# Benign early repolarisation

## A normal ECG variation

**VIVIENNE MILLER** MB BS, FRACGP, DRACOG, DCH, MACPM, MWAME

*Articles in this section are inspired by, but not based on, real cases to illustrate the importance of knowledge about ECGs in relation to clinical situations in general practice. Management is not discussed in detail.*

**Emmanuel, aged 35 years, comes to see you, his GP, because he has been declined insurance until he obtains a cardiology review as his ECG has been considered abnormal. He works part time as a bouncer and is a very muscular, well built, tall (188 cm), healthy man, who is originally from Nigeria. He takes no medications and has no past or family history of relevance. He shows you the ECG and asks you what the problem could be.**

**Q1. Is this ECG abnormal (see Figure)?**
The ECG shows a 'high take off', or elevated J point, which has probably been confused with pathological ST elevation.

**Q2. What is meant by a 'high take off'?**
The ST segment and T wave have formed a continuum because of the elevated J point. This is called a benign early repolarisation. This is hypothesised to be due to early repolarisation after slowed depolarisation of the action potential, the net result being this ECG finding. In people of Indigenous African descent (men and women), this ECG finding may be genetic because it is typical in this group of people. It may also be seen in healthy, muscular young men (Caucasian and Asian), and sometimes in women. It usually occurs in people under 50 years of age and especially under 35 years of age. It is not seen in the elderly and does not develop if it was not previously present.

**Q3. What are the typical findings of benign early repolarisation on ECG?**
Typically there is notching or slurring and elevation of the J point (the junction at the end of the QRS complex and the beginning of the ST segment on the ECG). There is terminal QRS slurring or notching (a positive deflection at the end of the QRS complex). A widespread, concave ST elevation under 0.5 mm in the limb leads and under 2 mm in the praecordial leads follows; this is best seen in the praecordial leads V2 to V5 and should occur in at least two leads in a row. T waves may be prominent and mildly asymmetrical, and (apart from aVR) are in the same direction as the QRS complex. The descending section of the T wave is steeper than the ascending section and appears straighter. It is important to note that the ECGs in patients with this variation may differ slightly depending on heart rate and it is more obvious in those with bradycardia. Over years, the ECG may also change and the changes of early depolarisation may be lost, especially in patients over 50 years of age.

The J point elevation is benign, but true J waves (Osborn waves, the marked positive deflections at the QRS-ST segment junction) are more likely to be pathological.

**Q4. What are the differential diagnoses of benign early repolarisation?**
The differential diagnoses of benign early

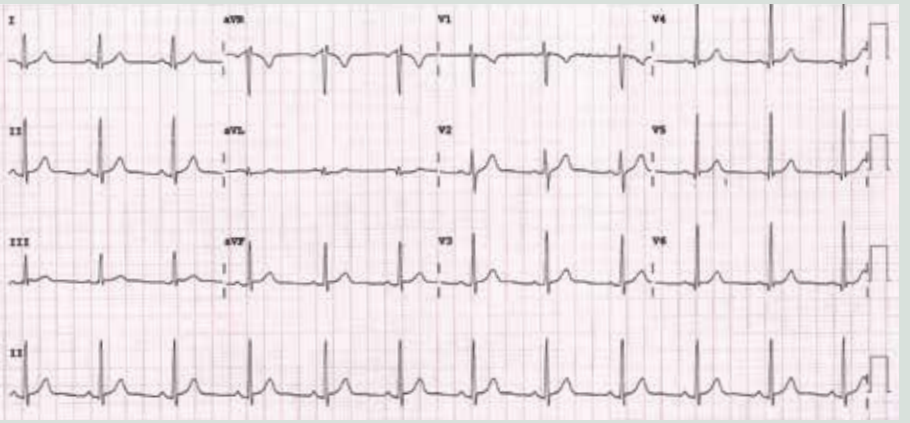

**Figure. Benign early repolarisation showing widespread concave ST segment elevation of <0.5 mm in limb leads and <2 mm in two of more contiguous praecordial leads.**

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Dr Miller is a GP in Sydney, NSW. She is also an editor, author and medical journalist and is the Medical Editor of *Cardiology Today*.

**SERIES EDITOR:** Dr Richard Hillock MB ChB, FRACP, FCSANZ is a Cardiologist and an Electrophysiologist at SA Heart Centres, South Australia.

repolarisation are pericarditis, cardiomyopathy or a widespread myocardial ischaemia. It differs from pericarditis and cardiomyopathy because an elevated J point with notching or slurring may be seen. The shape of the ST elevation is concave, but not 'scooped out' as is typical in people with pericarditis. There is no reciprocal ST depression (except in aVR) or T wave inversions seen in people with myocardial infarction, and the ST elevation is not very significant compared with the changes of putative widespread ischaemia. Importantly, the clinical picture and physical examination of all these conditions is quite different to benign early repolarisation and serial ECGs remain stable.

Osborn waves are less likely to be benign and occur with hypothermia, hypercalcaemia, brain injury, hypervagotonia (usually from spinal cord injury) and vasospastic angina.

**Q5. What do you tell Emmanuel?**

You explain that he has a normal variation in his ECG but the insurance company will still want him to see a cardiologist to confirm this. It would also help to repeat the ECG to prove there has been no change. In people of Indigenous African descent this sort of variation (plus others he does not have) are particularly common and mean nothing. These changes are also common in very fit people under the age of 50 years.

**Q6. Which groups of people commonly have ECG variations that are normal?**

- **People of Indigenous African descent.** Higher voltages may occur as a normal variation in people of Indigenous African descent (however, it should be noted that most of these studies have been carried out in African American people). T wave inversion in the praecordial leads is also very common in this group and is usually normal. However, it is always abnormal in leads V5 to V6.
- **Women.** QRS duration, voltage measurements and ECG criteria for left ventricular hypertrophy have lower accuracy in women, independent of body habitus. Women have a tendency for longer QTc intervals (and an increased risk of torsade de pointes).
- **Athletes.** Sinus bradycardia (as low as 40 beats per minute) is commonly seen as a normal variation in athletes who are asymptomatic with a normal cardiac examination and the bradycardia disappears during exercise. Athletes have an increased rate of incomplete right bundle branch block. The voltage appears increased in ECGs of athletes because of increased muscle mass. This may mimic ventricular hypertrophy. A cardiac echocardiogram is required to distinguish between pathological hypertrophy and physiological adaptation.
- **People with chest wall variations.** People with thin chest walls and reduced subcutaneous fat over the chest may appear to have high voltage on the ECG. This is also seen in people with pectus excavatum, wasting conditions and other illnesses.
- **Children and young adults.** Sinus arrhythmia is common in children and young adults. Young children tend to have a higher heart rate compared with adults. Modern ECG machines should be programmed to have an age-specific algorithm. A persistent juvenile T wave pattern consists of a T wave inversion in leads V1 to V3 in children and this is considered normal. It usually persists until the late teenage years.

Incomplete right bundle branch block is usually a normal finding, especially in young people, and occurs in up to 10% of the population. Consideration of follow up is wise in older people because of the possibility of an underlying condition, such as right ventricular hypertrophy, myocardial ischaemia or cardiomyopathy.

**Q7. What are some other variations of normal on ECGs?**

T wave inversion in lead III may be a normal variant. New T wave changes are generally not. Variations in ECG electrode placement can sometimes cause spurious new T wave changes. Incorrect voltage may cause spurious abnormalities.

Choosing a reduced voltage setting on the ECG machine produces changes similar to conditions seen in myxoedema, loss of cardiac muscle mass, severe hypovolaemia, pericardial effusion and severe chronic obstructive airways disease. Choosing an increased voltage setting on the machine produces changes similar to those of a thin chest wall, ventricular hypertrophy, increased muscle mass and cardiomyopathy.

ECG machine diagnoses are not always correct and may overdiagnose or miss abnormalities, especially variations of normal.

## Key points

- **Benign early repolarisation is hypothesised to be due to early repolarisation after slowed depolarisation of the action potential. It is a normal variation.**
- **Benign early repolarisation is typically seen in healthy muscular young men, those under the age of 50 years, and especially in people of Indigenous African descent.**
- **People of Indigenous African descent also often have T wave inversion in the praecordial leads and this is of no significance unless they are in leads V5 and V6 (which is always abnormal).**
- **People with thin chest walls and reduced subcutaneous fat over the chest may appear to have high voltage on the ECG.**
- **Right bundle branch block is common in children and is rarely of consequence.**
- **Incomplete right bundle branch block is common and usually a normal finding but may be associated with underlying pathology.**
- **Incorrect settings on the ECG machine may mimic abnormalities.**
- **Diagnoses from ECG machines are not always correct and may overdiagnose or miss abnormalities, especially variations of normal.**

**Outcome**

*Emmanuel has a repeat ECG, which is unchanged. He sees a cardiologist who organises for Emmanuel to have a cardiac echocardiography, the results of which are also normal. The cardiologist writes a report for the insurance company explaining the normal variation on the ECG. Emmanuel is now free to consider all his insurance options.* **CT**