Impact of right coronary dominance on triple-vessel coronary artery disease

A cross-sectional study

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Abstract
This study was conducted to investigate the relationship between right coronary dominance and coronary angiographic characteristics in patients with or without significant coronary artery disease (CAD).

A total of 2225 patients undergoing coronary angiography (CAG) between January 2011 and November 2014 were recruited in our study. Based on the CAG results, patients were divided into the left dominance (LD) group, right dominance (RD) group, and co-dominance (CD) group. Multinomial logistic regression was applied to analyze the relationships between coronary dominance and triple-vessel CAD.

We found that patients with RD had a higher prevalence of triple-vessel CAD (36.6\% vs 27.3\%, \( P = .008 \)) and significant stenosis in the right coronary artery (40.5\% vs 29.2\%, \( P = .001 \)). In addition, results of multinomial logistic regression analysis showed that RD was significantly associated with the triple-vessel disease (odds ratio 1.768, 95\% confidence interval 1.057–2.956, \( P = .030 \)).

In conclusion, RD positively correlated with triple-vessel CAD rather than LD or CD in patients. This result suggested that RD may serve as a risk factor for triple-vessel CAD and more effective measures should be taken in RD patients to prevent fatal cardiovascular events.

Abbreviations: 95\% CI = 95\% confidence interval, CAD = coronary artery disease, CAG = coronary angiography, CD = co-dominance, DBP = diastolic blood pressure, DVD = double-vessel disease, IVS = inter ventricular septum, LD = left dominance, OR = odds ratio, RCA = right coronary artery, RD = right dominance, SBP = systolic blood pressure, sCAD = Significant CAD, SVD = single-vessel disease, TVD = triple-vessel disease.

Keywords: coronary angiography, fatal cardiovascular events, right coronary dominance

1. Introduction
The phenotype of coronary artery dominance includes left dominance (LD), right dominance (RD), and co-dominance (CD) based on the vascular supply of the posterior interventricular septum (IVS\textsuperscript{1,2}). In the general population, LD and RD have reported prevalence of approximately 5\% to 12\% and 82\% to 89\% respectively, whereas CD is found in 3\% to 7\% of individuals\textsuperscript{3-5}. Several studies have shown that LD is associated with increased long-term mortality in patients with significant coronary artery disease (CAD) and acute coronary syndrome\textsuperscript{6,7}. A literature review indicated evidence demonstrating that LD has been found to be an independent predictor for the prognosis of patients with coronary emergencies\textsuperscript{8,9}.

Significant CAD (sCAD) is defined as \( \geq 50\% \) luminal narrowing in at least one of the epicardial coronary arteries. Triple-vessel disease (TVD) is a severe type of sCAD since it involves significant stenosis in any 3 of the major epicardial coronary arteries (i.e., the right coronary artery, left anterior descending artery, and left circumflex artery\textsuperscript{10}). Additionally, TVD is associated with higher rates of major adverse cardiac events and mortality than single-vessel disease (SVD) and double-vessel disease (DVD)\textsuperscript{10,11}. Currently, little is known about the relationship between coronary artery dominance and multivessel disease. Therefore, we conducted this study to investigate whether patients with right coronary dominance have a higher prevalence of TVD.

2. Methods
2.1. Study population
Between January 2011 and November 2014, 2225 in-hospital patients were recruited from the Second Affiliated Hospital, Xi’an Jiaotong University. Patients who underwent coronary angiography (CAG) during their hospital stay were included in our...
study. Exclusion criteria were patients who had undergone previous coronary artery bypass graft operation, those with a history of chronic and systemic disease, those with incomplete CAG reports and medical records, and pregnant women. All patients were referred because they had standard clinical indications for CAG. All patients signed the informed consent, and their records were anonymized and de-identified before analysis. The study protocol was approved by the Ethics Committee of the Second Affiliated Hospital, Xi’an Jiaotong University, and was conducted in accordance with the Declaration of Helsinki.

Dyslipidemia was defined as patients with a total cholesterol level ≥200 mg/dL, triglyceride level ≥150 mg/dL, low-density lipoprotein level ≥130 mg/dL, or high-density lipoprotein level ≤40 mg/dL. A current smoker was defined as a person who had ever smoked 100 cigarettes and was currently smoking every day or some days. Diabetes mellitus was diagnosed as patients with a fasting plasma glucose level ≥7.0 mmol/L (126 mg/dL) or 2-hour post-load plasma glucose level ≥11.0 mmol/L (200 mg/dL). Hypertension was defined as patients with a systolic blood pressure (SBP) ≥140 mm Hg and/or diastolic blood pressure (DBP) ≥90 mm Hg in office, daytime SBP ≥135 mm Hg and/or DBP ≥85 mm Hg, or night-time SBP ≥120 mm Hg and/or DBP ≥70 mm Hg in ambulatory blood pressure monitoring.

2.2. CAG results

All patients underwent CAG using the Judkins method, following puncture of the femoral artery or through the radial artery approach. The CAG report was written and double-checked by 2 independent interventional cardiologists. Based on the CAG results, patients were divided into the LD group (the posterior descending artery was being supplied by the left circumflex artery), RD group (the posterior descending artery was being supplied by the right coronary artery), and CD group (the posterior descending artery was being supplied by both the left circumflex artery and right coronary artery). Patients with LD or CD anomalies were placed into the left-CD group, because these patients had similar distribution of coronary stenosis. Those with RD anatomy were included in the RD group. Significant stenosis was defined as lesions with a diameter stenosis ≥50%, SVD, DVD, and TVD had one, 2, and 3 vessels with significant stenosis, respectively. The control group included patients without significant stenosis.

The severity of CAD was evaluated with the Gensini score. In this scoring system, 1 represents 1% to 25% stenosis, 2 represents 26% to 30% stenosis, 4 represents 51% to 75% stenosis, 16 represents 76% to 99% stenosis, and 32 represents complete occlusion. Then the score is multiplied by different factors according to the functional significance of the coronary artery.

2.3. Statistical analysis

Results are presented as a mean ± standard deviation for continuous variables and numbers (percentage) for binary variables. Analysis of variance and the chi-square test were used to compare variables between the subgroups of coronary artery dominance. Variables with statistical significance in univariate models were then included in multivariate analyses. Multinomial logistic regression analysis was used to test the association between coronary vessel disease and variables (i.e., age, sex,
smoking status, diabetes mellitus, hypertension, hyperlipidemia, family history of CAD, and coronary dominance. A P-value <.05 was considered statistically significant. All statistical analyses were conducted using SPSS, version 18.0 (SPSS Inc., Chicago, IL).

3. Results

3.1. Baseline characteristics

This study recruited 2225 patients (2016 with RD, 150 with LD, and 59 with CD). Baseline characteristics of the patient population, categorised by coronary artery dominance, were shown in Table 1. The mean age of all patients (1545 men, 680 women) was 58.5 ± 10.3 years. There was no significant difference in demographical characteristics, CAD risk factors, and medical history among the 3 groups.

3.2. CAG results of patients

Patients were divided into the RD, LD, and CD groups, based on CAG results. Patients in the RD group tended to have a higher Gensini score of the right coronary artery than patients in the LD and CD groups (P = .004). Two hundred forty-six (11.0%) patients had no significant stenosis, 711 (32.0%) had single-vessel disease, 474 (21.3%) had 2-vessel disease, and 794 (35.7%) were diagnosed as having triple-vessel disease. In addition, patients with RD had a higher proportion of triple-vessel disease (36.6% vs 27.3%, P = .008) and significant stenosis in the right coronary artery (RCA) (40.5% vs 29.2%, P = .001) than left-CD group (Fig. 1A and B).

3.3. Association between triple-vessel disease and right dominance

Results of multinomial logistic regression analysis of risk factors associated with coronary vessel stenosis were shown in Table 2. Age (odds ratio [OR] 1.028, 95% confidence interval [CI] 1.012–1.044, P < .001) and sex (OR 1.446, 95% CI 1.006–2.137, P = .046) were significantly different between the single-vessel disease group and control group. Age, sex, smoking status, diabetes mellitus, and hypertension were all correlated with double-vessel disease and triple-vessel disease. In addition to other risk factors above, RD was also shown to be independently associated with triple-vessel disease when comparing with the control group (OR 1.768, 95% CI 1.057–2.956, P = .030).

4. Discussion

Coronary artery dominance is classified as LD, RD or CD depending on the origin of the posterior descending artery. In patients with LD, most left ventricular myocardial are supplied by the poster lateral branches and posterior descending artery originating from the left circumflex artery. In contrast, the IVS is supplied by the posterior descending branch of the RCA in individuals with RD. Additionally, the IVS is shared by the RCA and left circumflex artery in CD.

CAG is also used to detect coronary artery stenosis, and it shows the coronary dominance at the same time. Scoring system was usually used to evaluated the severity of coronary artery stenosis in clinical practice. SYNTAX score is a tool to select revascularization strategies while Gensini score is a...
quick way to qualified the coronary stenosis.\textsuperscript{[29,30]} In this study, we used Gensini score to investigate the association between coronary dominance and CAD and found that RD group prone to have high Gensini score than those with LD and CD. Many previous studies have shown that an LD system is predictive for the prognosis of patients with coronary emergencies. A study of 1131 patients showed that LD was associated with a significantly increased risk of 30-day mortality and early re-infarction after ST-elevated myocardial infarction.\textsuperscript{[31]} Goldberg et al\textsuperscript{[6]} demonstrated that LD was a risk factor for increased long-term mortality in patients with acute coronary syndrome. However, the relationship between RD and clinical manifestations in patients with CAD is unknown.

Currently, the overwhelming majority of research has focused on the role of the LD coronary system in the prognosis of CAD. A previous study with a large population described a different prevalence of TVD between RD and LD.\textsuperscript{[22]} However, they did not perform further analysis to verify the association of RD with TVD. In our study, patients with RD tended to have a high prevalence of TVD and significant stenosis in the RCA. Results of multinomial logistic regression showed that RD maybe a predictor for TVD. All these findings suggest that RD dominance may play a detrimental role in the severity of CAD. Moreover, we also investigate the role of RD in the TVD stratified by gender and the subgroup analysis showed that no significant interactions were not found in this analysis. Therefore, the assessment of coronary vessel dominance with CAG would facilitate risk stratification in clinics.

The current study has several limitations. First, our study was retrospective, so it is difficult to conclude whether a relationship between RD and TVD exists. Second, the left CD group was relatively small, which was ascribed to the small population of patients with LD and CD. Thus, a larger population may have stronger statistical power. Finally, the patients were recruited exclusively from a single centre in the northwest region of China. Therefore, a study with a multicentral and long period of observation should be undertaken to verify our findings.

In conclusion, right coronary dominance was associated with a higher prevalence of TVD than LD and CD. RD may serve as an independent risk factor for triple-vessel CAD.

Author contributions

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