of cardiac mortality, heart failure, nonfatal myocardial infarction, revascularization, and stroke shortly after primary PCI, during hospital stay, and at 3 months follow-up after STEMI. Moreover, a significantly lower left ventricular ejection fraction at admission was observed by both 2D and 3D echocardiography in patients with a left dominant system.**

Conclusion: **In patients with STEMI treated with primary PCI, left coronary artery dominance confers a higher risk of various adverse clinical events after primary PCI, during hospital stay, and at 3 months follow-up compared to right and balanced coronary artery dominance.**

Disclosure: Authors have nothing to disclose with regard to commercial support.

Received 16 August 2017; revised 1 January 2018; accepted 3 January 2018.
Available online 11 January 2018

* Corresponding author at: Cairo University, Cairo, Egypt.
E-mail address: Noha.Ali@kasralainy.edu.eg (N.H. Hanboly).

P.O. Box 2925 Riyadh – 11461KSA
Tel: +966 1 2520088 ext 40151
Fax: +966 1 2520718
Email: sha@sha.org.sa
URL: www.sha.org.sa

Peer review under responsibility of King Saud University.
URL: www.ksu.edu.sa
https://doi.org/10.1016/j.jsha.2018.01.001

Production and hosting by Elsevier

Keywords: Coronary arterial dominance, Primary percutaneous coronary intervention, Three dimensional echocardiography

Introduction

The coronary artery that supplies the posterior descending artery (PDA) and posterolateral branches is defined as coronary vessel dominance that affects the relative clause of the different coronary arteries to the total left ventricular blood flow [1]. The right coronary artery (RCA) supplies the posterior portion of the interventricular septum and gives the PDA in a right-dominant circulation. By contrast, when the left circumflex (LCX) artery supplies this territory, it is called left-dominant circulation [1]. In a codominant circulation, the supply of the posterior interventricular septum is shared by the RCA and the LCX [2,3]. Right-dominant circulation is a well-balanced coronary circulation in which the left ventricle (LV) is supported by all coronary blood flow through three arteries; this is in contrast to patients with a left dominant system, where 60% of the LV myocardium is supplied by the PDA and the posterolateral branches originating from the LCX [4]. This less well-balanced coronary circulation might have an undue influence on the prognosis of patients with coronary artery disease (CAD). Up to now, the prognostic importance of coronary vessel dominance in patients presenting with first ST-segment elevation myocardial infarction (STEMI) remains uncertain [4]. There is limited knowledge about the clinical relevance of this anatomical variation, but the presence of a left dominant system was associated with an increased mortality in patients presenting with acute coronary syndrome (ACS) that was observed by Goldberg et al. [5] and the National Cardiovascular Database Cath Percutaneous Coronary Intervention (Cath-PCI registry) [6] as both showed higher in-hospital mortality after percutaneous coronary intervention (PCI) in patients with a left dominant system [6]. Short- and long-term outcomes of patients with STEMI who undergo primary PCI have been affected by left ventricular systolic dysfunction and remodeling [7]. Infarct size, heart rate, and severity of coronary artery disease were independent predictors of LV systolic dysfunction and remodeling after STEMI [8–10]. LV dysfunction is also affected by coronary arterial dominance, as Yip et al. [11] showed that a left dominant system was independently predictive of failed reperfusion in patients with LCX artery infarction. The effect of coronary arterial dominance on LV dysfunction and remodeling at follow-up is unclear [12].

Three-dimensional (3D) echocardiography is a novel imaging technique based on acquisition and display of volumetric data sets in the beating heart. This permits a comprehensive evaluation of LV anatomy and function from a single acquisition. Moreover, it allows assessment of the geometry and function of LV without pre-established assumptions regarding cardiac chamber shape and allows an echocardiographic assessment of the LV that is less operator-dependent and therefore more reproducible [13].

The aim of this study was to evaluate the prognostic value of coronary arterial dominance after primary PCI on cardiac mortality, heart failure, nonfatal myocardial infarction, revascularization, stroke, and readmission for ACS and LV systolic function studied using the novel 3D echocardiography.

Abbreviations

PDA	Posterior descending artery
RCA	Right coronary artery
LCX	Left circumflex artery
LV	Left ventricle
ACS	Acute coronary syndrome
STEMI	Segment elevation myocardial infarction
TIMI III flow	Thrombolysis In Myocardial Infarction III flow
PCI	Percutaneous coronary intervention
BCD	Balanced coronary dominant group
LCD	Left coronary dominant group
LVEF	Left ventricle ejection fraction
2D	Two Dimensional echocardiography
3D	Three Dimensional echocardiography
EDV	End diastolic volume
ESV	End systolic volume
LD	Left dominant anatomy
REBUS study	RElevance of Biomarkers for future risk of thromboembolic events in UnSelected post-myocardial infarction patients
WMSI	Wall motion score index
MAPSE	Mean annular plane systolic excursion
PREDICTION study	Prediction of Progression of Coronary Artery Disease and Clinical Outcomes Using Vascular Profiling of Endothelial Shear Stress and Arterial Wall Morphology

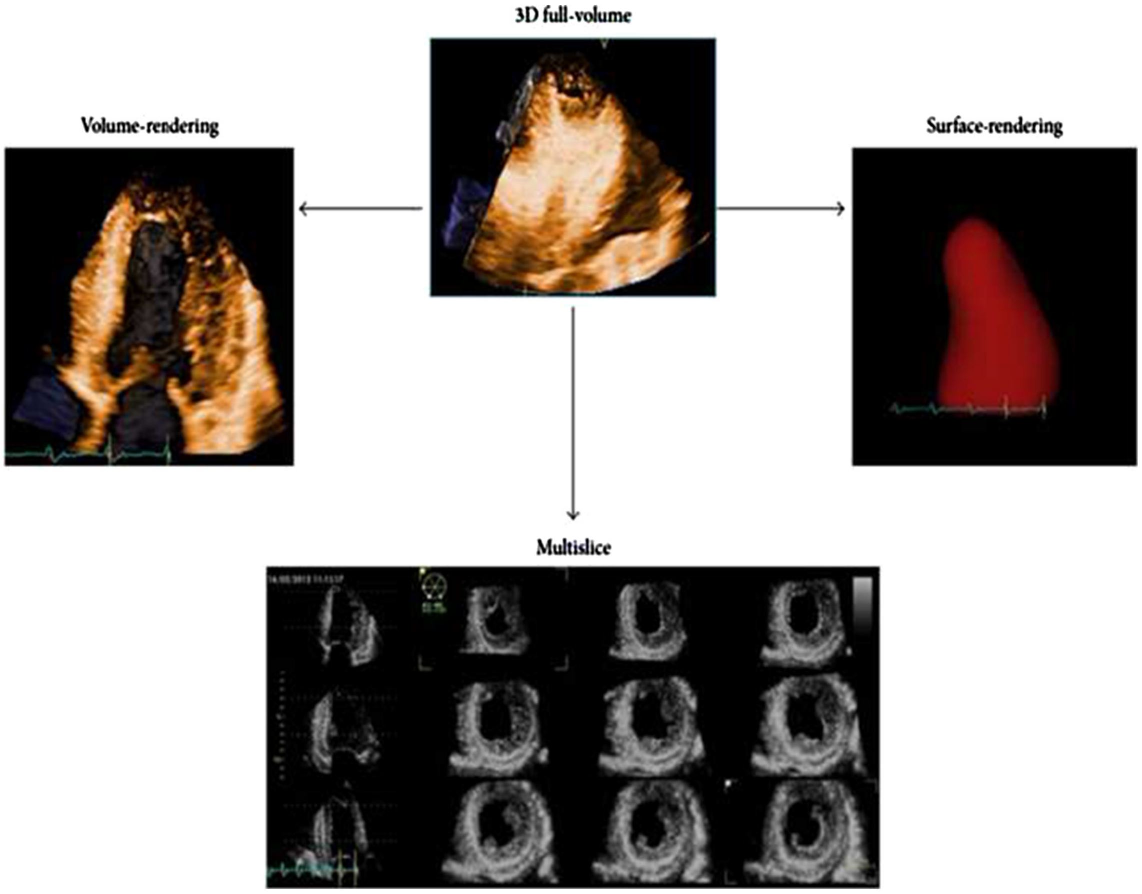

Fig. 1. Pyramidal three-dimensional (3D) data set.

Patients and methods

This prospective observational study was carried out from January 2015 to December 2016. It included 300 consecutive patients with STEMI who were admitted to Dallah Hospital (Riyadh, Saudi Arabia) and underwent successful primary PCI with thrombolysis in myocardial infarction (TIMI) III flow.

Written consent was obtained from all participants. The study protocol was approved by the local ethics committee. The patients were divided into three groups according to coronary dominance: right coronary dominant group (RCD; $n = 227$) patients, left coronary dominant group (LCD; $n = 40$) patients, and balanced coronary dominant group (BCD; $n = 33$) patients.

Demographic, clinical, echocardiographic, and angiographic details were collected from each patient. Patients with prior coronary artery bypasses graft, previous PCI, unsuccessful PCI, cardiogenic shock, STEMI with mechanical complication (ventricular septal defect, rupture myocardium and mitral regurgitation), left main disease >50%, previous myocardial infarction (STEMI and non-STEMI), and valvular heart disease were excluded.

Transthoracic echocardiography

Participants were placed in the left lateral position and connected to an electrocardiogram monitor. The apical four-chamber view was obtained using a 4V1c transducer (1–4 MHz). The frame rate was 51 ± 5 frames/s.

Left ventricle ejection fraction (LVEF) was measured by the two- dimensional (2D) biplane Simpson's method. LV wall motion score index (WMSI) was assessed according to the American Society of Echocardiography guidelines (American College of Cardiology/American Heart Association) [14].

Real-time full-volume three-dimensional transthoracic echocardiography (RT3D-TTE) was performed using the Acuson SC2000 (Siemens Ultrasound, Mountain View, CA, USA) imaging system with a 4Z1c real-time volume transducer (2.8 MHz).

Full LV volumes were acquired at every cardiac cycle for three to five consecutive cycles. Care was taken to include the entire LV within the imaging

Table 1. Demographics and clinical characteristics of the study groups.

Variable	Total	RCD group (n = 227) n (%)	LCD group (n = 40) n (%)	BCD group (n = 33) n (%)	p
Age (y)	57.3 ± 13.4	56.4 ± 11.5	57.5 ± 10.9	56.1 ± 8.9	0.8
Sex					
Male	273 (91%)	206 (90.7%)	37 (92.5%)	30 (90.9%)	0.9
Female	27 (9%)	21 (9.3%)	3 (7.5%)	3 (9.1%)	
Risk factors					
DM	145 (48.3%)	110 (48.5%)	19 (47.5%)	16 (48.5%)	0.994
Hypertension	141 (47.0%)	105 (46.3%)	19 (47.5%)	17 (51.5%)	0.85
Current smoker	95 (31.7%)	72 (31.7%)	13 (32.5%)	10 (30.3%)	0.979
Dyslipidemia	74 (24.7%)	56 (24.7%)	10 (25.0%)	8 (24.2%)	0.997
Clinical characteristics at admission					
Systolic BP (mmHg)	123.1 ± 19.1	127.1 ± 23.1	126.3 ± 15.9	124.8 ± 18.2	0.8
Heart rate (bpm)	81.2 ± 14.5	80.8 ± 16.3	83.9 ± 14.9	79.03 ± 12.5	0.38

Continuous data are expressed as mean ± standard deviation.
BCD = balanced coronary dominant group; BP = blood pressure; bpm = beat per minute; DM = diabetes mellitus; LCD = left coronary dominant group; RCD = right coronary dominant group.

volume using automatically generated simultaneous 2D reference planes.

Apical four-chamber view echocardiography was carried out avoiding foreshortening and ensuring that the entire LV is within the sector. Live three- dimensional (3D) mode was selected to view the entire LV in 3D. Full volume mode was then selected from the screen to calculate LVEF (Fig. 1).

Analysis of the RT3D-TTE images was performed offline using a fully automated knowledge-based endocardial detection algorithm. End diastolic volume was selected by the algorithm using the peak R-wave from the electrocardiography signal.

End systolic volume was selected as the systolic frame with the minimal volume. The LV cavity (including the papillary muscles) was then displayed for analysis. End diastolic volume, end systolic volume, and ejection fraction (EF) were displayed.

We used the cardiac cycle with the best endocardial detection for analysis. The LV can be visualized using different display modalities: volume rendering for visualizing morphology and spatial relationships among adjacent structures, surface rendering for quantitative purposes, and multislice (multiple 2D tomographic views extracted automatically from a single 3D data set) for morphological and functional analysis at different regional levels [13].

Coronary angiography and primary PCI

The images of the coronary angiography and PCI were obtained according to standardized angiographic projections. During the analysis, coronary vessel dominance, the culprit vessel, and severity of CAD were recorded.

The extent of CAD was expressed as the presence of one-, two-, or three-vessel disease (stenosis causing ≥70% luminal narrowing). Complete revascularization was defined as treating all present significant coronary artery stenosis (≥70%luminal narrowing) during primary PCI or during secondary revascularization prior to discharge. Angiographic success of PCI was defined as TIMI III flow with residual stenosis below 20% [15].

The study evaluated the prognostic value of coronary arterial dominance after primary PCI during hospital stay and at 3 months follow-up with regard to cardiac mortality, heart failure defined as New York Heart Association functional class ≥3, nonfatal myocardial infarction after PCI revascularization, stroke, and readmission for ACS.

Moreover, the relationship between coronary arterial dominance and systolic LV function shortly after STEMI and at 3 months follow-up was studied using both 2D and 3D echocardiography.

Statistical analysis

The continuous variables are presented as mean ± standard deviation or as median and interquartile ranges. Categorical variables are presented as numbers and percentages. Differences in baseline characteristics among the three coronary arterial dominance groups (right dominance, left dominance, and balanced) were evaluated with the chi-square and one-way analysis of variance tests. Statistical analyses were performed using SPSS software version 20.0 (SPSS Inc., Chicago, IL, USA). A p value <0.05 by a two-sided test was considered statistically significant.

Table 2. Different site of STEMI among the studied groups.

ECG change ($n = 300$)		RCD group ($n = 227$)	LCD group ($n = 40$)	BCD group ($n = 33$)	Chi-square	p
	n (%)	n (%)	n (%)	n (%)		
Extensive anterior (V1–V6)	53 (17.7%)	33 (14.53%)	11 (27.5%)	7 (21.21%)	4.5	0.1
Anterior (V3 and V4)	30 (10%)	29 (12.77%)	7 (17.5%)	4 (12.12%)	0.7	0.7
Anteroseptal (V1–V4)	20 (6.7%)	13 (5.7%)	3 (7.5%)	4 (12.12%)	1.9	0.38
Anterolateral (V3–V6)	27 (9%)	19 (8.37%)	6 (15%)	4 (12.12%)	1.97	0.37
Septal (V1 and V2)	7 (2.3%)	5 (2.2%)	1 (2.5%)	2 (6%)	1.65	0.4
Lateral (V5 and V6)	36 (12%)	28 (12.3%)	4 (10%)	4 (12.12%)	0.18	0.9
High lateral (I, aVL)	20 (6.7%)	15 (6.6%)	3 (7.5%)	3 (9.09%)	0.29	0.86
Inferior (II, III, aVF)	70 (23.3%)	58 (25.5%)	5 (12.5%)	6 (18.18%)	3.75	0.15
Posterior: tall R wave and ST depression in V1–V2	53 (17.66%)	46 (20.26%)	3 (7.5%)	4 (12.12%)	4.6	0.1

BCD = balanced coronary dominant group; LCD = left coronary dominant group; N = number; RCD = right coronary dominant group; STEMI = ST-segment elevation myocardial infarction.

Results

The mean age of patients was 57.3 ± 13.4 years, and there was a male preponderance (91% of the study population).

There were no statistically significant differences in terms of age, sex, or traditional CAD risk factors (diabetes mellitus, hypertension, smoking, dyslipidemia; Table 1). The site of STEMI was extensively anterior in the left coronary dominant group and inferior or posterior in the right coronary dominant group (Table 2).

With regard to laboratory data [lipid profile, serum creatinine, and hemoglobin A1c (HbA1c)% levels], there were no significant differences between all studied groups ($p = 0.6$, 0.24, and 0.12, respectively).

Left ventricular function by 2D and 3D echocardiography at admission and 3 months follow-up among the studied groups

The study showed a lowering of EF by both 2D and 3D echocardiography at admission in the left coronary dominant group compared to other coronary dominant groups ($p = 0.019$ for 2D echocardiography and $p = 0.024$ for 3D echocardiography).

LVEF assessed by 3D echocardiography within 48 hours of admission and at 3 months follow-up showed a significant lowering of EF at admission in the left coronary dominant group (40.08 ± 12.7 7) compared with the right coronary dominant group (45.88 ± 11.55) and the balanced coronary dominant group (44.94 ± 13.92; $p = 0.024$) (Figs. 2 and 3).

WMSI was increased in the left coronary dominant group (4.33 ± 2.55) compared to the right coronary dominant group (2.83 ± 2.10) and the balanced coronary dominant group (3.03 ± 2.35; $p = 0.001$). However, at 3 months follow-up, LVEF and WMSI showed no significant differences between all studied groups (Fig. 4).

Coronary angiography among the studied groups

The RCA was most often the culprit vessel lesion and the most vascularized vessel among patients with a right dominant system. Meanwhile, the left anterior descending (LAD) artery was most often the culprit vessel lesion and the most vascularized vessel in patients with a left dominant system (Fig. 5), whereas in patients with a balanced dominant system, the LCX artery was most often the culprit vessel and the most vascularized vessel (Fig. 6).

There was no significant difference between all studied groups regarding number of the diseased vessels, complete revascularization, thrombus aspiration direct stenting, total stent length, and maximal inflated pressure used during stenting (Table 3).

Myocardial infarction after PCI and revascularization

During hospital stay, out of 300 patients, 14 (4.66%) patients had myocardial infarction after PCI, 13 (4.33%) of them were revascularized and one patient had thrombolysis therapy.

Seven (3.08%) patients had myocardial infarction after PCI in the right coronary dominant group, six patients were revascularized, and one patient had thrombolysis therapy.

Moreover, five (12.5%) patients had myocardial infarction after PCI in the left coronary dominant group and all of them were revascularized. Patients in the left coronary dominant group had significantly higher rates of heart failure, in-hospital cardiac mortality, and stroke ($p = 0.01$, 0.008, and 0.007, respectively; Fig. 7).

During 3 months follow-up, patients in the left coronary dominant group had significantly higher rates of heart failure and cardiac mortality ($p = 0.01$ and 0.025, respectively; Fig. 8).

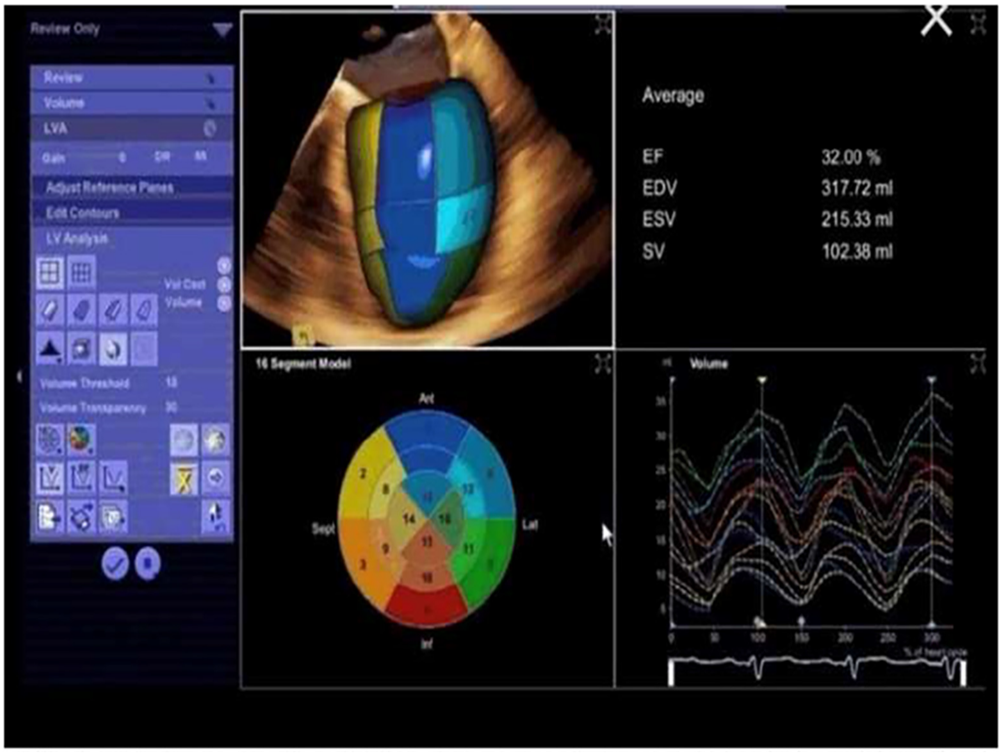

Fig. 2. Left ventricle ejection fraction (EF) % in a patient with left coronary dominant circulation. EDV = end diastolic volume; EF = ejection fraction; ESV = end systolic volume; SV = stroke volume.

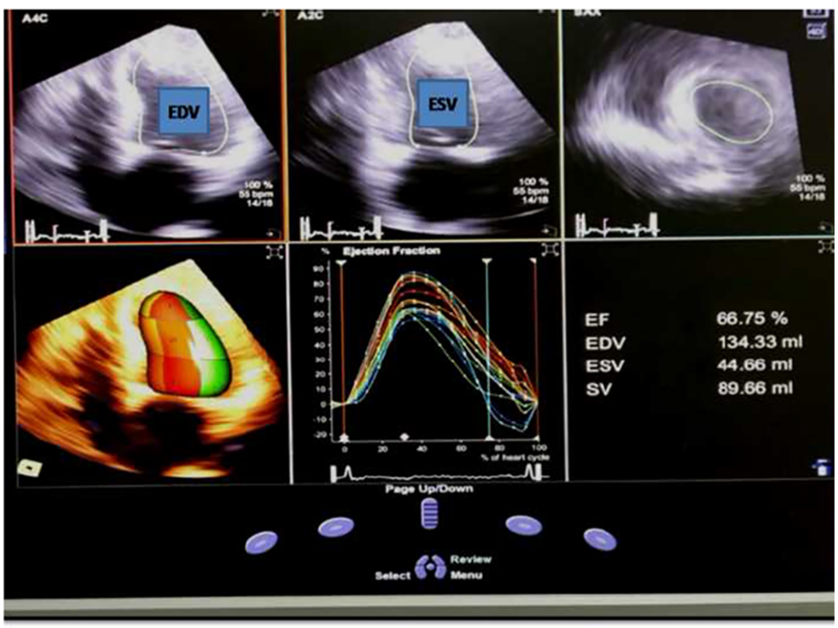

Fig. 3. Left ventricle ejection fraction (EF)% in a patient with right coronary dominant circulation. EDV = end diastolic volume; EF = ejection fraction; ESV = end systolic volume; SV = stroke volume.

Discussion

Variations in the balance of the coronary arteries are common, particularly with regard to the supply of the posterior aspect of the LV. In the majority of patients, the RCA reaches the crux of the heart and supplies the PDA.

Left-dominant anatomy, described as a variant of normal anatomy, has a prevalence of approximately 5–15% in the general population. In these

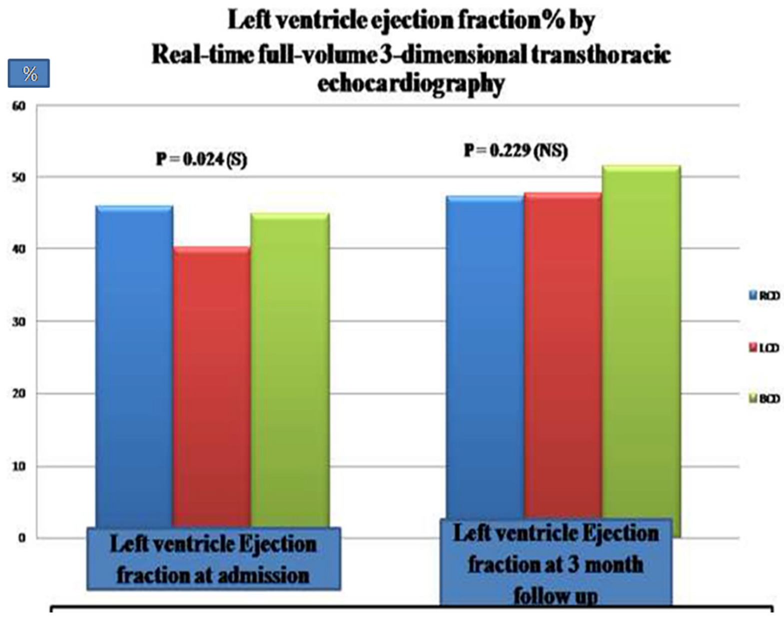

Fig. 4. Left ventricle ejection fraction (EF)% by three-dimensional echocardiography at admission and 3 months follow-up according to coronary arterial dominance. BCD = balanced coronary circulation; LCD = left coronary dominant; RCD = right coronary dominant; S = Statistically significant; NS = Not statistically significant.

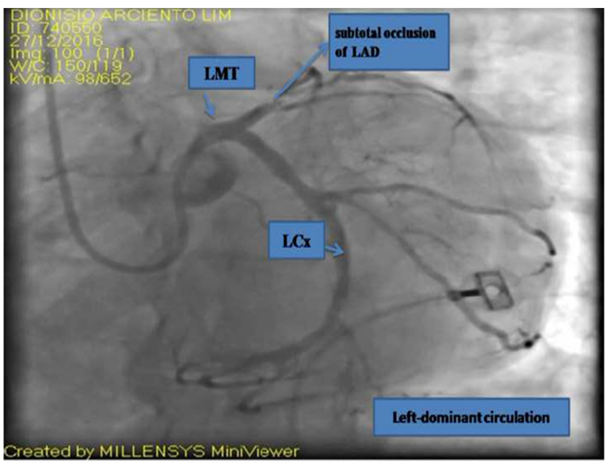

Fig. 5. Left coronary angiogram of a patient with left dominant circulation showing subtotal occlusion of LAD. LAD = left anterior descending artery; LCx = left circumflex; LMT = left main trunk.

individuals, the LCX artery reaches the crux and supplies the posterior descending and usually the atrioventricular nodal branches [16].

Dominant LCX has several acute angles in its course that results in turbulence and shear stress during blood flow leading to thrombus formation and platelet activity [17].

The PDA, arising from the RCA, may serve as a backup supply in normal anatomy, with the right dominant system acting in a protective manner. Left-dominant patients usually have only the left coronary artery to supply the majority of the myocardium. Thus, an event in a major vessel may lead to a worse outcome [18]. Another factor contributing to the poor outcome of patients with a left dominant system could be lack of collateral circulation in patients with a left dominant system [19]. However, data describing the effects of coronary dominance in modern PCI are scarce.

The study aimed to evaluate the prognostic value of coronary arterial dominance after primary PCI during hospital stay and at 3 months follow-up on LV systolic function studied by 2D and 3D echocardiography as well as on cardiac mortality.

The angiographic data were similar between coronary vessel dominance groups regarding the number of stents inserted into lesion site, either of which bare metal stents or drug eluting stents.

However, The RCA was most often the culprit vessel in patients with a right dominant system, whereas in patients with a left dominant system, the LAD artery was the culprit vessel and the LCX artery was most often the culprit vessel in a balanced system.

Importantly, the majority of patients presented with single vessel disease. Complete revascularization was achieved in 223 patients (74.3%), and thrombus aspiration was achieved in 110 patients (36.8%).

In our study, right dominance was present in 75.6% of study population, left dominance in 13.3%, and balanced dominance was present in

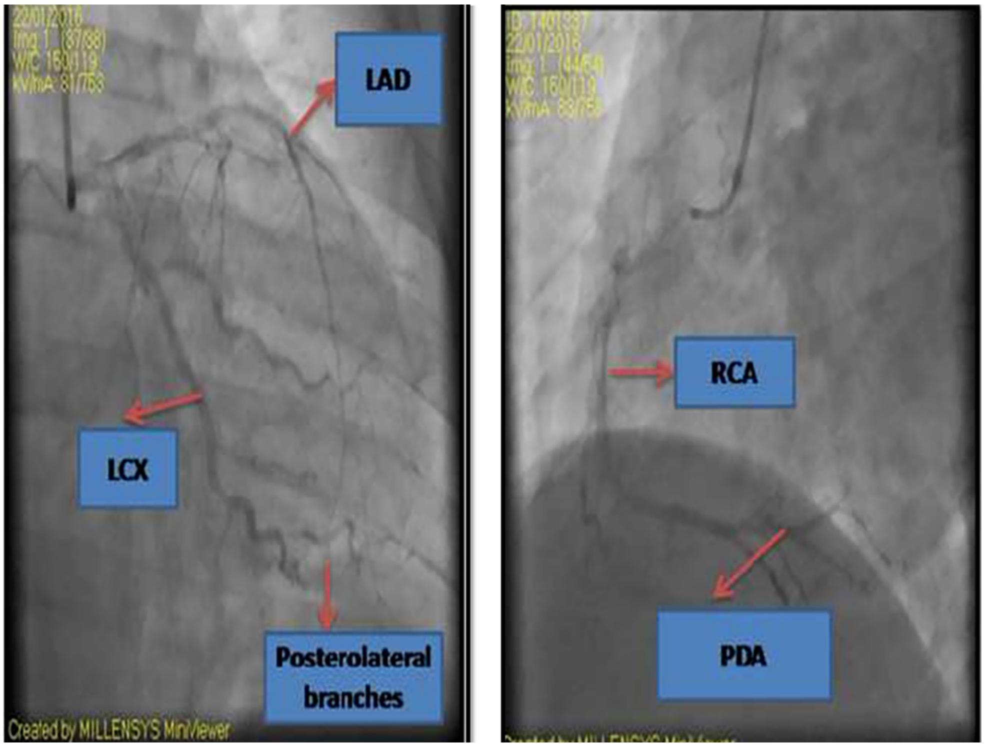

Fig. 6. Left and right coronary angiograms of a patient with codominant coronary circulation showing right coronary artery (RCA) lesion. LAD = left anterior descending artery; LCx = left circumflex; PDA = posterior descending artery.

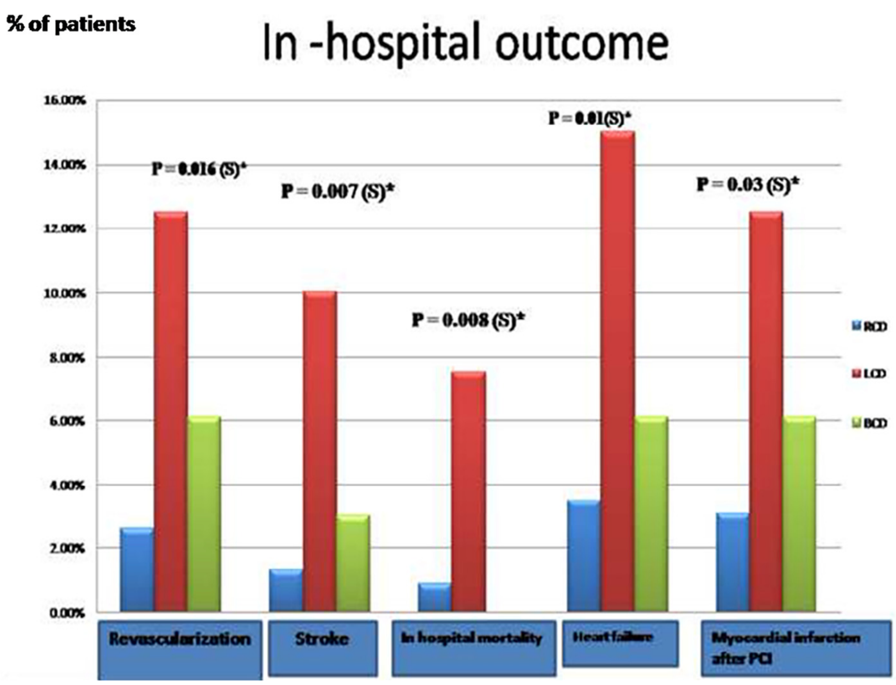

Fig. 7. In-hospital clinical outcome among the studied groups. BCD = balanced coronary circulation; LCD = left coronary dominant; PCI = percutaneous coronary intervention; RCD = right coronary dominant; S = statistically significant.

11%, which was not significantly different from values given in the previous literature, varying from 8.2% to 15% for left dominance and from 72% to 90% for right dominance [1]. Although

Table 3. Coronary angiography of the studied groups.

	Total (*n* = 300) *n* (%)	RCD group (*n* = 227) *n* (%)	LCD group (*n* = 40) *n* (%)	BCD group (*n* = 33) *n* (%)	*p*
Number of diseased vessels among the studied groups					
Single-vessel disease	152 (50.7%)	114 (50.2%)	21 (52.5%)	17 (51.5%)	0.96
Two-vessel disease	95 (31.7%)	72 (31.7%)	13 (32.5%)	10 (30.3%)	0.97
Three-vessel disease	53 (17.7%)	41 (18.1%)	6 (15.0%)	6 (18.2%)	0.9
Complete revascularization	223 (74.3%)	168 74.0%	30 75.0%	25 75.8%	0.97
Thrombus aspiration	110 (36.8%)	83 (36.6%)	15 (37.5%)	12 (37.5%)	0.99
Direct stenting	66 (22.1%)	50 (22.0%)	9 (22.5%)	7 (21.9%)	0.997
Total stent length (mm)	41.42 ± 24.05	40.11 ± 24.61	42.50 ± 23.08	41.66 ± 24.48	0.821
Stent diameter (mm)	2.94 ± 0.61	3.03 ± 0.51	2.93 ± 0.62	2.86 ± 0.72	0.18
Total stent number per patient	1.73 ± 0.87	1.60 ± 0.80	1.93 ± 0.94	1.66 ± 0.87	0.080
Drug eluting stent per patient	1.7 ± 0.88	1.55 ± 0.83	1.90 ± 0.96	1.66 ± 0.87	0.054
Maximal inflation pressure (mmHg)	20.48 ± 5.17	22.03 ± 7.41	19.92 ± 5.89	19.50 ± 5.21	0.053

BCD = balanced coronary dominant group; LCD = left coronary dominant group; RCD = right coronary dominant group.

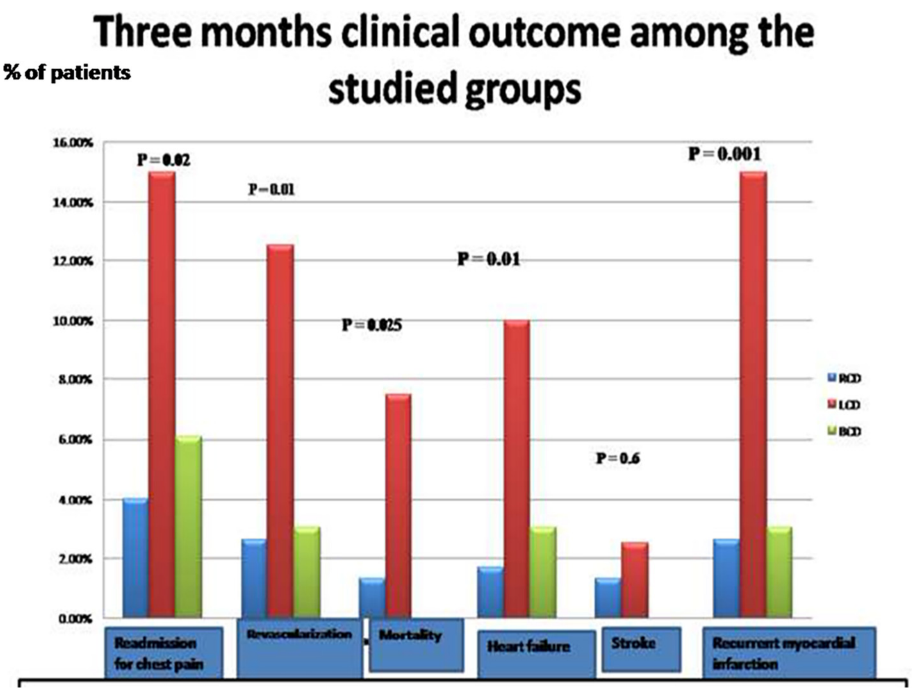

Fig. 8. Three months clinical outcome among the studied groups. BCD = balanced coronary circulation; LCD = left coronary dominant; RCD = right coronary dominant.

coronary artery anomalies were not among the exclusion criteria of the study and its prevalence in the form of absent left main coronary artery, myocardial bridge, coronary arteriovenous fistulae, or aneurysms varies from 0.2% to 8.4% [20], the current study did not record any coronary anomaly.

The main finding of this study is that a left dominant system is associated with increased risk of cardiac mortality, heart failure, non-fatal myocardial infarction, revascularization, stroke or transient ischemic attacks shortly after primary PCI during hospital stay and at 3 months follow-up after STEMI.

Moreover, slightly lower LVEF at discharge was observed in patients with a left dominant system, with contrast at 3 months follow-up after STEMI, as LVEF was comparable to a right dominant or balanced system.

Knaapen et al. [3], when screening 1620 *post-mortem* angiograms, showed that the prevalence of a left dominant system decreased with age, suggesting a higher death rate among patients with a left dominant coronary artery system, which is due to the larger amount of myocardium at risk in these patients.

Goldberg et al. [5] recruited 27,289 patients presenting with ACS. They concluded that the presence of a left dominant system was associated with an increased mortality over a mean follow-up of 3.5 years.

The Cath-PCI Registry studied the relation between left coronary dominance, codominance and right coronary dominance to in-hospital mortality in 207,926 PCIs for ACS and they confirmed that left- and co- dominance were associated with modestly increased in-hospital mortality [6].

Another study investigated 767 patients admitted between 2007 and 2012 with STEMI and treated with primary PCI. The study showed that left coronary artery dominance confers a higher risk of death and reinfarction than RCA dominance in STEMI treated with primary PCI, and coronary artery dominance should be included in prognostic stratification [15].

Another study found higher in-hospital mortality rates and cardiogenic shock in patients with acute occlusion of a proximal dominant LCX when compared to patients with a proximal LAD artery occlusion, which emphasized the importance of a dominant circumflex artery that may be responsible for 60% of the blood supply to the LV [21].

The REBUS (REIevance of Biomarkers for future risk of thromboembolic events in UnSelected post-myocardial infarction patients) study recruited 421 patients with myocardial infarction (MI). The study concluded that WMSI reflected the size of myocardial infarction better than global LV function parameters such as LVEF or mean annular plane systolic excursion [22]. However, the influence of coronary arterial dominance on LV function in patients with STEMI was unclear.

LVEF and WMSI were assessed in our study by 2D echocardiography within 48 hours of admission and at 3 months follow-up. We found a significant lowering of EF at admission in the left coronary dominant group (44.2 ± 12.8%) than in the right coronary dominant group (50.4 ± 12.3%) and the balanced coronary dominant group (49.8 ± 14.9%; $p = 0.019$).

Moreover, WMSI showed a higher level in the left coronary dominant group (4.3 ± 2.5) than in the right coronary dominant group (2.8 ± 2.1) and the balanced coronary dominant group (3.03 ± 2.3; $p = 0.001$). Later on, at 3 months follow-up, both LVEF and WMSI showed no significant differences between all studied groups.

To our knowledge, the current study was unique in using the novel 3D echocardiography for proper assessment of the LV EF and correlate it to coronary dominance groups. Using 3D echocardiography, we found a significant lowering of EF at admission in the left coronary dominant group (40.08 ± 12.7%) than in the right coronary dominant group (45.88 ± 11.55%) and the balanced coronary dominant group (44.94 ± 13.92%; $p = 0.024$).

The relation between coronary artery dominance and distribution of coronary blood flow volume was discussed by Sakamoto et al. [22]. The study evaluated volumetric coronary blood flow in 1322 vessels from 496 patients in the Prediction of Progression of Coronary Artery Disease and Clinical Outcomes Using Vascular Profiling of Endothelial Shear Stress and Arterial Wall Morphology (PREDICTION) study. Coronary blood flow volume was calculated by coronary segment volume measurement using angiography and intravascular ultrasound and the contrast transit time through the segment. The study showed that coronary blood flow in the LCX coronary artery was significantly higher in left-dominant or balanced circulation than in right-dominant circulation, whereas flow in the RCA was significantly lower in left-dominant or balanced circulation than in right-dominant circulation, and there was no significant difference in the LAD coronary artery. This explained how coronary artery dominance can affect coronary blood flow volume in the LCX and RC arteries, as the extent of myocardial perfusion area was associated with coronary blood flow volume.

That finding explained the results of our study, which concluded that patients in the left coronary dominant group had significantly higher rates of heart failure, in-hospital cardiac mortality, and stroke ($p = 0.01$, 0.008, and 0.007, respectively) during hospitalization. Moreover, using univariate analysis the current study showed that Killip class ≥II, extensive anterior myocardial infarction, peak troponin-T level, LVEF, WMSI, and left coronary dominance were predictors of in-hospital outcome.

Study limitations

Patients with previous myocardial infarction or revascularization were excluded; therefore, the present study population may represent a relatively low-risk population. Male preponderance, representing 91% of the study population, is considered another limitation.

Conclusions

This study demonstrated that patients with a left dominant system were associated with increased risk of cardiac mortality, heart failure, nonfatal myocardial infarction, and revascularization, shortly after primary PCI either during hospital stay or at 3 months follow-up after STEMI.

Moreover, a slightly lower LVEF at discharge was observed in patients with a left dominant system; however, its incidence matched those with right dominant and balanced systems at 3 months follow-up after STEMI, suggesting that left coronary vessel dominance remains a predictor of worse outcomes after correcting for abnormal LV systolic function.

It is noted that that a left dominant system is one of the risk factors for future adverse events after STEMI.

Intensive pharmacological treatment and a program of specific care should preferably be considered for patients with acute STEMI and left coronary dominance.

Acknowledgment

The authors are grateful to the nursing staff of Dallah Hospital for their cooperation.

References

[1] Bazzocchi G, Romagnoli A, Sperandio M, Simonetti G. Evaluation with 64-slice CT of the prevalence of coronary artery variants and congenital anomalies: a retrospective study of 3,236 patients. Radiol Med 2011;116:675–89.
[2] Oliveira C, Mota P, Basso S, Catarino R. Congenital coronary variants and anomalies: prevalence in cardiovascular multislice computed tomography studies in a single center. Open J Radiol 2014;4:163–72.
[3] Knaapen M, Koch A, Koch C, Koch K, Li X, Rooij P, et al. Prevalence of left and balanced coronary arterial dominance decreases with increasing age of patients at autopsy. A postmortem coronary angiograms study. Cardiovasc Pathol 2013;22:49–53.
[4] Akdemir R, Jim M, Letsas K, Nikus K, Srichai M. Acute inferior wall myocardial infarction due to occlusion of the wrapped left anterior descending coronary artery. Case Rep Cardiol 2013;2013:983943.
[5] Goldberg A, Southern D, Galbraith P, Traboulsi M, Knudtson M, Ghali W, et al. Coronary dominance and prognosis of patients with acute coronary syndrome. Am Heart J 2007;154:1116–22.
[6] Parikh N, Honeycutt E, Roe M, Neely M, Rosenthal E, Mittleman M, et al. Left and codominant coronary artery circulations are associated with higher in-hospital mortality among patients undergoing percutaneous coronary intervention for acute coronary syndromes: report from the National Cardiovascular Database Cath Percutaneous Coronary Intervention (CathPCI) Registry. Circ Cardiovasc Qual Outcomes 2012;5:775–82.
[7] Caroline E, Fleur R, Joanne D, Jacob M, Wouter J, Philipp A, et al. Prognostic value of coronary vessel dominance in relation to significant coronary artery disease determined with non-invasive computed tomography coronary angiography. Eur Heart J 2012;33:1367–77.
[8] Parodi G, Antoniucci D. Left ventricular remodeling after primary percutaneous coronary intervention. Am Heart J 2010;160:S11–5.
[9] Masci P, Ganame J, Francone M, Walter D, Valentina L, Ilaria I, et al. Relationship between location and size of myocardial infarction and their reciprocal influences on post-infarction left ventricular remodelling. Eur Heart J 2011;32:1640–8.
[10] Ezekowitz J, Armstrong P, Granger C, Theroux P, Stebbins A, Kim R, et al. Predicting chronic left ventricular dysfunction 90 days after ST-segment elevation myocardial infarction: an Assessment of Pexelizumab in Acute Myocardial Infarction (APEX-AMI) sub-study. Am Heart J 2010;160:272–8.
[11] Yip H, Wu C, Fu M, Yeh K, Yu T, Hung WC, et al. Clinical features and outcome of patients with direct percutaneous coronary intervention for acute myocardial infarction resulting from left circumflex artery occlusion. Chest 2002;122:2068–74.
[12] Gebhard C, Fuchs TA, Stehli J, Gransar H, Berman DS, Budoff MJ, et al. Coronary dominance and prognosis in patients undergoing coronary computed tomographic angiography: results from the CONFIRM (Coronary CT Angiography Evaluation For Clinical Outcomes: an International Multicenter) Registry. Eur Heart J Cardiovasc Imaging 2015;16:853–62.
[13] Agati L, Bruschke A, Egstrup K. The clinical benefits of adding a third dimension to assess the left ventricle with echocardiography. Scientifica (Cairo) 2014:897431.
[14] Lang RM, Badano LP, Mor-Avi V, Afilalo J, Armstrong A, Ernande L, et al. Recommendations for cardiac chamber quantification by echocardiography in adults: an update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging. J Am Soc Echocardiogr 2015;28:1–39.
[15] Abu-Assi E, Castineira-Busto M, Gonzalez-Salvado V, Raposeiras-Robin S, Abumuaileq R, Pena-Gil C, et al. Coronary artery dominance and long-term prognosis in patients with ST-segment elevation myocardial infarction treated with primary angioplasty. Rev Esp Cardiol 2016;69:19–27.
[16] Veltman C, De Graaf F, Schuijf J, Van W, Jukema J, Kaufmann P, et al. Prognostic value of coronary vessel dominance in relation to significant coronary artery disease determined with non-invasive computed tomography coronary angiography. Eur Heart J 2012;33:1367–77.
[17] Yu S, Latour J, Marchandise B, Bois M. Shear stress-induced changes in platelet reactivity. Thromb Haemost 1979;40:551–60.
[18] Kuno T, Numasawa Y, Miyata H, Takahashi T, Sueyoshi K, Ohki T, et al. Impact of coronary dominance on in-hospital outcomes after percutaneous coronary intervention in patients with acute coronary syndrome. PLoS ONE 2013;8:e72672.
[19] Veltman CE, van der Hoeven BL, Hoogslag GE, Boden H, Kharbanda RK, de Graaf MA, et al. Influence of coronary vessel dominance on short- and long-term outcome in patients after ST segment elevation myocardial infarction. Eur Heart J 2015;36:1023–30.
[20] Altin C, Kanyilmaz S, Koc S, Gursoy Y, Bal U, Aydinalp A, et al. Coronary anatomy, anatomic variations and anomalies: a retrospective coronary angiography study. Singapore Med J 2015;56:339–45.
[21] Ilia R, Cafri C, Weinstein J, Gueron M. Acute myocardial infarction due to occlusion of the dominant left circumflex artery proximally. Am J Cardiol 2003;92:54–5.
[22] Sakamoto S, Takahashi S, Coskun A, Papafaklis M, Takahashi A, Saito S, et al. Relation of distribution of coronary blood flow volume to coronary artery dominance. Am J Cardiol 2013;11:1420–4.