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

Bin Yan,1 Jian Yang,1 Yajuan Fan,2 Binbin Zhao,2 Qingyan Ma,2 Lihong Yang,1 Xiancang Ma2

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 SYNTAX 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.4–5

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).6 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.
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. 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). Smoking was defined as ever-smoked 100 cigarettes or currently smoking every day or some days.

**CAG results**
All patients underwent CAG using a standard clinical technique through the femoral artery or radial artery approach. 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. 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 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.
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.

Table 2 Gensini score and coronary dominance

| Variable                  | 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    |

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    |

RESULTS
Patient characteristics
The study included 1654 patients (1235 men and 419 women, mean age 59.4±10.4) who underwent
Coronary artery dominance was closely related to the severity of CAD. A previous study with a large population found a higher prevalence of triple vessel disease in patients with RD than in patients with LD. 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. Right coronary dominance was associated with the severity of CAD. 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.

### DISCUSSION

Coronary circulation is categorised as RD, LD and CD according to the blood supply of the posterior IVS using CAG or CT-CAG. Previous studies have shown that coronary artery dominance was closely related to cardiovascular outcomes. 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. Goldberg et al. 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%. 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. 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. 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.

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### Contributors

All authors contributed to the study design, writing and revision of the report. BY, JY and XM collected the data. BZ and YF did the primary data analysis, and CY, BY and XM participated in further data analysis. XM handled supervision in our study. All authors approved the final version of the report.

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### Competing interests

None declared.

### Patient consent

Obtained.
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