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CME ARTICLE

ECGs of structural heart disease: Part 2

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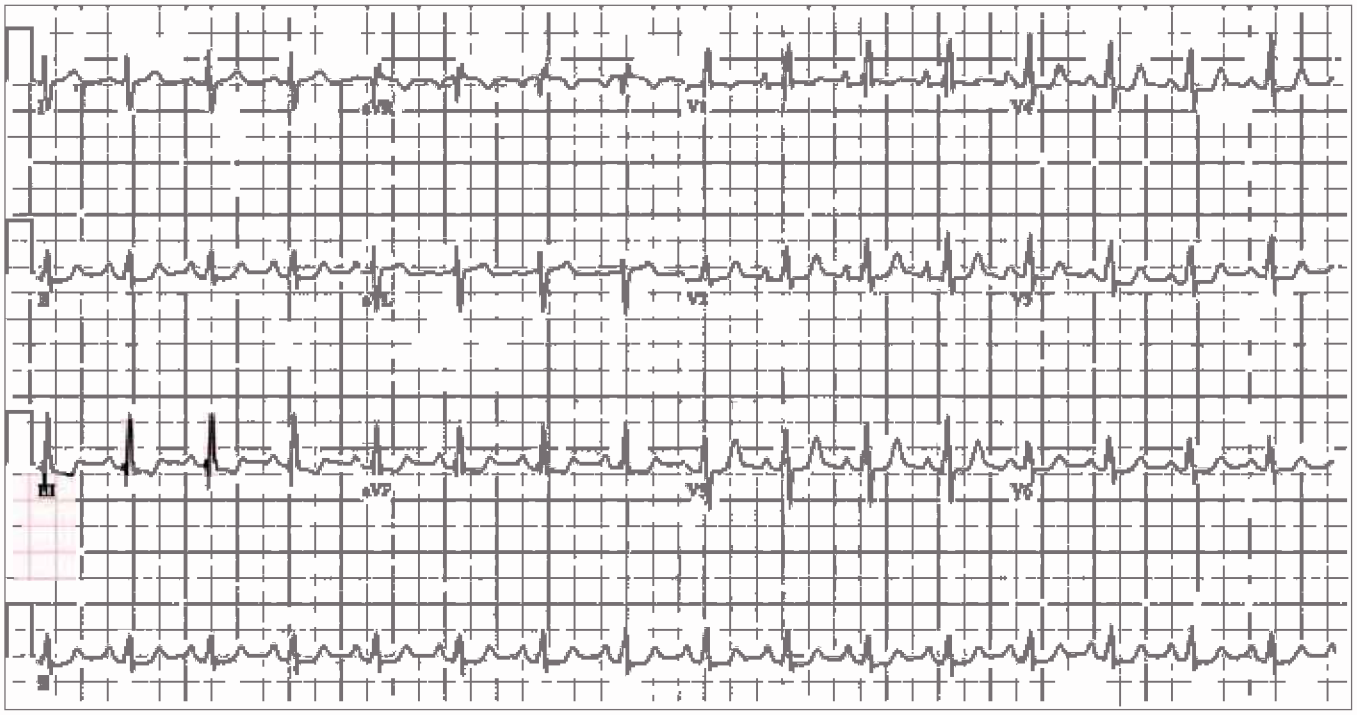

Fig. 1 ECG shows sinus rhythm, right axis deviation and incomplete right bundle branch block.

CASE 1

CLINICAL PRESENTATION

A 37-year-old woman with a history of chest pain, intermittent episodes of shortness of breath and reduced effort tolerance was seen at the cardiac clinic. On examination, she was found to have a fixed split second heart sound and a pansystolic murmur at the apex. What does the electrocardiogram (ECG) in Fig. 1 show?

ECG INTERPRETATION

The ECG shows incomplete right bundle branch block (RBBB) with a right axis deviation of + 103°, sinus rhythm, QRS duration of less than 120 milliseconds (ms) and an rsR′ pattern in V1.

CLINICAL COURSE

Transoesophageal echocardiography showed ostium secundum atrial septal defect (ASD) with significant left-to-right shunting. The defect size measured 24 mm anteroposteriorly and 22 mm superoinferiorly (Fig. 2). There was concomitant mild-to-moderate mitral regurgitation (due to mitral valve prolapse) and moderate pulmonary hypertension. The pulmonary artery systolic pressure (PASP) was 67 mmHg. In addition, both the right atrium and right ventricle were dilated, with moderate right ventricular dysfunction.

The patient underwent a successful ASD closure with an Amplatzer device (arrow in Fig. 3). A routine follow-up echocardiogram six months later showed an improvement in PASP to 38 mmHg. There was no shunt across the device (arrow), as visualised on transthoracic echocardiography (Fig. 4). Incidentally, the patient was admitted 2.5 years after the ASD closure, for atypical chest pain. Her ECGs at the emergency department and subsequently in the ward were normal. There was an absence of RBBB.

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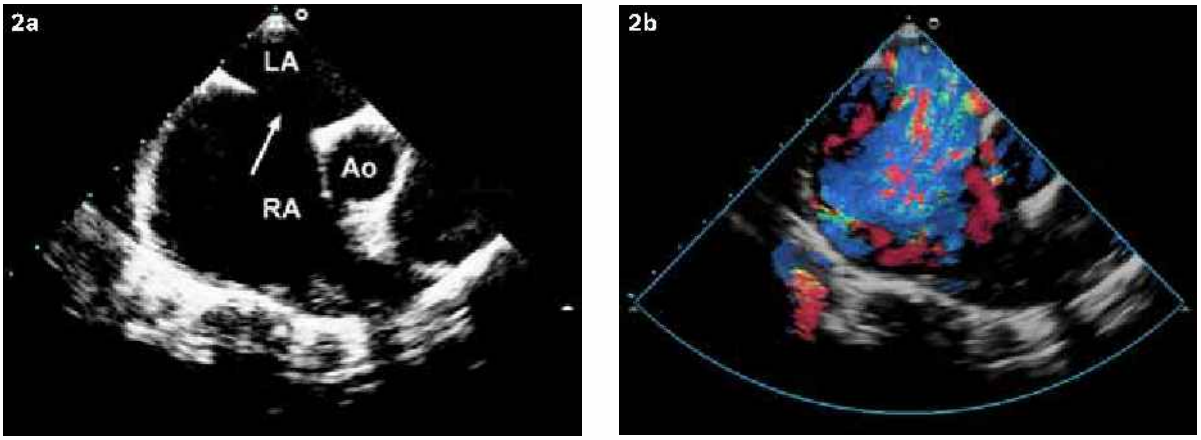

Fig. 2 Transoesophageal echocardiography images show (a) a large atrial septal defect (arrow); and (b) left-to-right shunting across the defect on colour Doppler (Ao: aorta; LA: left atrium; RA: right atrium).

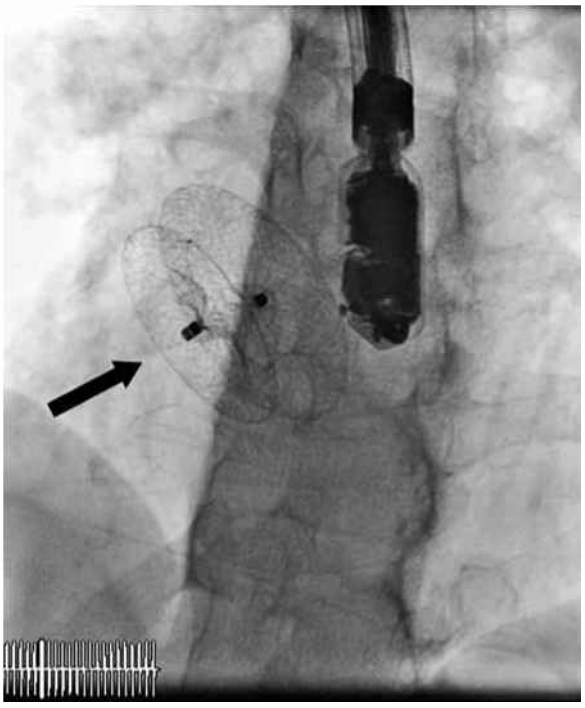

Fig. 3 Fluoroscopic image shows the atrial septal defect closed with an Amplatzer device (arrow).

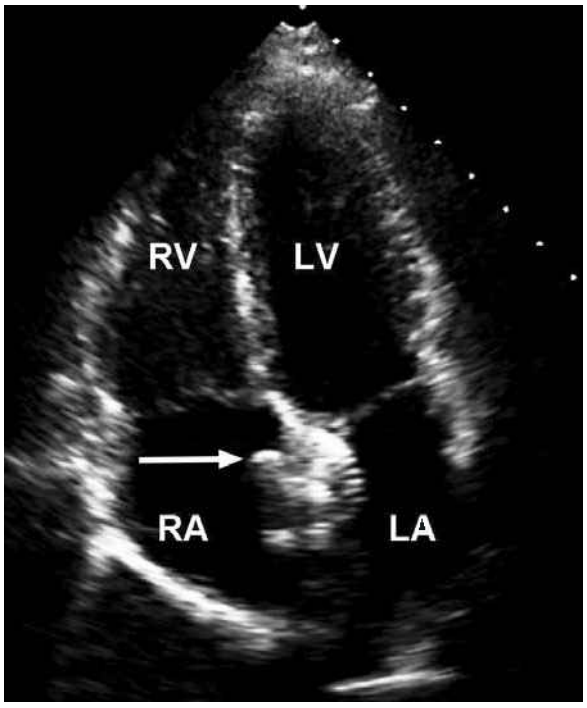

Fig. 4 Transthoracic echocardiography image shows the Amplatzer closure device *in-situ* (arrow) (LA: left atrium; LV: left ventricle; RA: right atrium; RV: right ventricle).

CASE 2

CLINICAL PRESENTATION

A 38-year-old man was found to have congenital heart disease at the age of 18 months. He had a hypercyanotic spell at three years of age, and was diagnosed to have tetralogy of Fallot and supravalvular pulmonary stenosis, for which he underwent surgical correction. What does the ECG in Fig. 5 show?

ECG INTERPRETATION

The ECG shows complete RBBB. The rhythm is sinus. The ventricular complex shows an rSR′ pattern with a prominent R′ wave. The QRS duration is 180 ms. The S wave is wide in lateral leads I, aVL, V5 and V6. T wave inversions in V1 and V2 are secondary repolarisation changes of the RBBB.

CLINICAL COURSE

Currently, the patient is being followed up at the adult congenital heart disease clinic, and his last echocardiography showed mildly dilated right ventricle with normal left ventricular function, mild-to-moderate aortic regurgitation and severe pulmonary regurgitation.

CASE 3

CLINICAL PRESENTATION

A 60-year-old woman was seen at the cardiac clinic following an abnormal ECG after hysterectomy. What does the ECG in Fig. 6 show?

ECG INTERPRETATION

The ECG shows complete left bundle branch block (LBBB) with left axis deviation. The QRS duration is wide and more than 120 ms. The R wave is negative in the right-sided precordial leads V1–V3 and is positive in the left precordial leads V4–V6.

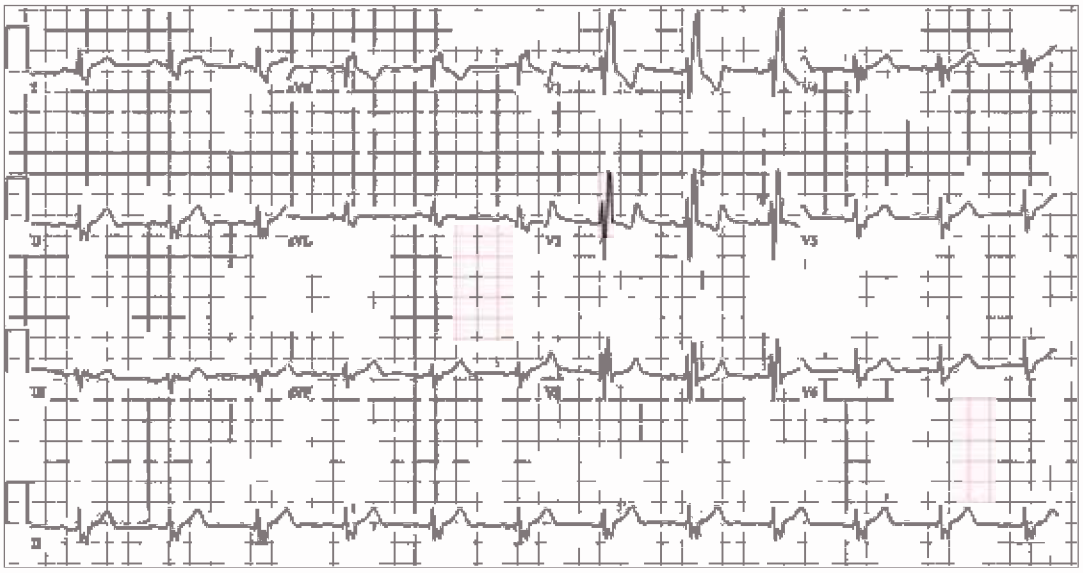

Fig. 5 ECG shows complete right bundle branch block.

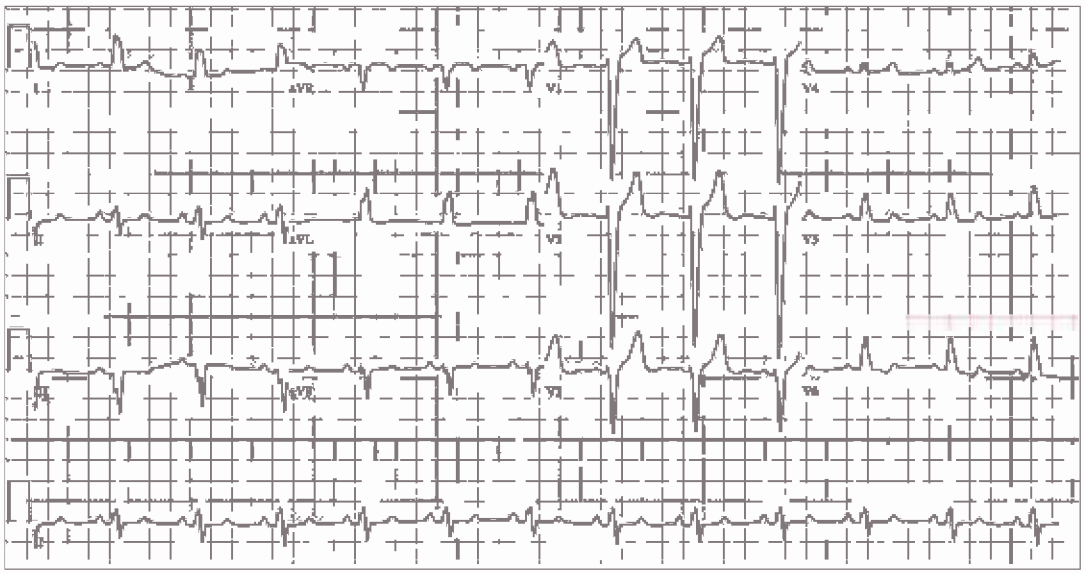

Fig. 6 ECG shows complete left bundle branch block with the QRS duration > 120 ms.

CLINICAL COURSE

The patient had a normal echocardiogram, and a subsequent computed tomographic coronary angiogram showed only minor coronary artery disease.

DISCUSSION

The ECGs in Case 1, 2 and 3 demonstrate incomplete RBBB, complete RBBB and complete LBBB, respectively. Bundle branch block results in QRS interval prolongation and changes in the QRS vector, which orients in the direction of the delayed depolarisation. Conduction down the right and the left bundle branch results in simultaneous activation of the right and left ventricle, respectively. Bundle branch block occurs due to a delay or complete cessation of conduction through specialised conduction tissues, in which case it is activated through non-specialised conduction tissues.

The World Health Organisation (WHO)/International Society and Federation of Cardiology (ISFC) task force ECG criteria[1] for incomplete RBBB are defined by QRS interval between 110 ms and 120 ms[2] and (a) an rsr′, rsR′ or Rsr′ in the right precordial leads; (b) wide S wave in leads V5–V6 and lead I. The criteria for the diagnosis of complete RBBB[1] include: (a) QRS duration ≥ 120 ms in adults; (b) an rsr′, rsR′, or rSR′ in lead V1 or V2. The R′ or r′ deflection is usually wider than the initial R wave. In a minority of patients, a wide and often notched R wave pattern may be seen in leads V1 and/or V2; (c) S wave duration > R wave duration or > 40 ms in leads I and V6; (d) R peak time is increased (> 50 ms) in lead V1 but normal in leads V5 and V6.

The WHO/ISFC task force ECG criteria[1] for the diagnosis of complete LBBB include: (a) QRS duration ≥ 120 ms; (b) broad notched or slurred R wave in the left-sided leads (I, aVL, V5-V6) and an occasional RS pattern in V5 and V6 that is attributed to displaced transition of QRS complex; (c) absent Q waves in the left-sided leads, with a possible exception in lead aVL, where a narrow Q wave may be present in the absence of myocardial pathology; (d) R peak time > 60 ms in leads V5 and V6, but

normal in leads V1, V2 and V3, when small initial r waves can be discerned in the above leads. The American Heart Association/American College of Cardiology Foundation and Heart Rhythm Society consensus document published in 2009 reviewed the earlier WHO/ISFC criteria and recommended some minor alterations.[2]

The prevalence of bundle branch block increases with age, at an incidence of 1% from age 50 years to 17% at the age of 80 years.[3] RBBB could occur due to a sudden increase in the right ventricular pressure, leading to stretch or trauma along the course of the right bundle that runs beneath the endocardial surface. RBBB could occur in pulmonary embolism, hypertension, myocardial infarction and other ischaemic heart disease, myocarditis, congenital heart disease such as ASD, degenerative disease of the conducting system and transiently during right heart catheterisation.

RBBB can occur in patients with a structurally normal heart, and the long-term outcome in this situation is good when compared to patients with underlying heart disease. In one study, it was found that 94% of patients with complete RBBB and no evidence of cardiovascular disease had good prognoses.[4] RBBB in healthy adults does not result in an increase in mortality due to myocardial infarction, heart failure and all-cause mortality.[5] Patients with isolated incomplete and complete RBBB generally do not require any treatment. However, in patients with pre-existing or associated cardiovascular abnormalities, RBBB is associated with increased mortality.[6]

The prevalence of LBBB is less than 1%. LBBB usually exists in the presence of organic disease. It has been associated with a high prevalence of cardiovascular diseases,[7,8] such as coronary artery disease, hypertension, myocarditis,[12] cardiomyopathies and valvular heart disease. However, in Case 3, LBBB was not associated with structural heart disease. In patients with LBBB, treadmill test is not an ideal choice, as ECG interpretation would be inconclusive. On a separate note, new LBBB during exercise may be associated with subsequent major cardiac events.[13] LBBB has been associated with increased mortality[7,9,10] and is an independent predictor of heart failure, sudden death, cardiovascular death and all-cause mortality in patients with ischaemic heart disease.[9,11]

Patients with heart failure and LBBB could have poor outcomes due to dyssynchrony of the ventricles, and a longer QRS duration is associated with significant left ventricular systolic dysfunction[14] These patients would benefit from cardiac resynchronisation therapy and implantable cardioverter-defibrillator to reduce the risk of heart failure events and mortality.[15,16]

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ABSTRACT Electrocardiography (ECG) is a simple, non-invasive tool to identify cardiac conduction abnormalities. Bundle branch blocks are frequently associated with various medical conditions, some of which could be life threatening if not treated. Right bundle branch block is relatively common when compared to left bundle branch block. Echocardiography is helpful for identifying any structural abnormalities in order to ascertain the prognostic significance of a bundle branch block. Diagnostic tests such as nuclear stress test, multislice computed tomography coronary angiogram, and even invasive coronary angiogram, may be indicated in selected patients.

Keywords: ECG, echocardiography, left bundle branch block, right bundle branch block

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SINGAPORE MEDICAL COUNCIL CATEGORY 3B CME PROGRAMME

(Code SMJ 201202A)

	True	False
Question 1. The following are the ECG criteria for diagnosis of incomplete right bundle branch block:		
(a) QRS < 120 ms.	☐	☐
(b) Wide S wave in V5 and V6.	☐	☐
(c) rsR′ in lead V1.	☐	☐
(d) ST segment depression and T wave inversion.	☐	☐
Question 2. Right bundle branch block could be associated with the following conditions:		
(a) Atrial septal defect.	☐	☐
(b) Myocardial infarction.	☐	☐
(c) Pulmonary embolism.	☐	☐
(d) Following right heart catheterisation.	☐	☐
Question 3. The following are the ECG criteria for diagnosis of complete left bundle branch block:		
(a) QRS > 120 ms.	☐	☐
(b) Right axis deviation.	☐	☐
(c) Absence of Q waves in the lateral leads.	☐	☐
(d) ST and T wave changes are in the direction opposite to the dominant wave.	☐	☐
Question 4. The causes of left bundle branch block include:		
(a) Myocardial infarction.	☐	☐
(b) Cardiomyopathy.	☐	☐
(c) Pulmonary hypertension.	☐	☐
(d) Conduction tissue disease.	☐	☐
Question 5. Following a long haul flight, a 60-year-old man presents to the emergency department with a sudden onset of chest pain. He was noted to have a blood pressure of 90/60 mmHg and a heart rate of 120 beats per minute. His ECG shows incomplete right bundle branch block. The most likely diagnosis is:		
(a) Pulmonary embolism.	☐	☐
(b) Myocardial infarction.	☐	☐
(c) Pneumothorax.	☐	☐
(d) Pleurisy.	☐	☐

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(1) Answers will be published in the SMJ April 2012 issue. (2) The MCR numbers of successful candidates will be posted online at www.sma.org.sg/cme/smj by 19 March 2012. (3) All online submissions will receive an automatic email acknowledgment. (4) Passing mark is 60%. No mark will be deducted for incorrect answers. (5) The SMJ editorial office will submit the list of successful candidates to the Singapore Medical Council. (6) One CME point is awarded for successful candidates.

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