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Association of coronary dominance with the severity of coronary artery disease: a cross-sectional study in Shaanxi Province, China

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ABSTRACT

Objective To investigate whether coronary artery dominance is associated with the severity of coronary artery disease (CAD).

Design Cross-sectional study.

Setting Single-centre.

Participants Between July 2015 and February 2017, 1654 patients who underwent coronary angiography (CAG) were recruited into this cross-sectional study.

Measurement and methods According to coronary dominance, patients were classified into left dominance (LD), right dominance (RD) and codominance (CD) based on the CAG results. Multiple linear regression analysis was performed to test the association between severity of CAD and coronary dominance.

Results The total Gensini score was significantly higher in the RD group than in the left-CD group (42.3±33.6 vs 36.3±29.8; p=0.033). After adjusting for potential confounding factors, the results of multivariate linear regression showed that RD was associated with the severity of CAD (β=6.699, 95% CI 1.193 to 12.205, p=0.017).

Conclusions The results suggest that right coronary dominance was associated with the severity of CAD.

INTRODUCTION

Coronary artery disease (CAD) is one of the most common types of diseases around the world.[1] It is recognised that obesity, blood pressure, smoking, diabetes, exercise, diet, cholesterol and depression were associated with the incidence of CAD.[2] In clinical practice, the severity of coronary artery stenosis is usually evaluated by the Gensini score or the SYNergy between percutaneous coronary intervention with TAXus and cardiac surgery (SYNTAX) score.[3] Several studies have shown that coronary artery dominance is associated with cardiovascular prognosis in patients with acute coronary syndrome.[4–7] Variation of coronary dominance includes left dominance (LD), right dominance (RD) and codominance (CD) based on the

vascular supply of the posterior interventricular septum (IVS).[8 9] In the general population, RD is the most prevalent, found in approximately 70% of the population, while LD occurs in about 10% of cases and CD is present in 20% of cases.[10] LD was found to be associated with increased long-term mortality in patients with CAD.[11 12] However, little is known about the role of RD in CAD. Previous studies showed that RD, LD and CD have a prevalence of approximately 82%–89%, 5%–12% and 3%–7%, respectively, in a hospital population.[4 13–15] There seems to have different distributions of coronary dominance between the general population and patients with CAD. Therefore, we conducted this study to investigate whether right coronary dominance was associated with CAD and its severity.

METHODS

Study population

Between July 2015 and February 2017, 1654 in-hospital patients who underwent coronary angiography (CAG) during their hospital stay were recruited from the CAG database of the First Affiliated Hospital of Xi'an Jiaotong University. All patients included in this study had standard clinical indications for CAG.

Table 1 Baseline characteristics of patients

Clinical variables	Total (n=1654)	First (n=347)	Second (n=329)	Third (n=486)	Fourth (n=492)
Age (years)	59.4±10.4	58.5±9.9	59.1±10.6	59.3±10.6	60.2±10.4
Gender, n (%)					
Male	1235 (74.7)	225 (64.8)	239 (72.6)	368 (75.7)	403 (81.9)
Female	419 (25.3)	122 (35.2)	90 (27.4)	118 (24.3)	89 (18.1)
Baseline SBP (mm Hg)	134.6±21.0	135.8±19.9	135.8±20.4	134.4±20.6	133.1±22.6
Baseline DBP (mm Hg)	78.3±12.3	79.1±12.9	78.5±12.0	77.7±11.3	78.3±12.8
Heart rate (bpm)	75.5±13.2	74.3±12.1	75.3±14.0	75.4±12.6	76.6±14.1
CAD risk factors, n (%)					
Diabetes mellitus	321 (19.4)	33 (9.5)	65 (19.8)	102 (21.0)	121 (24.6)
Hypertension	870 (52.6)	174 (50.1)	175 (53.2)	263 (54.1)	258 (52.4)
Current smoking	841 (50.8)	156 (45.0)	170 (51.7)	262 (53.9)	253 (51.4)
Hyperlipidaemia	182 (11.0)	42 (12.1)	37 (11.2)	51 (10.5)	52 (10.6)
Diagnosis, n (%)					
AMI	730 (44.1)	44 (12.7)	97 (29.5)	251 (51.6)	338 (68.7)
Unstable angina	311 (18.8)	67 (19.3)	83 (25.2)	81 (16.7)	80 (16.3)
CAD on CAG, n (%)					
One-vessel disease (≥50%)	465 (28.1)	239 (68.9)	124 (37.7)	76 (15.6)	26 (5.3)
Multivessel disease (≥50%)	1189 (71.9)	108 (31.1)	205 (62.3)	410 (84.4)	466 (94.7)
History, n (%)					
Prior MI	134 (8.1)	9 (2.6)	16 (4.9)	49 (10.1)	60 (12.2)
Family history of CAD	475 (28.7)	107 (30.8)	98 (29.8)	126 (25.9)	144 (29.3)
Coronary dominance, n (%)					
Right dominance	1500 (90.6)	304 (87.6)	297 (90.3)	445 (91.5)	454 (92.3)
Left dominance	110 (6.7)	30 (8.7)	22 (6.7)	30 (6.2)	28 (5.7)
Codominance	44 (2.7)	13 (3.7)	10 (3.0)	11 (2.3)	10 (2.0)

Four groups were based on the Gensini score: first grade (0–12.5), second grade (13–24.5), third grade (25–52.5) and fourth grade (≥53). Results are presented as mean±SD or n (%).
AMI, acute myocardial infarction; bpm, beats per minute; CAD, coronary artery disease; CAG, coronary artery angiography; DBP, diastolic blood pressure; MI, myocardial infarction; SBP, systolic blood pressure.

The exclusion criteria were (1) previous coronary artery bypass graft operation or CAG, (2) those with chronic and systemic disease, and (3) incomplete CAG reports and medical records. All patients' records were anonymised and de-identified before analysis.

Patient and public involvement

Patients were not involved in the hypothesis, design, conduct and data analysis, and we will not disseminate the results of this study to participants.

Definitions

Hypertension was defined as an office blood pressure over 140/90 mm Hg or a 24-hour ambulatory blood pressure over 135/85 mm Hg.[16] Diabetes mellitus was diagnosed in patients with a fasting plasma glucose level ≥7.0 mmol/L (126 mg/dL) or 2-hour postload plasma glucose level ≥11.0 mmol/L (200 mg/dL).[17] Smoking was defined as ever-smoked 100 cigarettes or currently smoking every day or some days.[18]

CAG results

All patients underwent CAG using a standard clinical technique through the femoral artery or radial artery approach.[19] The CAG report was written and checked by interventional cardiologists. The phenotype of coronary dominance was divided based on the CAG. The posterior descending artery was originated the right coronary artery (RCA) in patients with RD. The posterior descending artery that diverged from the left circumflex (LCx) artery was defined as LD. Codominant anatomy was defined when the posterior descending artery (PDA) originated from the RCA and a large posterolateral branch that originated from the LCx branch reached near the posterior interventricular groove.[10 13] The severity of CAD was evaluated using the Gensini score. In this scoring system, 0 indicates no abnormality, 1 represents stenosis of ≤25%, 2 represents stenosis of 26%–50%, 4 represents stenosis of 51%–75%, 16 represents stenosis of 76%–99%, and 32 represents complete occlusion. The

Table 2 Gensini score and coronary dominance

	RD (n=1500)	Left+CD (n=154)	P values
Age (years)	59.4±10.4	59.2±9.5	0.769
Gender, n (%)			0.242
Male	1114 (74.3)	121 (78.6)	
Female	386 (25.7)	33 (21.4)	
Baseline SBP (mm Hg)	134.8±21.2	132.6±19.5	0.231
Baseline DBP (mm Hg)	78.4±12.4	78.1±11.0	0.819
Heart rate (bpm)	75.4±13.1	76.5±14.8	0.341
CAD risk factors, n (%)			
Diabetes mellitus	295 (19.7)	26 (16.9)	0.406
Hypertension	797 (53.1)	73 (47.4)	0.175
Current smoking	758 (50.5)	83 (53.9)	0.427
Hyperlipidaemia	164 (10.9)	18 (11.7)	0.776
Total Gensini score	42.3±33.6	36.3±29.8	0.033
LM	1.7±7.3	1.7±7.7	0.935
LAD	21.1±21.1	19.7±20.0	0.433
RCA	7.8±10.8	4.7±8.5	<0.001
LCx	9.1±14.5	8.2±12.4	0.424
Diagonal branch	1.3±2.7	1.1±2.4	0.402
Septal branch	0.1±0.5	0.1±0.8	0.491
OM	0.7±2.2	0.6±2.0	0.848
Posterior descending artery	0.6±2.1	0.2±1.5	0.013

bpm, beats per minute; CAD, coronary artery disease; CD, codominance; DBP, diastolic blood pressure; LAD, left anterior descending branch; LCx, left circumflex branch; LM, left main coronary artery; OM, obtuse marginal branch; RCA, right coronary artery; RD, right dominance; SBP, systolic blood pressure.

score is then multiplied by different factors according to the functional significance of the coronary artery. The evaluation of each segment was performed by multiplying the scores by 5 for the left main trunk, by 2.5 for the proximal left anterior descending (LAD) branch, by 1.5 for the middle LAD, by 1 for the distal LAD, by 1 for the first diagonal branch, by 0.5 for the second diagonal branch, by 2.5 for the proximal LCx, by 1 for the distal LCx and posterior descending branch, and by 0.5 for the posterior branch, while the RCA was performed by multiplying the scores by 1 for the proximal, middle and distal RCA and the posterior descending branch, and by 0.5 for the posterior branch. The final score was calculated by adding the scores of each segment.[20–22] The patients were then divided into four groups according to the total score (0–12, 13–24, 25–52 and ≥53).[23]

Statistical analysis

All statistical analyses were performed using SPSS V.24.0. A p value <0.05 was considered statistically significant. The continuous variables are presented as mean±SD. Categorical variables are presented as number and percentages.
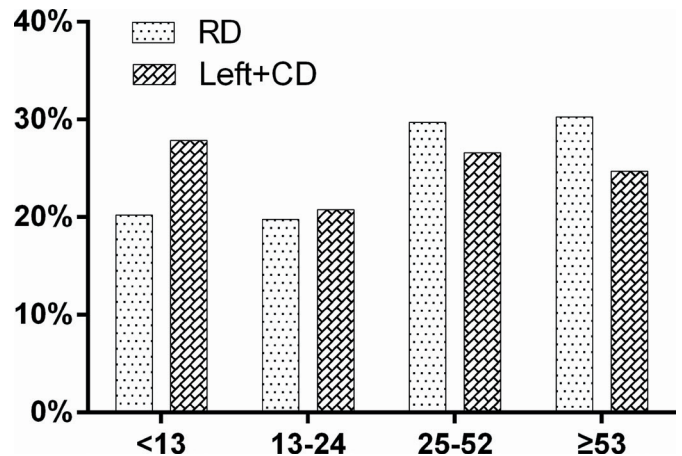

Figure 1 Distribution of RD and left-CD groups in different grades of Gensini score. CD, codominance; RD, right dominance.

Analysis of variance and the χ^2 test were used to compare the variables between the subgroups of different grades of the Gensini score. Gensini score was divided into first grade (0–12.5), second grade (13–24.5), third grade (25–52.5) and fourth grade (≥53). Patients with LD or CD anatomies were placed in the left-CD group, while those with RD anatomy were included in the RD group. A multiple linear regression analysis was performed to test the association between the severity of CAD and the following variables: age, gender, smoking status, diabetes mellitus, hypertension, hyperlipidaemia, heart rate, family history of CAD, systolic blood pressure (SBP), diastolic blood pressure (DBP) and coronary dominance.

RESULTS
Patient characteristics
The study included 1654 patients (1235 men and 419 women, mean age 59.4±10.4) who underwent

Table 3 Univariate linear regression analysis for Gensini score

Variable	β (95% CI)	P values
Right dominance	5.991 (0.474 to 11.508)	0.033
Age	0.187 (0.033 to 0.342)	0.017
Male	9.811 (6.150 to 13.472)	<0.001
Smoking	1.098 (−2.113 to 4.309)	0.503
Hypertension	1.033 (−2.182 to 4.247)	0.529
Diabetes mellitus	8.408 (4.369 to 12.447)	<0.001
Hyperlipidaemia	−2.038 (−7.167 to 3.091)	0.436
Family history of CAD	−0.652 (−4.200 to 2.896)	0.719
SBP	−0.065 (−0.142 to 0.013)	0.100
DBP	−0.008 (−0.141 to 0.125)	0.911
Heart rate	0.148 (0.025 to 0.271)	0.018

CAD, coronary artery disease; DBP, diastolic blood pressure; SBP, systolic blood pressure.

Table 4 Multivariate linear regression analysis for Gensini score

Variable	β (95% CI)	P values
Unadjusted	5.991 (0.474 to 11.508)	0.033
Model 1	6.404 (0.945 to 11.862)	0.022
Model 2	6.699 (1.193 to 12.205)	0.017
Model 3	6.829 (1.312 to 12.346)	0.015

Model 1: adjusted for age and gender.
Model 2: adjusted for age and gender, diabetes, and heart rate.
Model 3: adjusted for age and gender, diabetes, heart rate, smoking, hypertension, hyperlipidaemia, history of coronary artery disease, systolic blood pressure and diastolic blood pressure.

CAG. Patients were divided into four groups based on the Gensini score, which were 0–12 (first grade; n=347), 13–24 (second grade; n=329), 25–52 (third grade; n=486) and ≥53 (fourth grade; n=492). Gender, SBP, DBP, heart rate, diabetes mellitus, hypertension, smoking, hyperlipidaemia, coronary vessel disease, history of CAD and coronary dominance were compared in the four groups. The baseline characteristics are shown in table 1 according to Gensini score.

Association between Gensini score and coronary dominance

The total Gensini score was significantly higher in the RD group than in the left-CD group (42.3±33.6 vs 36.3±29.8; p=0.033). Also, patients in the RD group have a higher Gensini score than patients in the left-CD groups in RCA (p<0.001) and posterior descending artery (p=0.013) (table 2). In addition, RD tended to have higher proportion in the third and fourth grade of the Gensini score (figure 1).

Univariate linear regression analysis showed that RD, age, gender, diabetes and heart rate were associated with increasing Gensini score (table 3). After adjusting for age, gender, diabetes and heart rate, RD (β=6.699, 95% CI 1.193 to 12.205, p=0.017) was positively associated with the Gensini score of patients (table 4). The final multiple linear regression model also showed a positive correlation between RD and Gensini score.

DISCUSSION

Coronary circulation is categorised as RD, LD and CD according to the blood supply of the posterior IVS using CAG or CT-CAG.[4] Previous studies have shown that coronary artery dominance was closely related to cardiovascular outcomes.[4] A study of 1131 patients showed that LD was associated with an increased risk of 30-day mortality and early reinfarction after ST-elevated myocardial infarction.[24] Goldberg et al[7] demonstrated that LD was a risk factor for increased long-term mortality in patients with acute coronary syndrome. However, little is known about the role of RD in CAD. In this study, we found that RD was associated with the severity of CAD. The results indicated that RD was more prone to have serious CAD stenosis and may serve as a marker of CAD severity.

In the general population, RD anatomy has a prevalence of approximately 70%.[10] In addition, LD and RD have a reported prevalence of approximately 5%–12% and 82%–89%, respectively, whereas CD is found in 3%–7% of individuals based on a hospital population.[5–7 25 26] The proportion of RD, LD and CD in our study was 90.6%, 6.7% and 2.7%, respectively. The phenomenon reminds us that the RD group may have higher percentage in a hospital population than in the general population.

The Gensini score is a quick and easy way to quantify the severity of CAD in the clinical work. Therefore, we used this scoring system to further investigate the association between coronary dominance and CAD. In our study, the total Gensini score of an RD patient was obviously higher than a patient with left-CD. After multiple linear regression, RD showed a positive correlation with Gensini score. A previous study with a large population found a higher prevalence of triple vessel disease in patients with RD than in patients with LD.[26] The result indicated that patients with RD tended to have more serious coronary stenosis. At present, the mechanism between RD and the severity of CAD is still not known. Therefore, further research is needed to detect the underlying mechanism for developing more severe lesions in patients with RD.

Some potential limitations in this study should be noted. First, our finding was based on a Northern Chinese population. Therefore, the results should not be extended to all ethnic groups. Second, our data were obtained from a hospital database, so the outcomes of patients were unavailable. Finally, the study population was relatively small, which led to a smaller group of individuals with LD and CD.

CONCLUSION

The present study reported that patients with RD had a significantly higher proportion of serious coronary stenosis than patients with LD and CD. Right coronary dominance was associated with the severity of CAD. A prospective, multicentre cohort study may further validate our findings.

Ethics approval The study protocol was approved by the Ethics Committee of The First Affiliated Hospital of Xi'an Jiaotong University.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement No additional data are available.

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