

Left axis deviation

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.

April is a 41-year-old woman who has recently applied for life insurance. She is extremely fit, does boxing and goes to the gym most days, has no known medical problems and takes no medications. She has been to your practice numerous times for simple conditions and preventive healthcare. On one occasion, when she was suffering a viral illness, she was documented as having a mitral systolic murmur, grade 2/6, and so the insurance company required her to have an echocardiogram and ECG before considering her application. April's echocardiogram was essentially normal, showing mild mitral valve regurgitation with mild left atrial dilation, trivial tricuspid valve regurgitation and normal ventricular function, left ventricular ejection fraction and pulmonary artery pressure. Her ECG is shown in Figure 1.

CARDIOLOGY TODAY 2015; 5(3): 28-29

Dr Miller is a GP in Sydney, a medical journalist and author, and 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.

Q1. What does this ECG show?

The axis is deviated to the left. The ECG shows an upright (positive) QRS complex in lead I and is inverted (negative) in leads aVF and II (if lead II is upright, the axis is normal).

Q2. What is left axis deviation?

The axis is the overall vector describing the direction of ventricular myocardial depolarisation in the frontal plane of the heart. This relates to the relative mass of the right and left ventricle, which is dynamic during fetal life and infancy, and the electrical conduction through the His-Purkinje system that co-ordinates ventricular activation. Acquired disease of the left anterior fascicle underpins many of the causes of left axis deviation. Left axis deviation is a QRS axis between -30 and -90° (Figure 2). Left ventricular hypertrophy does not necessarily cause left axis deviation; this is controversial. It should be recalled that the normal left ventricle is always thicker than the right ventricle.

Q3. How do you calculate left axis deviation on an ECG?

There is left axis deviation if the QRS complex is upright (dominant R wave) in lead I and the QRS complex is inverted (dominant S wave) in leads aVF and II.

Figure 2 shows left and right axis deviations:

- if the QRS complex is positive in lead I but negative in lead II, the axis is leftward (-30 to -90°)
- if the QRS complex is positive (upright) in both leads I and II, the axis falls between -30 and $+90^\circ$ and is normal
- if the complexes are negative in lead I and positive in aVF, the axis is rightward ($+90$ to 180°)
- if the complexes are negative in both leads I and aVF, the axis is extreme (180 to -90°).

Q4. In what situations is left axis deviation nonpathological?

Left axis deviation may occur physiologically with age as a normal variation; however, there should be no other abnormality present on clinical examination, the ECG or the echocardiogram or other investigations if this diagnosis is made.

Nonpathological causes of left axis deviation are incorrect lead placement (the precordial leads are positioned too far to the left side or the position is swapped), which is uncommon but does occur, and if lead V1 is closer to the left ventricle, such as occurs with a more horizontal placement of the heart in the thorax (such as might occur in shorter, overweight patients and those who are obese).

Athletes not uncommonly have ECG criteria suggesting physiological left

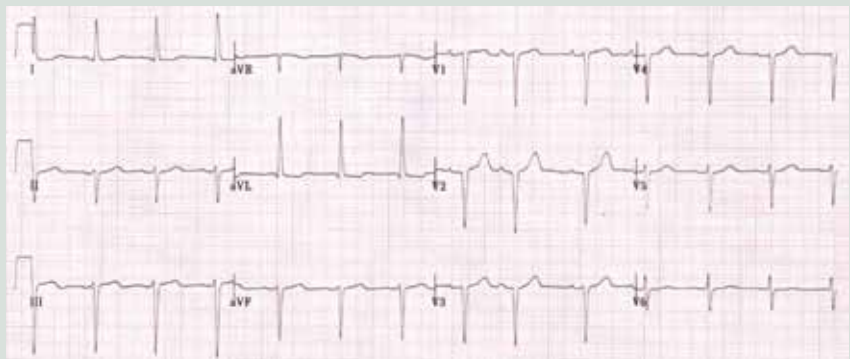


Figure 1. ECG showing left axis deviation.

Image courtesy of Life in The Fast Lane. <http://lifeinthefastlane.com>

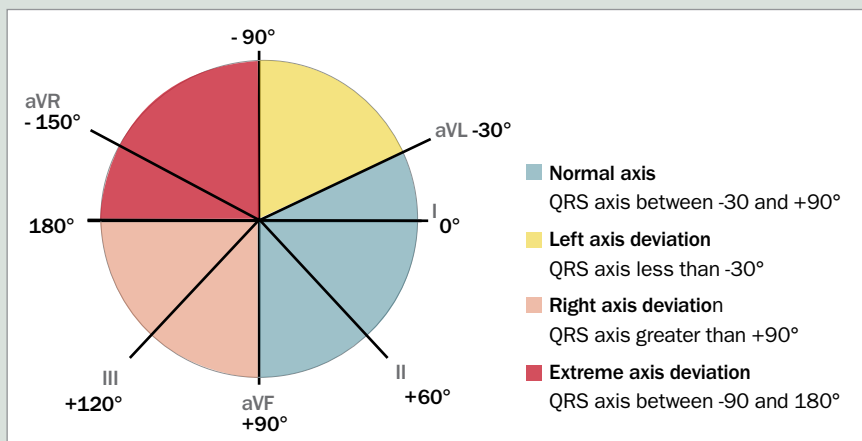


Figure 2. ECG axis interpretation.

ventricular hypertrophy, but left axis deviation is uncommon in athletes and not considered normal.

In asymptomatic patients with isolated left axis deviation, the possibility of an underlying cardiomyopathy should always be considered and long-term follow up is advised.

Q5. What medical conditions are associated with left axis deviation?

Left axis deviation is associated with the conditions listed below.

Acquired cardiac disease, in which conduction delay in the His-Purkinje system affects the cardiac axis

- Cardiomyopathy (dilated, infiltrative, hypertrophic)
- Left ventricular hypertrophy, including:
 - asymmetric septal hypertrophy (possible)
 - inferior or anterolateral myocardial infarction
 - aortic stenosis
 - hypertensive heart disease
 - neuromuscular disease.

Left ventricular hypertrophy remains linked to left axis deviation but is no longer considered to be a leading cause of the condition. Left ventricular hypertrophy does not necessarily change to overall vector of ventricular depolarisation (given the left ventricle already predominates in its effect). However, such hypertrophy may be associated with conduction system degeneration/fibrosis that can manifest as conduction delay or block in the left anterior hemifascicle and, hence, left axis deviation.

Congenital disease

- Endocardial cushion defects
- Tricuspid atresia

- Single ventricle
- Coarctation of proximal aorta.

Acquired conditions affecting ventricular activation

- Left bundle branch block
- Paced ventricular rhythm (with an apical right pacing lead)
- Ectopic ventricular rhythm
- Pre-excitation syndromes (right-sided accessory pathways)
- Hyperkalaemia.

Other

- Abnormal cardiac localisation within the thorax, including:
 - diaphragmatic displacement by pregnancy
 - ascites
 - abdominal tumour
 - shorter patients
 - overweight patients
 - achondroplasia
- Emphysema.

Q6. What investigations are indicated if a patient has left axis deviation?

A full history should be ascertained in a patient with left axis deviation, especially any family history of sudden death or early heart failure as this may suggest the possibility of cardiomyopathy. The clinical examination will guide the investigation.

The single most informative investigative test is an echocardiogram. Other investigations that may be considered include:

- basic investigations for cardiac disease, including chest x-ray, echocardiogram, blood testing for cardiovascular risk factors (lipids, glucose), kidney function (hyperkalaemia, renal failure), liver

Key points

- Left axis deviation is diagnosed on an ECG by the presence of a positive QRS (dominant wave) in lead I and a negative QRS (dominant S wave) in leads II and aVF.
- The most common causes of left axis deviation are an inferior myocardial infarction, age-related degeneration of the left anterior hemifascicle, left bundle branch block, ventricular pacing and cardiomyopathy.
- Left axis deviation should always prompt consideration of underlying cardiomyopathy.
- Isolated left axis deviation may be a normal physiological variant in older patients.
- Echocardiography is the most informative investigation in a patient with left axis deviation, and should be advised over the long-term for the follow up of isolated left axis deviation.

function (fatty liver, liver congestion), full blood count (anaemia, polycythaemia) and thyroid function

- investigations indicated by clinical examination, family history and age, including: coronary stress imaging, coronary angiography, electrophysiological studies and cardiac MRI (which is more sensitive than echocardiography for early disease).

Outcome

April saw a cardiologist to discuss the results of the echocardiography and the ECG. There was no family history to suggest cardiomyopathy and she was reassured that she could continue to exercise as she has always done. She was informed that she should have second-yearly echocardiography in future, as it is unusual to have developed a significant left axis deviation at her age and apparently good state of health. She was told the insurance company would probably insure her life on the basis of the cardiologist's investigation, but that because follow up was needed conditions may apply. **CT**