Assessment of an incidental finding of left bundle–branch block

Incidental left bundle–branch block occurs in up to 1.5% of healthy adults without symptoms or signs of cardiovascular disease. It may be found during investigation for non-cardiac disease, during preoperative assessment, private health screening or inpatient monitoring. This article outlines how to assess these patients.

Left bundle–branch block refers to a conduction block in any part of the left-sided conduction pathway, from the bundle of His to the fascicles (*Figure 1*), which slows the depolarization and contraction of the left ventricle.

Figure 1. Schematic of the heart's conduction system, demonstrating (a) normal conduction and (b) left bundle–branch block.

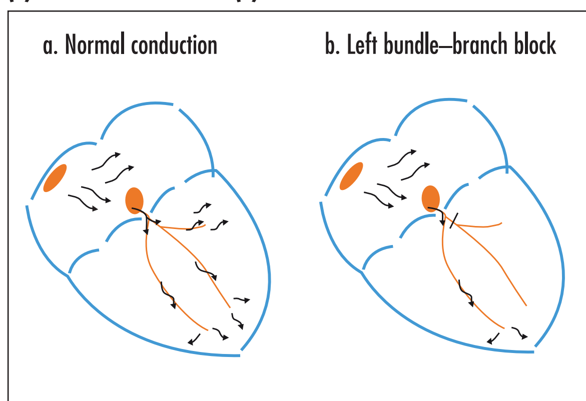
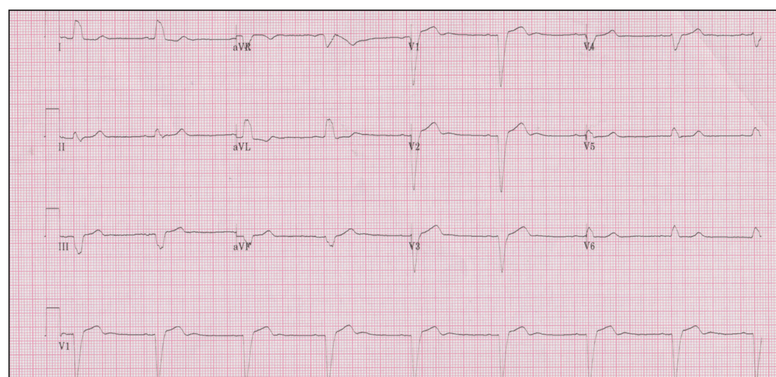


Figure 2. A 12-lead electrocardiogram demonstrating left bundle–branch block, with a broad QRS duration (162 ms) and sinus bradycardia (rate 49 bpm). Note the QS complex in lead V1 and R wave in lead V6.



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Specifically, left bundle–branch block may result in early activation and contraction of the inter-ventricular septum and late activation of the posterior and lateral wall, resulting in inter- and intra-ventricular dyssynchrony, leading to left ventricular systolic dysfunction in up to 28% of patients (Schneider et al, 1979). However, the largest longitudinal study of 110 000 patients followed up for over 9 years found no difference in survival between patients with left bundle–branch block and matched controls (Fahy et al, 1996).

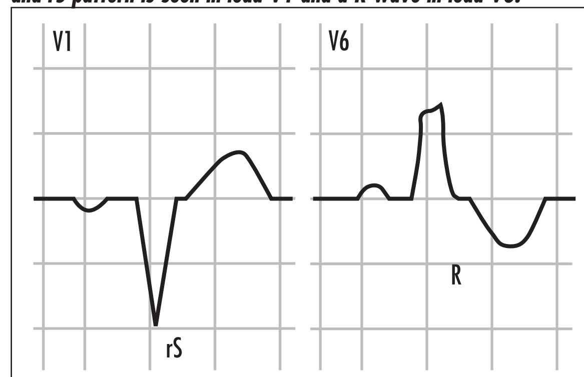
Left bundle–branch block is identified by a characteristic QRS pattern seen on the electrocardiogram (*Figure 2*), classically a QRS duration greater than 120 ms, a QS or rS complex (W shape) in lead V1 and R or RsR' complex (M shape) in lead V6 (*Figure 3*).

Incidental left bundle–branch block occurs in up to 1.5% of healthy adults without symptoms or signs of cardiovascular disease (Francia et al, 2007). It may be found during investigation for non-cardiac disease, during preoperative assessment, private health screening and during inpatient monitoring. This article reviews how to assess patients with incidental left bundle–branch block, which can be daunting for the non-specialist.

Which clinical features are important?

Following the discovery of an 'incidental' finding, a focused clinical assessment should be undertaken to rule out significant, quiescent disease.

Figure 3. A schematic of the QRS complex seen in on an electrocardiogram in left bundle–branch block. A broad QRS duration and rS pattern is seen in lead V1 and a R wave in lead V6.



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History

Does the patient have any previously undeclared symptoms of chest tightness, breathlessness or syncope? A past, social and family history should identify any relevant risk factors, cardiovascular disease or first-degree relatives with ischaemic heart disease or sudden death.

Examination

The patient should undergo cardiovascular examination, for signs of a cause of left bundle–branch block, such as aortic stenosis or hypertension, or consequences of left bundle–branch block such as left ventricular systolic dysfunction-heart failure or bradycardia.

Which patients to refer

A history or examination suggesting acute myocardial ischaemia, sustained loss of consciousness or acute heart failure warrants urgent inpatient assessment. If there are no such adverse findings, then outpatient investigation is appropriate.

What are the first-line investigations?

Blood tests

Left bundle–branch block is caused by ischaemic heart disease most commonly, but also rarely hyperkalaemia, hyperglycaemia, sarcoidosis and myocarditis, so a full blood count, renal function, liver function, cholesterol, serum glucose and C-reactive protein levels should be checked in all patients.

Transthoracic echocardiography

Transthoracic echocardiography is a non-invasive imaging technique, using ultrasound waves to interrogate the structure and function of the heart, such as the presence and severity of left ventricular hypertrophy, left ventricular systolic dysfunction and valvular heart disease. All patients with incidental left bundle–branch block should undergo echocardiography. A small retrospective cohort study suggests that even in the presence of a structurally normal heart, the finding of left bundle–branch block may not be benign (Miller et al, 2005).

24-hour Holter monitor

A Holter monitor is a wearable device that records a 3-lead electrocardiogram for a period of 24 hours. This is indicated only if patients report symptoms of dizziness or syncope in the presence of coexisting atrioventricular block, suggesting diffuse conduction system disease. Two small, well-designed prospective studies, demonstrated that while 13% of patients with left bundle–branch block will develop higher degree atrioventricular block it may not be possible to predict this from the electrocardiogram alone (Eriksson et al, 2005; Boulé et al, 2014). As a result, some authors advocate an invasive strategy including electrophysiological study and implantable loop recorder in all patients, but the cost efficacy or impact on morbidity or mortality is unknown (Moya et al, 2011).

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Which patients to refer

The following should be routinely referred to outpatients:

- Patients for whom echocardiography or Holter monitoring is not available
- Patients with identification of an asymptomatic cause, e.g. aortic stenosis
- Patients with identification of an asymptomatic consequence, e.g. left ventricular dysfunction
- Patients with a finding of asymptomatic bradycardia
- Patients with alternating left and right bundle–branch block
- Patients with pauses longer than 3 seconds during Holter monitoring.

If blood tests, echocardiography and/or the Holter monitor are normal, the patient does not require referral, but should be given a copy of the electrocardiogram and reassured.

What subsequent investigations should be performed?

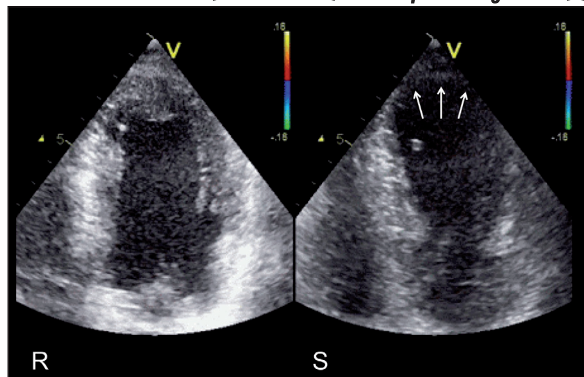
Assuming no other cause has been identified, the next step is to definitively rule out ischaemic heart disease. In the presence of left bundle–branch block, conventional exercise tolerance testing cannot be used as the ST segment is uninterpretable and so non-invasive imaging modalities are used. If ischaemic heart disease is identified, its severity and reversibility are assessed, but if the patient is asymptomatic only multi-vessel or left mainstem disease will lead to consideration of revascularization and prognostic benefits.

Stress echocardiography

Stress echocardiography images the left ventricle at rest and during stress, either physical, e.g. static cycling, or pharmacological, e.g. dobutamine. In the presence of significant disease, stress induces dynamic, or exacerbates pre-existing, left ventricular systolic dysfunction (*Figure 4*).

A meta-analysis of over 64 studies which included incidental left bundle–branch block showed that while the sensitivity of stress echocardiography for detecting any ischaemic heart disease in the presence of left bundle–branch block was similar to myocardial perfusion scan (74.6 *vs* 88.5%), stress echocardiography was significantly

Figure 4. Stress echocardiogram showing normal contraction of the left ventricle (apical 4-chamber view) during rest (R), with impaired contraction and dilation (white arrows) of the apex during stress (S).



more specific (88.7 *vs* 41.2%) (Biagini et al, 2006). Three large, well-conducted prospective cohort studies showed that in the presence of a normal stress echocardiogram, there is no increased risk of mortality during medium term follow up (over 4 years) in patients with incidental left bundle–branch block (Bouzas-Mosquera et al, 2009; Cortigiani et al, 2013; Supariwala et al, 2014).

Stress echocardiography is widely available, uses no ionizing radiation and has high spatial resolution but image acquisition is challenging in patients who are obese, or those with lung disease or poor acoustic windows.

Myocardial perfusion study

A myocardial perfusion scan uses a radiolabelled agent taken up by the myocardium, the radiation emitted is then detected by a gamma camera. In the presence of reversible ischaemia there is reduced uptake of the agent during physical or pharmacological stress (*Figure 5*) and in the presence of infarction, reduced uptake at rest and stress.

In addition to the above meta-analysis, two well-conducted small cohort studies compared myocardial perfusion scan with stress echocardiography in the diagnosis of any ischaemic heart disease in patients with incidental left bundle–branch block (Soylu et al, 2008; Pavlovic et al, 2010). The sensitivity of the myocardial perfusion scan was equal to stress echocardiography (88–100 *vs* 88–100%) but the specificity (29–80 *vs* 84–94%) was considerably lower, supporting previous findings. Finally a prospective cohort study showed that in the presence of a normal myocardial perfusion scan, patients with left bundle–branch block have no increased risk of mortality, during short-term (less than 4 years) follow up (Wagdy et al, 1998).

Myocardial perfusion scanning is widely available and well validated but is limited by long acquisition protocols, relatively low temporal resolution, motion artefacts, high false positive (46%) rate when used with exercise and radiation between 6–9 mSv (a plain chest film is 0.02 mSv) (Vaduganathan et al, 1996).

Cardiovascular magnetic resonance

Cardiac magnetic resonance uses magnetic fields at a resonance frequency to excite hydrogen atoms in cardiac tissue; the radiofrequency signal emitted is detected and converted into an image. Images are taken at rest and during administration of a pharmacological stressor, e.g. adenosine, during which a gadolinium-based contrast agent is used to assess myocardial viability. This is termed first pass perfusion, where the normally perfused myocardium changes from black to grey but areas of ischaemia (perfusion defects) will turn grey slower than the surrounding tissue. Infarction or fibrosis is seen 10 minutes after gadolinium administration where the affected area of myocardium remains bright, termed late gadolinium enhancement (*Figure 6*).

A single, well-designed cohort study used cardiac magnetic resonance to investigate ischaemic heart disease in the presence of left bundle–branch block, comparing it to stress echocardiography with invasive angiography used as the reference standard (Mordi et al, 2014). Cine cardiac magnetic resonance had the same sensitivity (72%) but higher specificity (95% *vs* 72%) than stress echocardiography, which increased to 82% and 95% with addition of first pass perfusion and late gadolinium enhancement. However, there are no studies comparing cardiac magnetic resonance to myocardial perfusion imaging or computed tomography.

Independent of body habitus, cardiac magnetic resonance has high spatial and temporal resolution and uses no ionizing radiation, but it is not as widely available as stress echocardiography or myocardial perfusion imaging, is more costly and is contraindicated with certain implantable devices, pregnancy and end-stage renal disease.

Computed tomography

Computed tomography uses ionizing radiation emitted and detected from a rotating gantry, together with iodinated contrast, to build a three-dimensional reconstruction of the heart and vessels (*Figure 7*).

A single, small, well-conducted cohort study investigated the accuracy of computed tomography in patients with left bundle–branch block in diagnosing is ischaemic heart disease *vs* invasive coronary angiography. This study showed high sensitivity (97%) and high specificity (99%) but no other imaging modality was used as a comparator (Ghostine et al, 2006).

Computed tomography has high spatial resolution, rapid data acquisition, and unlike other imaging studies

Figure 5. Myocardial perfusion scan demonstrating normal perfusion of the left ventricle (in the sagittal plane) at rest (R) in the bottom images, with impaired perfusion (white arrow heads) of the apex and anterior walls during stress (S) in the top images.

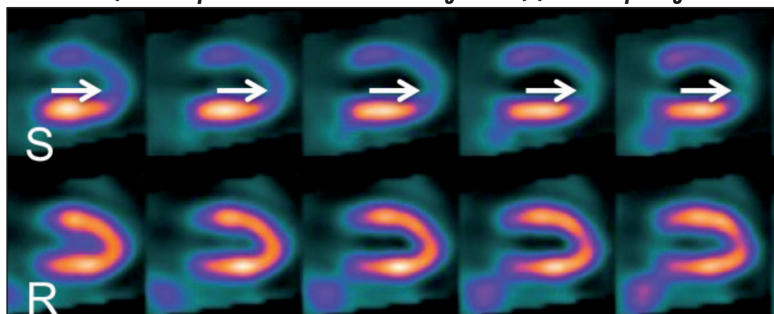
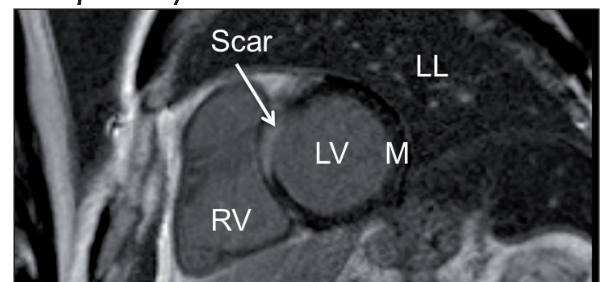


Figure 6. Cardiac magnetic resonance scan demonstrating the left ventricle (LV) and (RV) in short axis along the sagittal plane. The left lung (LL) is seen next to the normal dark myocardium (M) with bright late gadolinium enhancement of the septum, suggesting scar from a previous myocardial infarction.



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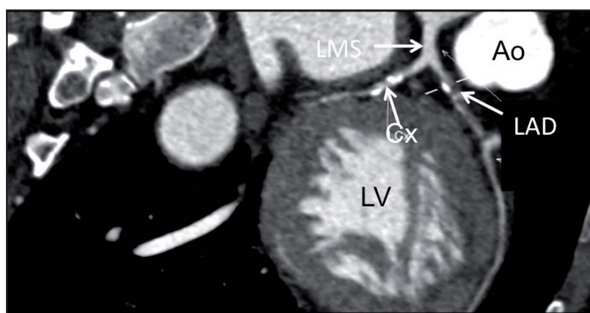

Figure 7. Axial cardiac computed tomography showing the left ventricle (LV), aorta (Ao) and left main stem (LMS). There is calcified atherosclerotic plaque in the circumflex (Cx) artery and mixed soft/calcified plaque in the left anterior descending artery (LAD).

previously discussed can assess coronary anatomy in detail; however, even with modern multi-detector gantries, the dose of radiation remains 2–5 mSv.

Invasive coronary angiography

If a functional study suggests significant and reversible ischaemic heart disease, and the patient has previously undeclared symptoms of myocardial ischaemia, invasive coronary angiography may be used to delineate precisely the location and severity of the coronary atherosclerosis. However, it should not be used as a first-line investigation, or in asymptomatic patients, as 70% of patients with incidental left bundle–branch block will have a normal study and it does not assess causes other than ischaemic heart disease (Herbert, 1975). Furthermore it is invasive, uses ionizing radiation (4–6 mSv) and has a risk of serious complications (e.g. 1% risk of vascular injury and 0.1% risk of myocardial infarction, stroke or death).

Conclusions

In investigation of ischaemic heart disease causing incidental left bundle–branch block, there are no studies directly comparing all modalities, no prospective studies following a normal computed tomography/cardiac magnetic resonance scan and no randomized controlled trials. Stress echocardiography has the most robust evidence, so should be used first line if available. Cardiac magnetic resonance and computed tomography have higher specificity and sensitivity, but based on single studies. Myocardial perfusion scanning remains first line in many centres, and while the evidence base is broad and clinical experience extensive, it lacks the specificity of other modalities. **BJHM**

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Conflict of interest: none.

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Biagini E, Shaw LJ, Poldermans D et al (2006) Accuracy of non-invasive techniques for diagnosis of coronary artery disease and prediction of cardiac events in patients with left bundle branch block: a meta-analysis. *Eur J Nucl Med Mol Imaging* **33**: 1442–51 (doi: 10.1007/s00259-006-0156-9)

Boulé S, Ouadah A, Langlois C et al (2014) Predictors of advanced His-Purkinje conduction disturbances in patients with unexplained syncope and bundle branch block. *Can J Cardiol* **30**: 606–11 (doi: 10.1016/j.cjca.2014.03.040)

Bouzas-Mosquera A, Peteiro J, Alvarez-Garcia N et al (2009) Prediction of mortality and major cardiac events by exercise echocardiography in patients with normal exercise electrocardiographic testing. *J Am Coll Cardiol* **53**: 1981–90 (doi: 10.1016/j.jacc.2009.01.067)

Cortigiani L, Rigo F, Gherardi S et al (2013) Prognostic implication of Doppler echocardiographic derived coronary flow reserve in patients with left bundle branch block. *Eur Heart J* **34**: 364–73 (10.1093/eurheartj/ehs310)

Eriksson P, Wilhelmsen L, Rosengren A (2005) Bundle-branch block in middle-aged men: risk of complications and death over 28 years: The Primary Prevention Study in Göteborg, Sweden. *Eur Heart J* **26**: 2300–6

Fahy GJ, Pinski SL, Miller DP et al (1996) Natural history of isolated bundle branch block. *Am J Cardiol* **77**: 1185–90

Francia P, Balla C, Paneni F et al (2007) Left bundle-branch block--pathophysiology, prognosis, and clinical management. *Clin Cardiol* **30**: 110–15 (doi: 10.1002/clc.20034)

Ghostine S, Caussin C, Daoud B et al (2006) Non-invasive detection of coronary artery disease in patients with left bundle branch block using 64-slice computed tomography. *J Am Coll Cardiol* **48**: 1929–34 (doi: 10.1016/j.jacc.2006.04.103)

Herbert WH (1975) Left bundle branch block and coronary artery disease. *J Electrocardiol* **8**: 317–24

Miller WL, Ballman KV, Hodge DO et al (2005) Risk factor implications of incidentally discovered uncomplicated bundle branch block. *Mayo Clinic Proc* **80**: 1585–90 (doi: 10.4065/80.12.1585)

Mordi I, Stanton T, Carrick D et al (2014) Comprehensive dobutamine stress CMR versus echocardiography in LBBB and suspected coronary artery disease. *JACC Cardiovasc Imaging* **7**: 490–8 (doi: 10.1016/j.jcmg.2014.01.012)

Moya A, García-Civera R, Croci F et al (2011) Diagnosis, management, and outcomes of patients with syncope and bundle branch block. *Eur Heart J* **32**: 1535–41 (doi: 10.1093/eurheartj/ehr071)

Pavlovic S, Sobic-Saranovic D, Djordjevic-Dikic A et al (2010) Comparative utility of gated myocardial perfusion imaging and transthoracic coronary flow reserve for the assessment of coronary artery disease in patients with left bundle branch block. *Nucl Med Commun* **31**: 334–40 (doi: 10.1097/MNM.0b013e328335e5f2)

Schneider JF, Thomas HE Jr, Kreger BE et al (1979) Newly acquired left bundle-branch block: the Framingham study. *Ann Intern Med* **90**: 303–10

Soylu O, Celik S, Karakus G et al (2008) Transthoracic Doppler echocardiographic coronary flow imaging in identification of left anterior descending coronary artery stenosis in patients with left bundle branch block. *Echocardiography* **25**: 1065–70 (doi: 10.1111/j.1540-8175.2008.00729.x)

Supariwala AA, Po JR, Mohareb S et al (2014) Prevalence and long-term prognosis of patients with complete bundle branch block (right or left bundle branch) with normal left ventricular ejection fraction referred for stress echocardiography. *Echocardiography* **32**: 483–9 (doi: 10.1111/echo.12680)

Vaduganathan P, He ZX, Raghavan C et al (1996) Detection of left anterior descending coronary artery stenosis in patients with left bundle branch block: exercise, adenosine or dobutamine imaging? *J Am Coll Cardiol* **28**: 543–50

Wagdy HM, Hodge D, Christian TF et al (1998) Prognostic value of vasodilator myocardial perfusion imaging in patients with left bundle-branch block. *Circulation* **97**: 1563–70

KEY POINTS

- Following the discovery of incidental left bundle–branch block, a focused history and examination should assess for quiescent ischaemic, valvular or structural heart disease.
- All patients with incidental left bundle–branch block should undergo transthoracic echocardiography for investigation of possible causes and consequences.
- Patients with incidental left bundle–branch block, syncope and atrioventricular block require a 24-hour Holter monitor to rule out significant bradyarrhythmia.
- The evidence supports the use of stress echocardiography first line for ruling out ischaemic heart disease as a cause of left bundle–branch block.