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Clinical characteristics and the severity of coronary atherosclerosis of different subtypes of bundle-branch block

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Abstract

Background: Right bundle-branch block (RBBB) and left bundle-branch block (LBBB) play a role in the pathogenesis and progression of coronary artery disease (CAD). However, the clinical features and the severity of coronary artery disease associated with different subtypes of bundle-branch block, according to time of new appearance, is not well characterized in patients with no known CAD.

Methods: We retrospectively analyzed data pertaining to consecutive patients with RBBB or LBBB who underwent coronary angiography. The severity of coronary lesions was evaluated using the SYNTAX score. The differential effect of new-onset RBBB, old RBBB, new-onset LBBB, and old LBBB on the severity of CAD and its association with clinical characteristics was quantified. Multivariate logistic regression analysis was performed to evaluate the effect of RBBB and LBBB on the degree of coronary atherosclerosis in patients without known CAD.

Results: Out of the 243 patients, 72 patients had old LBBB, 37 had new-onset LBBB, 93 patients had old RBBB, and 41 patients had new-onset RBBB. On univariate analysis, age, systolic blood pressure, diastolic blood pressure, creatinine, serum glucose, and glycosylated hemoglobin level were associated with high SYNTAX score ($p < .05$ for all). Patients in the new-onset RBBB, old RBBB, new-onset LBBB, and old LBBB groups showed significant differences in baseline characteristics and coronary atherosclerosis ($p < .05$ for all). However, there were no significant between-group differences with respect to the degree of coronary atherosclerosis as assessed by SYNTAX score.

Conclusions: New-onset RBBB, old RBBB, new-onset LBBB, and old LBBB were not associated with the severity of coronary lesions as assessed by SYNTAX score in patients without known CAD.

KEYWORDS
clinical characteristics, left bundle-branch block, right bundle-branch block, SYNTAX score

1 | INTRODUCTION

Patients with coronary artery disease (CAD), particularly those with acute coronary syndrome (ACS), often exhibit unstable disease progression and unfavorable prognosis. Therefore, risk stratification of these patients is of much clinical relevance (Jun et al., 2019; Khot et al., 2003; Messerli Franz et al., 2019). Numerous studies have confirmed the direct relationship between the onset of left bundle-branch block (LBBB) and outcome measures such as all-cause mortality, cardiac death, acute myocardial infarction (MI), sudden cardiac death, and congestive heart

failure, both in patients with and without pre-existing CAD (Bristow et al., 2004; Di Marco et al., 2020; Kiehl Erich et al., 2019; Moss et al., 2009; Witt et al., 2016). In recent studies, presence of right bundle-branch block (RBBB) in patients with different phenotypes of ACS was found associated with cardiovascular disease at baseline, high-risk clinical features, less cardiac intervention, and poor clinical outcomes (Chan et al., 2016; Widimsky et al., 2012). This prompted calls for revision of the reperfusion guidelines to reflect the unfavorable prognosis of new-onset RBBB, especially in the ACS, even in the absence of ST elevation (Widimsky et al., 2012). Evidently, clinical evaluation of RBBB and LBBB has important clinical significance for cardiovascular risk assessment.

There are differences between RBBB and LBBB with respect to physical anatomy and pathologic changes, and this may lead to potential differences in the severity of coronary lesions in CAD patients. In addition, these patients may have different clinical characteristics and may show different cardiovascular risk assessment according to the type of BBB. However, the differential risk profiles of patients with LBBB and RBBB are not well characterized in patients without known CAD. To the best of our knowledge, the difference represents potential risk of different subtypes of LBBB and RBBB classified according to the time of appearance has not been reported, especially with respect to the degree of coronary atherosclerosis assessed by SYNTAX score. To address these outstanding questions, the aim of the current study was to evaluate the potential differences with respect to the extent of coronary heart disease between LBBB and RBBB using SYNTAX score calculator in patients without known CAD.

2 | METHODS

2.1 | Patient population

We conducted a retrospective cohort study at the First Affiliated Hospital of Bengbu Medical University (reference period: January 2016 to October 2019). A total of 243 outpatients with symptoms of chest pain without known CAD who underwent coronary angiography and were diagnosed with LBBB or RBBB by electrocardiogram (ECG) were included. A flow chart showing the patient selection criteria is shown in Figure 1. Patients with the following clinical conditions were excluded, as these factors may affect the LBBB or RBBB: aortic stenosis, ischemic heart disease, dilated cardiomyopathy, primary degenerative disease (fibrosis) of the conducting system, hyperkalemia, digoxin toxicity; right ventricular hypertrophy, cor pulmonale, pulmonary embolus, rheumatic heart disease, myocarditis or cardiomyopathy, degenerative disease of the conduction system, congenital heart disease (e.g., atrial septal defect), previous CAD, previous percutaneous transluminal coronary intervention (PCI), severe liver function impairment, severe renal impairment, coronary bypass graft, malignant tumors, patients with implanted pacemakers, and indeterminate age at appearance of bundle-branch block (BBB) (if the BBB was present at admission and no previous ECG records were available). Because this was a retrospective observational study, the Ethics Committee granted an exemption from requiring ethics approval and waived the need to obtain informed consent from eligible patients.

2.2 | Diagnostic criteria for RBBB and LBBB

The diagnosis of RBBB and LBBB was based on the standard ECG criteria (Willems et al., 1985). Patients were divided into groups according to the time of appearance of BBB: new, if the BBB appeared after admission or was present at admission but was not recorded on an ECG within the previous 6 months; old, if the BBB was present at admission and documented on a previous ECG.

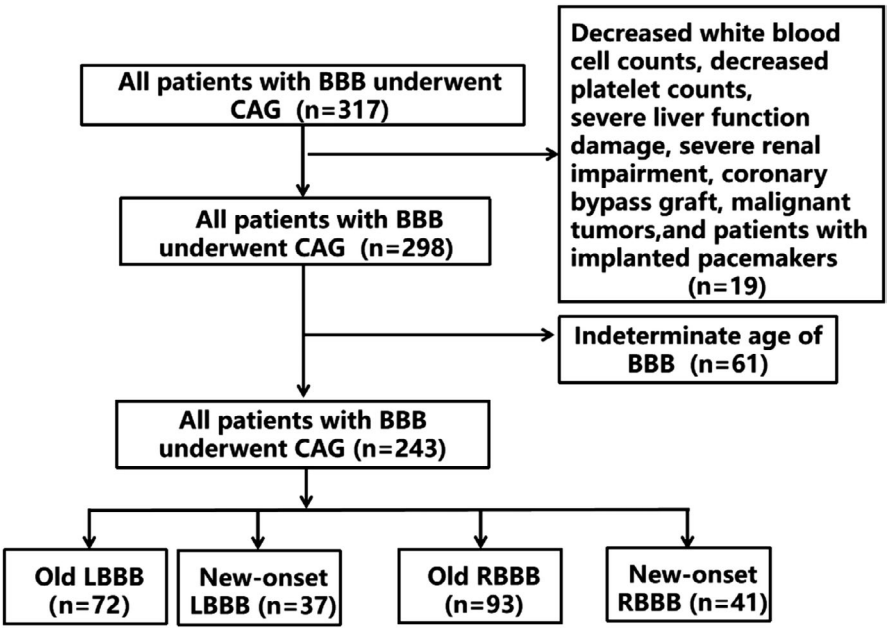

FIGURE 1 Flow chart of patient enrollment

2.3 | CAG and SYNTAX score calculator

Coronary angiography was performed for each patient by an experienced cardiologist using the standard procedure. CAD was diagnosed based on the existence of significant narrowing (≥50%) in any of the main coronary arteries, according to coronary artery lesion classification of the European Society of Cardiology/European Association for Cardio Thoracic Surgery (Corrigendum, 2018). The SYNTAX score of individual patients was calculated from the coronary angiographic data using the SYNTAX score tool. The score was calculated by two independent investigators who assessed the degree of stenosis of the coronary lesions. Disagreement, if any, was resolved by consensus with the involvement of a third investigator. Patients were divided into three groups based on the score: low-risk group, score 1–22; intermediate-risk group, 23–32; highest-risk group, ≥33 (Sianos et al., 2005).

2.4 | Statistical analysis

All analyses were performed using SPSS 22.0 for Windows statistical software (SPSS Inc). Continuous variables are expressed as mean ± standard deviation or median (25th to 75th percentiles), while categorical variables are presented as frequencies (percentages). Between-group differences with respect to normally distributed continuous variables were evaluated using one-way ANOVA; those with respect to non-normally distributed variables were assessed using the Mann–Whitney U test or Kruskal–Wallis variance analysis as appropriate. The chi-squared (χ^2) test was employed for the comparison of categorical variables. To construct the model for multivariate regression analyses, univariate models for each of the predictor variables were run, and variables that showed a significant association in univariate analysis were included in the multivariate logistic analysis $p < .05$ were considered indicative of statistical significance.

3 | RESULTS

3.1 | Clinical characteristics of patients with right bundle-branch block and left bundle-branch block

A total of 243 patients with BBB were included in this study. The baseline coronary risk factors and biochemical parameters of patients in various groups disaggregated by the time of appearance of BBB are presented in Table 1. Those with new-onset RBBB had greater heart rate and greater white blood count as compared to those in the remaining three groups. Patients with new-onset or old LBBB were more likely to have lower ejection fraction (EF) and larger left ventricular end-diastolic volume and neutrophil-to-lymphocyte ratio compared to those with new-onset RBBB or old RBBB ($p < .05$ for all). Moreover, those with old LBBB had higher levels of urea nitrogen, uric acid, and creatinine compared to those in the remaining three groups ($p < .05$ for all). Patients with new-onset RBBB or old RBBB were more likely to be male, current smokers, and more likely to have used calcium-channel antagonists compared to those with new-onset LBBB or old LBBB ($p < .05$ for all). In addition, patients grouped according to the time of appearance of BBB showed no significant differences in the other observed characteristics ($p > .05$ for all).

3.2 | CAG findings according to the time of BBB

The angiographic findings are summarized in Table 2. Patients with new-onset BBB were more likely to exhibit more severe target vessel stenosis and lower target vessel TIMI grade compared to those with old BBB ($p < .05$ for all). Patients with new-onset RBBB had higher rate of anterior descending artery stenosis and high SYNTAX score compared to those in the remaining three groups ($p < .05$ for all). In addition, patients grouped according to the different subtypes of BBB showed no significant differences with respect to the other observed CAG findings ($p > .05$ for all).

3.3 | Characteristics of patients according to SYNTAX score

The coronary risk factors and laboratory data based on the severity of coronary artery atherosclerosis are shown in Table 3. Age, systolic blood pressure, diastolic blood pressure, white blood cell count, creatinine, glucose, neutrophil-to-lymphocyte ratio, lipoprotein(a), and glycosylated hemoglobin level increased gradually with the increase in SYNTAX score ($p < .05$ for all). Patients with SYNTAX Score > 0 were significantly more likely to be male, diabetic, have a family history of CAD, previous cerebrovascular disease, and more likely to have used aspirin and statins compared to those with SYNTAX Score $= 0$ ($p < .05$ for all).

3.4 | Factors associated with coronary lesion severity as assessed by SYNTAX score

On multivariate logistic regression analyses, age, systolic blood pressure, diastolic blood pressure, glucose, and lipoprotein(a) were independent predictors of SYNTAX score ($p < .05$ for all; Table 4).

4 | DISCUSSION

Among patients with no known CAD, new-onset BBB was associated with more severe target vessel stenosis and lower target vessel TIMI grade. New-onset RBBB may suggest a higher rate of anterior descending artery stenosis and high SYNTAX score. However, we found that new-onset RBBB, old RBBB, new-onset LBBB, and old LBBB were not associated with the severity of coronary artery atherosclerosis as assessed by SYNTAX Score in patients without known CAD. Different subtypes of BBB may have similar clinical

TABLE 1 Clinical characteristics of the study population disaggregated according to the time of occurrence of bundle-branch block

	Old LBBB (n = 72)	New-onset LBBB(n = 37)	Old RBBB (n = 93)	New-onset RBBB(n = 41)	F/Z/χ2	P
Sex (male/female)	42/30	16/21	62/31	31/10	10.031	0.018
Age (years)	64.90 ± 10.01	63.49 ± 10.28	64.60 ± 10.19	64.76 ± 9.90	0.172	0.915
Hypertension, n(%)	42(58.3)	19(51.4)	61 (65.6)	25(61.0)	2.450	0.484
Diabetes mellitus, n(%)	16(22.2)	7(18.9)	30 (32.3)	13(31.7)	3.808	0.283
Current smoking, n(%)	41(56.9)	21(56.8)	72 (77.4)	30(73.2)	10.374	0.016
Smoking time (years)	2712 ± 6.98	24.13 ± 9.05	30.76 ± 9.93	29.14 ± 9.82	1.380	0.256
Current alcohol drinking, n(%)	13(27.1)	8(33.3)	19 (20.4)	12(29.3)	2.412	0.491
Family history of CAD, n(%)	6(8.3)	2(5.4)	7 (7.5)	1(2.4)	2.037	0.565
BMI (kg/m^2)	26.38 ± 3.08	25.18 ± 3.17	25.53 ± 3.25	2614 ± 2.66	1.003	0.393
Previous cerebrovascular disease	3(4.2)	4(10.8)	12 (13.0)	3(7.3)	4.442	0.217
SBP (mmHg)	122.49 ± 21.37	128.11 ± 20.56	124.77 ± 16.63	121.29 ± 15.02	1.112	0.345
DBP (mmHg)	76.36 ± 9.07	76.00 ± 9.09	75.94 ± 9.60	76.66 ± 10.91	0.067	0.978
Heart rate (times/min)	78.07 ± 13.38	73.96 ± 12.65	74.91 ± 12.06	82.84 ± 18.18	3.389	0.019
Medication situation						
Aspirin, n(%)	30(41.7)	12(32.4)	42 (45.2)	18(43.9)	1.836	0.607
Statins, n(%)	31(43.1)	8(21.6)	33 (35.5)	17(41.5)	5.337	0.149
ACEI/ARB, n(%)	18(25.0)	9(24.3)	30 (32.3)	11(26.8)	1.434	0.698
CCB, n(%)	8(11.1)	5(13.5)	29 (31.2)	15 (36.6)	15.177	0.002
Left ventricular ejection fraction(%)	51.82 ± 11.93	56.24 ± 9.88	61.68 ± 6.47	58.47 ± 7.31	11.823	<0.001
LVEDD (mm)	54.89 ± 7.27	52.32 ± 5.17	48.78 ± 5.13	49.21 ± 5.67	10.799	<0.001
WBC 10^9/L	6.86 ± 1.99	7.04 ± 2.21	6.81 ± 2.23	8.09 ± 3.12	3.172	0.025
NLR	2.56(1.58, 3.27)	2.52(1.65, 2.99)	1.76 (1.40, 2.73)	2.18(1.58, 5.09)	8.059	0.045
Platelets/lymphocytes	119(85, 156)	119 (94,177)	108 (83, 141)	116(100, 157)	4.484	0.214
HGB g/L	138.4 ± 12.38	139.96 ± 17.95	140.29 ± 15.8	139.98 ± 16.88	0.154	0.927
PLT 10^9/L	209.64 ± 54.5	232.88 ± 69.48	208.24 ± 55.71	222.93 ± 77.61	1.353	0.259
MPV fL	11.05 ± 1.27	10.68 ± 1.41	10.82 ± 1.66	10.85 ± 1.18	0.408	0.748
BUN (mmol/L)	6.54 ± 1.81	5.41 ± 2.64	5.82 ± 1.57	5.59 ± 1.7	2.800	0.041
Creatinine (mmol/L)	79.94 ± 16.55	74.98 ± 21.98	71.08 ± 20.00	78.77 ± 26.20	2.895	0.036
Uric acid (μmol/L)	355.52 ± 97.75	320.5 ± 84.46	308.54 ± 91.92	335.61 ± 88.89	2.844	0.039
Serum glucose (mmol/L)	5.76 ± 2.34	5.81 ± 1.94	6.62 ± 2.94	6.90 ± 3.63	2.320	0.076
TG (mmol/L)	1.21(0.94, 1.84)	1.28(1.04,2.37)	1.47(1.04, 2.00)	1.48(1.04,3.00)	3.282	0.350
TC (mmol/L)	3.66 ± 1.02	3.91 ± 0.81	3.84 ± 1.15	3.64 ± 0.99	0.756	0.520
HDL-C (mmol/L)	1.05 ± 0.35	1.09 ± 0.28	1.14 ± 0.44	1.04 ± 0.29	1.117	0.343
LDL-C (mmol/L)	2.23 ± 0.8	2.45 ± 0.72	2.37 ± 0.99	2.23 ± 0.85	0.515	0.673
ApoA1 (g/L)	1.09 ± 0.18	1.18 ± 0.17	1.17 ± 0.35	1.1 ± 0.23	1.280	0.283
Apo-B (g/L)	0.77 ± 0.22	0.83 ± 0.27	0.85 ± 0.3	0.78 ± 0.25	1.123	0.341
Lp(a) (g/L)	96(71,203)	111(73, 224)	111 (65, 264)	148(75, 255)	2.143	0.543
HbA1c(%)	6.34 ± 1.75	5.94 ± 1.81	6.55 ± 2.10	6.53 ± 1.92	0.985	0.401

Abbreviations: BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; NLR, neutrophil-to-lymphocyte ratio; WBC, white blood count; PLT: platelet count; MPV, mean platelet volume; PCT, thrombocytocrit; PDW, platelet distribution width; RBC, red blood cell; HGB, hemoglobin; BUN, blood urea nitrogen; Cr, creatinine; TC, total cholesterol; TG, triglyceride; HDL-c, high-density lipoprotein cholesterol; LDL-c, low-density lipoprotein cholesterol; Apo-AI, apolipoprotein A1; Apo-B, apolipoprotein B; Lp(a), lipoprotein (a); CCB, calcium-channel blocker; ACEI, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; CAD, coronary artery disease; LAD, left anterior descending artery; LCX, left circumflex artery; RCA, right coronary artery;LVEDD, left ventricular end-diastolic dimension.

TABLE 2 CAG findings of patients according to the time of occurrence of bundle-branch block

	Old LBBB (n = 72)	New-onset LBBB(n = 37)	Old RBBB (n = 93)	New-onset RBBB(n = 41)	F/χ2	P
Target vessel					0.787	0.992
LAD, n(%)	21(53.8)	10(47.6)	27(54.0)	18(58.1)		
LCX, n(%)	8(20.5)	5(23.8)	9(18.0)	5(16.1)		
RCA, n(%)	10(25.6)	6(28.6)	14(28.0)	8(25.8)		
Number of vascular lesions					10.152	0.338
0, n(%)	27(37.5)	15(40.5)	39(41.9)	10(24.4)		
1, n(%)	20(27.8)	12(32.4)	28(30.1)	13(31.7)		
2, n(%)	15(20.8)	3(8.1)	16(17.2)	7(17.1)		
3, n(%)	10(13.9)	7(18.9)	10(10.8)	11(26.8)		
Target stenosis	78.38 ± 20.12	84.48 ± 18.39	73.24 ± 18.67	86.65 ± 17.77	3.849	0.011
Target vessel TIMI grading					54.167	<0.001
0, n(%)	9(19.1)	8(32.0)	6(10.7)	10(30.3)		
1, n(%)	0(0.0)	0(0.0)	1(1.8)	3(9.1)		
2, n(%)	3(6.4)	2(8.0)	3(5.4)	4(12.1)		
3, n(%)	35(74.5)	15(60.0)	46(82.1)	16(48.5)		
Stent implantation, n(%)	13(18.1)	7(18.9)	17(18.3)	13(31.7)	3.751	0.290
Balloon dilatation, n(%)	15(20.8)	7(18.9)	18(19.4)	13(31.7)	2.905	0.406
IABP, n(%)	0(0.0)	1(2.7)	0(0.0)	1(2.4)	4.199	0.102
Temporary pacemaker, n(%)	0(0.0)	1 (2.7)	2(2.2)	2(4.9)	3.469	0.257
Coronary dominance					7.365	0.061
Right edge type, n(%)	71(98.6)	32 (86.5)	85(91.4)	38(92.7)		
Left edge type, n(%)	1(1.4)	5 (13.5)	8(8.6)	3(7.3)		
Left main stenosis, n(%)	2(2.8)	1 (2.7)	8(8.6)	2(4.9)	3.426	0.331
LAD stenosis, n(%)	38(52.8)	14 (37.8)	43(46.2)	29(70.7)	9.888	0.020
LCX stenosis, n(%)	26(36.1)	12 (32.4)	30(32.3)	18(43.9)	1.856	0.603
RCA stenosis, n(%)	26(36.1)	15 (40.5)	39(41.9)	21(51.2)	2.476	0.480
Coronary slow flow, n(%)	0(0.0)	0(0.0)	2(2.2)	2(4.9)	3.613	0.231
SYNTAX Score	3(0, 13)	2(0, 13)	2(0, 10)	9(1, 23)	10.058	0.018

Abbreviations: LAD, left anterior descending; LCX, left circumflex artery; RCA, right coronary artery; TIMI, thrombolysis in myocardial infarction.

application value on severity of coronary artery atherosclerosis in patients without known CAD.

Previous studies have found an association of BBB with CAD risk and prognosis (Bansilal et al., 2011; Meyer Matthias et al., 2020). Acute coronary syndrome is a common cause of BBB. In a long-term outcomes study, emergency angina patients with BBB showed adverse cardiovascular outcomes and shorter survival time compared to patients without BBB (Bansilal et al., 2011). Patients with acute coronary syndrome who have BBB often have multiple clinical risk factors that are associated with poor long-term prognosis (Amal et al., 2020; Bussink Barbara et al., 2013). However, these studies focused on the association between RBBB or LBBB and CAD incidence and prognosis, rather than on the potential association between the different subtypes of BBB and clinical characteristics and coronary lesion characteristics. This limited our understanding of the potential association between BBB and coronary lesion severity and hazard assessment according to the time of appearance of BBB. We compared patients with different subtypes of BBB classified according to the time of appearance and observed some important differences.

BBB is a common finding in the general population (Bussink Barbara et al., 2013). Of note, anatomically, postmortem studies have demonstrated that the blood supply of the right bundle branch and the anterior half of the left bundle branch is mainly provided by the proximal left anterior descending (LAD) septal perforators, whereas the posterior half of the left bundle branch receives most of its blood supply from the right coronary artery (Amal et al., 2020). Among patients with left ventricle ejection fraction ≤ 35%, the mean anteroseptal scar size in patients with RBBB was significantly greater than that in patients with LBBB, and occlusion of a proximal LAD septal perforator was found to contribute to RBBB (Neumann Johannes et al., 2019). This is consistent with the present study wherein new-onset RBBB was more likely to be associated with anterior descending artery stenosis. A growing body of evidence supports the new European Society of Cardiology ST-segment elevation myocardial infarction

TABLE 3 Characteristics of patients according to SYNTAX score

	0 Score (n = 91)	Low (n = 123)	Middle (n = 17)	High (n = 12)	F/Z/χ^2	P
Sex (Male/Female)	47/44	77/46	16/1	11/1	19.240	<0.001
Age (years)	60.57 ± 10.00	66.71 ± 9.59	67.41 ± 8.72	68.50 ± 7.76	8.432	<0.001
Hypertension, n(%)	54(59.3)	76(61.8)	9 (52.9)	8 (66.7)	0.731	0.866
Diabetes mellitus, n(%)	12(13.2)	45(36.6)	5 (29.4)	4 (33.3)	15.846	0.001
Current smoking, n(%)	60(65.9)	85(69.1)	14 (82.4)	5 (41.7)	5.516	0.138
Smoking time(years)	28.64 ± 10.49	29.26 ± 9.00	27.57 ± 11.16	28.75 ± 6.41	0.068	0.977
Alcohol drinking, n(%)	17(23.0)	24(23.1)	5 (31.3)	6 (50.0)	4.137	0.247
Family history of CAD, n(%)	7(7.7)	4(3.3)	3 (17.6)	2 (16.7)	8.034	0.028
BMI (kg/m2)	26.25 ± 3.24	25.37 ± 3.08	25.58 ± 3.12	26.41 ± 2.04	1.110	0.347
Previous cerebrovascular disease n(%)	3(3.3)	14(11.5)	4 (23.5)	1 (8.3)	8.689	0.034
SBP (mmHg)	121.38 ± 16.62	123.48 ± 20.62	133.88 ± 11.95	135.50 ± 5.40	3.920	0.009
DBP (mmHg)	74.11 ± 8.01	76.46 ± 10.28	81.18 ± 9.46	82.25 ± 7.99	4.848	0.003
Heart rate (times/min)	75.28 ± 13.47	77.35 ± 12.94	78.06 ± 18.49	85.00 ± 18.86	1.601	0.191
Medication situation						
Aspirin, n(%)	28(30.8)	58(47.2)	11(64.7)	5 (41.7)	9.653	0.022
Statins, n(%)	25(27.5)	48(39.0)	11(64.7)	5 (41.7)	9.357	0.025
ACEI/ARB, n(%)	23(25.3)	38(30.9)	4(23.5)	3 (25.0)	1.073	0.784
CCB, n(%)	18(19.8)	33(26.8)	1(5.9)	5 (41.7)	7.257	0.064
Left ventricular ejection fraction(%)	59.26 ± 8.90	58.18 ± 9.34	56.33 ± 9.24	54.6 ± 11.77	0.961	0.413
LVEDD (mm)	50.49 ± 5.78	50.33 ± 6.43	51.5 ± 7.26	53.8 ± 6.14	1.013	0.388
WBC 10^9/L	6.65 ± 2.26	7.08 ± 2.27	8.10 ± 2.55	8.81 ± 2.87	4.358	0.003
NLR	1.84(1.42, 2.48)	2.47(1.47, 3.23)	2.80(1.50,6.08)	2.90 (1.80,3.87)	14.679	0.002
Platelets/lymphocytes	111(84, 146)	108(85, 148)	115(88,248)	142 (98,170)	3.520	0.318
HGB g/L	140.85 ± 15.17	138.84 ± 15.78	138.69 ± 15.36	142.58 ± 16.69	0.391	0.760
PLT 10^9/L	218.24 ± 55.54	207.01 ± 63.85	223.06 ± 86.03	243.67 ± 43.59	1.567	0.199
MPV fL	10.73 ± 1.15	10.91 ± 1.59	11.36 ± 2.03	10.56 ± 0.93	1.016	0.386
BUN (mmol/l)	5.94 ± 2.05	5.86 ± 1.78	6.07 ± 1.59	5.45 ± 1.16	0.308	0.819
Cr (mmol/L)	72.29 ± 18.67	75.67 ± 20.88	83.89 ± 28.80	88.09 ± 16.31	3.192	0.024
Uric acid (μmol/L)	318.30 ± 93.07	325.52 ± 93.52	342.02 ± 116.01	358.28 ± 43.67	0.804	0.493
Serum glucose(mmol/L)	5.31 ± 1.60	6.45 ± 3.05	7.95 ± 2.63	9.73 ± 3.68	13.720	<0.001
TG (mmol/L)	1.38(1.01, 1.84)	1.43(1.02, 2.32)	1.61(0.91, 3.29)	1.24 (0.82,3.09)	0.712	0.870
TC (mmol/L)	3.75 ± 0.99	3.75 ± 1.11	3.8 ± 0.89	4.1 ± 1.01	0.424	0.736
HDL-C (mmol/L)	1.14 ± 0.35	1.06 ± 0.4	1.14 ± 0.31	1.01 ± 0.26	0.911	0.437
LDL-C (mmol/L)	2.3 ± 0.88	2.28 ± 0.93	2.37 ± 0.69	2.66 ± 0.88	0.653	0.582
ApoA1 (g/L)	1.16 ± 0.23	1.13 ± 0.32	1.13 ± 0.26	1.1 ± 0.21	0.263	0.852
Apo-B (g/L)	0.82 ± 0.29	0.82 ± 0.27	0.81 ± 0.28	0.81 ± 0.18	0.015	0.998
Lp(a) (g/L)	78(61, 131)	127(76,280)	203(140, 264)	211 (133, 363)	34.175	<0.001
HbA1c (%)	5.92 ± 1.83	6.52 ± 1.94	7.22 ± 1.81	7.48 ± 1.76	4.510	0.004
Subtype of BBB					13.038	0.161
New-onset RBBB, n(%)	27(29.7)	39(31.7)	3(17.6)	3 (25.0)		
New-onset LBBB, n(%)	15(16.5)	19(15.4)	2(11.8)	1 (8.3)		
Old LBBB, n(%)	39(42.9)	46(37.4)	5(29.4)	3 (25.0)		
Old RBBB, n(%)	10(11.0)	19(15.4)	7(41.2)	5 (41.7)		

Abbreviations: BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; NLR, neutrophil-to-lymphocyte ratio; WBC, white blood count; PLT: platelet count; MPV, mean platelet volume; PCT, thrombocytocrit; PDW, platelet distribution width; RBC, red blood cell; HGB, hemoglobin; BUN, blood urea nitrogen; Cr, creatinine; TC, total cholesterol; TG, triglyceride; HDL-c, high-density lipoprotein cholesterol; LDL-c, low-density lipoprotein cholesterol; Apo-AI, apolipoprotein A1; Apo-B, apolipoprotein B; Lp(a), lipoprotein (a); CCB, calcium-channel blocker; ACEI, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; CAD, coronary artery disease; LAD, left anterior descending artery; LCX, left circumflex artery; RCA, right coronary artery; UA, unstable angina; NSTEMI, non–ST-segment elevation myocardial infarction; STEMI, ST-segment elevation myocardial infarction.

TABLE 4 Factors associated with coronary lesion severity as assessed by SYNTAX score

						95%CI	
	B	SE	WALS	P	OR	Lower limit	Upper limit
Sex	−0.361	0.302	1.437	0.231	0.697	0.386	1.259
Age	0.062	0.016	15.058	<0.001	1.063	1.031	1.097
SBP	0.017	0.008	4.641	0.031	1.017	1.002	1.033
DBP	0.065	0.015	17.469	<0.001	1.067	1.035	1.100
WBC	0.092	0.073	1.592	0.207	1.096	0.950	1.264
NLR	0.129	0.068	3.639	0.056	1.138	0.996	1.300
Cr	0.007	0.007	0.974	0.324	1.007	0.993	1.021
Serum glucose	0.223	0.064	12.276	<0.001	1.250	1.103	1.415
Lp(a)	0.002	0.001	4.332	0.037	1.002	1.001	1.003
HbA1c	0.087	0.083	1.103	0.294	1.091	0.928	1.284
Diabetes mellitus	0.039	0.370	0.011	0.917	1.040	0.503	2.149
Family history of CAD	−0.324	0.574	0.319	0.572	0.723	0.235	2.228
Cerebrovascular disease	0.220	0.493	0.200	0.655	1.246	0.475	3.274
Aspirin	0.118	0.454	0.068	0.795	1.125	0.463	2.737
Statins	0.200	0.449	0.198	0.656	1.221	0.507	2.948

Abbreviations: CI, confidence interval; OR, hazard ratio.

(STEMI) guidelines describing RBBB as a convenient risk stratification tool for patients with suspected myocardial infarction (Ahmad et al., 2016). Moreover, RBBB was shown to play a role in the progression of CAD, especially in the setting of multivessel disease or ischemic heart disease leading to adverse prognosis (Chan et al., 2016). Interestingly, LBBB may most commonly result from nonischemic pathology (Neumann Johannes et al., 2019). Therefore, patients with RBBB were more likely to have ischemic cardiomyopathy as compared with those with LBBB (Strauss David et al., 2013). Moreover, RBBB occurred after minor injury during right ventricular catheterization, suggesting that right bundle branch is relatively slim and fragile itself (Kawashima & Sasaki, 2011; Sorensen et al., 2013). Therefore, RBBB may serve as a more important early warning sign than LBBB in patients with chest pain due to suspected CAD; in particular, new-onset RBBB may serve as a useful risk stratifier and help identify patients with severe coronary artery atherosclerosis (Shrivastav et al., 2021). We compared patients with new-onset LBBB, new-onset RBBB, and old RBBB to those with old LBBB and found no significant difference in the severity of coronary artery atherosclerosis. Among patients with no known CAD, RBBB and LBBB were equally related to the severity of coronary artery atherosclerosis. Further studies including larger populations are necessary to confirm this conclusion. These results also suggest that we cannot ignore the role of RBBB in patients with chest pain who have no history of CAD.

4.1 | Study limitations

Our study has several limitations. First, this study involved patients treated at only two hospitals. Moreover, the observational nature of the study does not permit causal inferences. Therefore, our results need to be verified in a multi-center, prospective study. As an observational analysis, our results may have been influenced by confounding factors. Patient history of BBB was investigator reported, and it is possible that some patients with new-onset BBB may have been missed. Moreover, the BBB type may have been misclassified in some patients. Lastly, the number of patients with BBB was relatively small and the lack of longitudinal follow-up preempted any assessment of the clinical impact of RBBB and LBBB on future events.

5 | CONCLUSIONS

New-onset RBBB, old RBBB, new-onset LBBB, and old LBBB were not found to predict the severity of coronary artery atherosclerosis as assessed by SYNTAX score. However, our findings should be interpreted with due caution owing to the observational nature of the study.

ETHICS STATEMENT

Because this was a retrospective observational study, the First Affiliated Hospital of Bengbu Medical College Ethics Committee granted an exemption from requiring ethics approval and waived the requirement to obtaining informed consent from eligible patients.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

AUTHOR CONTRIBUTIONS

Hong Jiang and Benfang Wang conceived and designed the study. Benfang Wang collected and analyzed the data. Tongjian Zhu and Wei Hu involved in quality control of the study and revision. Tongjian Zhu wrote the paper. Tongjian Zhu, Wei Hu and Mingxian Chen contributed to the work equally and should be regarded as co-first authors. Hong Jiang and Benfang Wang contributed to the work equally and should be regarded as Co-corresponding. The manuscript was approved by all above authors.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the First Affiliated Hospital of Bengbu Medical College. But restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are, however, available from the authors upon reasonable request and with permission of the First Affiliated Hospital of Bengbu Medical College.

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REFERENCES

Ahmad A, Ravindra B, Abnash J, Dar I, Jain S, Warden B, Gharib W. (2016). Comorbidities of chronic complete right bundle branch block and correlations with coronary angiographic findings. *American Journal of the Medical Sciences*, *351*(1), 97–100

Amal P, Singh BK, George AA, Thomson VS, Mani T, Sharathbabu NM. (2020). Electrocardiographic Predictors of Mortality in Acute Anterior Wall Myocardial Infarction With Right Bundle Branch Block and Right Precordial Q-Waves (qRBBB). *Canadian Journal of Cardiology*, *36*, 1764–1769

Bansilal S, Aneja A, Mathew V, Reeder GS, Smars PA, Lennon RJ, Wiste HJ, Traverse K, Farkouh ME. (2011). Long-term cardiovascular outcomes in patients with angina pectoris presenting with bundle branch block. *American Journal of Cardiology*, *107*(11), 1565–1570

Bristow MR, Saxon LA, Boehmer J, Krueger S, Kass DA, De Marco T, Carson P, DiCarlo L, DeMets D, White BG, DeVries DW, Feldman AM, Comparison of Medical Therapy, Pacing, and Defibrillation in Heart Failure (COMPANION) Investigators (2004). Cardiac-resynchronization therapy with or without an implantable defibrillator in advanced chronic heart failure. *New England Journal of Medicine*, *350*, 2140–2150

Bussink Barbara E, Holst Anders G, Lasse J, Deckers JW, Jensen GB, Prescott E. (2013). Right bundle branch block: prevalence, risk factors, and outcome in the general population: results from the Copenhagen City Heart Study. *European Heart Journal*, *34*, 138–146

Chan WK, Goodman SG, Brieger D, Fox KA, Gale CP, Chew DP, Udell JA, Lopez-Sendon J, Huynh T, Yan RT, Singh SM, Yan AT, ACS I and GRACE Investigators. (2016). Clinical characteristics, management, and outcomes of acute coronary syndrome in patients with right bundle branch block on presentation. *American Journal of Cardiology*, *117*(5), 754–759

Corrigendum to: 2018 ESC/EACTS Guidelines on myocardial revascularization. *European Heart Journal*, (2019) *40*, 3096

Di Marco A, Rodriguez M, Cinca J, Bayes-Genis A, Ortiz-Perez JT, Ariza-Solé A, Sanchez-Salado JC, Sionis A, Rodriguez J, Toledano B, Codina P, Solé-González E, Masotti M, Gómez-Hospital JA, Cequier Á, Anguera I. (2020). New Electrocardiographic Algorithm for the Diagnosis of Acute Myocardial Infarction in Patients With Left Bundle Branch Block. *Journal of the American Heart Association*, *9*, e015573

Jun, W, Xing, L, Jun, P, Jin S, Jia L, Li X, Liu F, Yang Y. (2019). Mean platelet volume and coronary plaque vulnerability: an optical coherence tomography study in patients with non-ST-elevation acute coronary syndrome. *BMC Cardiovascular Disorders*, *19*, 128

Kawashima, T., & Sasaki, H. (2011). Gross anatomy of the human cardiac conduction system with comparative morphological and developmental implications for human application. *Ann. Anat*, *193*, 1–12

Khot, UN, Khot, MB, Bajzer, CT, Sapp, SK, Ohman, EM, Brener, SJ, Ellis, SG, Lincoff, AM, Topol, EJ. (2003). Prevalence of conventional risk factors in patients with coronary heart disease. *JAMA*, *290*, 898–904

Kiehl Erich, L, Venu, M, Mandsager Kyle, T, Wolski, KE, Wisniewski, L, Nissen, SE, Lincoff, AM, Borer, JS, Lüscher, TF, Cantillon, DJ. (2019). Effect of Left Ventricular Conduction Delay on All-Cause and Cardiovascular Mortality (from the PRECISION Trial). *American Journal of Cardiology*, *124*, 1049–1055

Messerli Franz, H, Hofstetter, L, Rimoldi Stefeno, F, Rexhaj, E, Bangalore, S. (2019). Risk Factor Variability and Cardiovascular Outcome: JACC Review Topic of the Week. *Journal of the American College of Cardiology*, *73*, 2596–2603

Meyer Matthias R, Dragana R, Giovanni, P, Rickli, H, Roffi, M, Rosemann, T, Eberli, FR, Kurz, DJ. (2020). Differences in presentation and clinical outcomes between left or right bundle branch block and ST segment elevation in patients with acute myocardial infarction. *Eur Heart J Acute Cardiovasc Care*, *9*, 848–856

Moss, AJ, Hall, WJ, Cannom, DS, Klein H, Brown MW, Daubert, JP, Estes NA 3rd, Foster, E, Greenberg, H, Higgins, SL, Pfeffer, MA, Solomon, SD, Wilber, D, Zareba, W, MADIT-CRT Trial Investigators. (2009). Cardiac-resynchronization therapy for the prevention of heart-failure events. *New England Journal of Medicine*, *361*, 1329–1338

Neumann Johannes, T, Sörensen Nils, A, Rübsamen, N, Ojeda F, Schäfer S, Keller T, Blankenberg S, Clemmensen P, Westermann D. (2019). Right bundle branch block in patients with suspected myocardial infarction. *Eur Heart J Acute Cardiovasc Care*, *8*, 161–166

Shrivastav, R, Perimbeti, S, Casso-Dominguez, A. Jneid H, Kwan T, Tamis-Holland JE. (2021). In Hospital Outcomes of Patients With Right Bundle Branch Block and Anterior Wall ST-Segment Elevation Myocardial Infarction (From a Nationwide Study Using the National Inpatient Sample). *American Journal of Cardiology*, *140*, 20–24

Sianos, G, Morel, MA, Kappetein, AP, Morice, MC, Colombo, A, Dawkins, K, van den Brand, M, Van Dyck, N, Russell, ME, Mohr, FW, Serruys, PW. (2005). The SYNTAX Score: an angiographic tool grading the complexity of coronary artery disease. *EuroIntervention*, *1*, 219–227

Sorensen, JT, Stengaard, C, Sorensen, CA, Thygesen K, Bøtker HE, Thuesen L, Terkelsen CJ. (2013). Diagnosis and outcome in a prehospital cohort of patients with bundle branch block and suspected acute myocardial infarction. *Eur Heart J Acute Cardiovasc Care*, *2*(2), 176–181

Strauss David, G, Zak, L, Selvester Ronald, H. Gerstenblith G, Tomaselli G, Weiss RG, Wagner GS, Wu KC. (2013). Right, but not left, bundle branch block is associated with large anteroseptal scar. *Journal of the American College of Cardiology*, *62*, 959–967

Widimsky, P, Rohác, F, Stásek, J, Kala P, Rokyta R, Kuzmanov B, Jakl M, Poloczek M, Kanovsky J, Bernat I, Hlinomaz O, Belohlávek J, Král A, Mrázek V, Grigorov V, Djambazov S, Petr R, Knot J, Bílková D, Fischerová M, Vondrák K, Maly M, Lorencová A. (2012). Primary angioplasty in acute myocardial infarction with right bundle branch block: should new onset right bundle branch block be added to future guidelines as an indication for reperfusion therapy? *European Heart Journal*, *33*, 86–89

Willems, JL, Robles de Medina, EO, Bernard, R. et al (1985). Criteria for intraventricular conduction disturbances and pre-excitation. World Health Organizational/International Society and Federation for Cardiology Task Force Ad Hoc. *Journal of the American College of Cardiology*, *5*, 1261–1275

Witt, CM, Wu, G, Yang, D, Hodge DO, Roger VL, Cha YM. (2016). Outcomes with left bundle branch block and mildly to moderately reduced left ventricular function. *JACC Heart Fail*, *4*, 897–903

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