

Right axis deviation

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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.

Elizabeth is a 72-year-old woman and is a well-known patient of yours. She has been a smoker for 45 years and has tried to give up many times. She used to smoke a pack a day when younger and she has cut it down to 15 cigarettes a day in the past two years as she has noticed gradually worsening shortness of breath. She is normally slim, slightly flushed, has a chronic productive cough and has a raised respiratory rate with exertion. She comes to you, her GP, today as she ran out of doxycycline two weeks ago. She takes this to reduce her chronic bronchitis. She also takes tiotropium bromide 18 µg in the morning and budesonide inhaler 200 mg two puffs twice daily.

You decide to investigate her recent worsening of shortness of breath. A low-dose CT scan shows chronic bronchitis, moderately severe emphysema, hyperinflation and flattening of the diaphragm. Her blood tests are essentially normal apart from a bicarbonate level of 19 mg/L. You organise an ECG (see Figure 1).

Q1. What does this ECG show?

The axis is deviated to the right. The ECG shows inversion (negativity) of the QRS complex in lead I and aVL and (usually) II, with a dominant S wave. The QRS is upright (positive), with a dominant R wave, in leads III and aVF.

Q2. What is right axis deviation?

The 'axis' is the direction of the depolarisation (from the right to left atria and then to the right and left ventricles) that stimulates myocardial contraction. Right axis deviation

is a QRS axis between +90 and +180° (see Figure 2). If right ventricular hypertrophy is present, the axis is usually deviated by +110° or more and this suggests cor pulmonale. A dominant R wave in V1 in the absence of right axis deviation suggests there is no right ventricular hypertrophy. The ECG is, however, not sensitive at detecting right ventricular hypertrophy.

Lead V1 is closest to the right ventricle and hence in cases of right ventricular hypertrophy there is a dominant R wave in V1. There are thus reciprocal changes in the limb

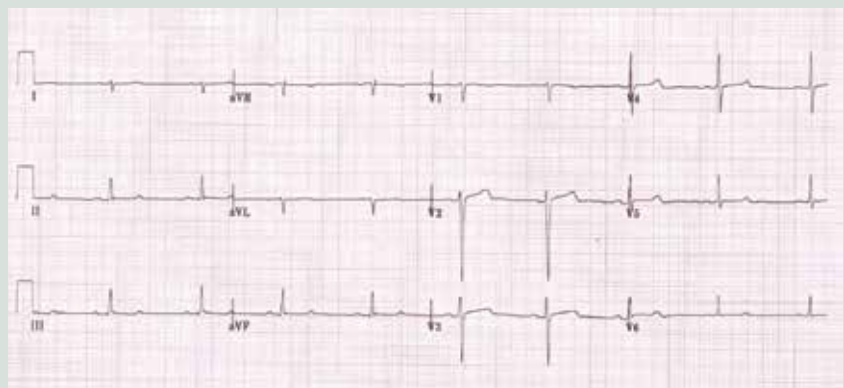


Figure 1. ECG showing right axis deviation.

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

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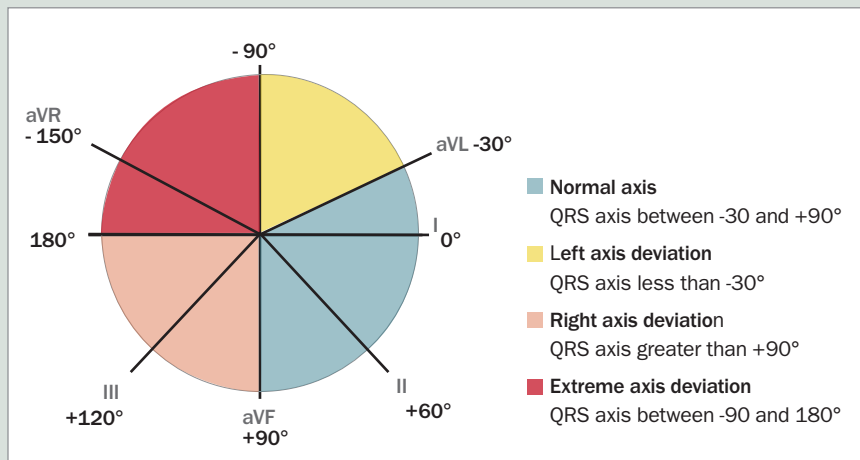


Figure 2. ECG axis interpretation.

leads appearing as right axis deviation. The right precordial leads (VI, VII) may show secondary changes with ST depression and T wave inversion.

Q3. How do you recognise right axis deviation on an ECG?

The QRS is positive (dominant R wave) in leads III and aVF and the QRS is negative (dominant S wave) in leads I and aVL.

Q4. In what situations is right axis deviation nonpathological?

Right axis deviation occurs in any situation where lead V1 is closer to the right ventricle or where the axis is reversed. Nonpathological causations include the following:

- right axis deviation is normal in infants and young children.
- incorrect limb lead application (swapping right and left sides accidentally) when taking the ECG
- very thin adults, especially with a more horizontally placed heart
- pectus excavatum.

Q5. What are the causes of right axis deviation?

- Right ventricular hypertrophy
- Lateral myocardial infarction
- Left posterior fascicular block
- Severe chronic lung disease (emphysema from smoking, poorly controlled chronic asthma, severe bronchiectasis, cystic fibrosis)

- Significant pulmonary emboli
- Pulmonary hypertension
- Congenital heart disease causing right ventricular hypertrophy (such as Eisenmenger's syndrome, pulmonary stenosis, atrioventricular septal defect and ventricular septal defect)
- Left sided accessory pathways (e.g. Wolff-Parkinson-White syndrome)
- Situs inversus
- Atrial septal defect (ostium secundum type)

Q6. What investigations, if any, are indicated if a patient has right axis deviation?

A full clinical history and examination will guide the type of investigation.

- Cardiac disease: chest x-ray, cardiac echocardiogram, blood testing for cardiovascular risk factors (lipids and blood glucose levels), kidney (renal failure), liver function (fatty liver, liver congestion), full blood count (anaemia, polycythaemia) and thyroid function. Also, as indicated, coronary stress imaging and coronary angiography.
- Respiratory disease: low-dose CT scan (to look for bronchiectasis, lung cancer, emphysema, interstitial lung disease, cardiac failure) and cardiac echocardiogram (to assess valves, cor pulmonale, left-sided heart failure, pulmonary artery pressure). Blood testing for full blood count

Key points

- The ECG is not sensitive at detecting right ventricular hypertrophy.
- To diagnose right axis deviation on the ECG, the QRS is positive (dominant R wave) in leads III and aVF and the QRS is negative (dominant S wave) in leads I and aVL.
- Right axis deviation occurs in any situation where lead V1 is closer to the right ventricle or where the axis is reversed.
- Right axis deviation is normal in infants and young children.
- Incorrect limb lead application (swapping right and left sides accidentally) when taking the ECG is a cause of right axis deviation.
- Basic investigations are guided by history and clinical examination but commonly include one or more of the following: a low-dose CT scan, cardiac echocardiogram, blood tests and respiratory function tests.

(polycythaemia) and assessment of renal function (failure) and liver function (engorged liver). Also, as indicated, lung function testing, ventilation-perfusion scan and d-dimer test.

Outcome

Elizabeth took a course of amoxicillin 500 mg four times daily for 10 days and was encouraged to cough effectively and every hour. After this she then restarted her doxycycline. Two weeks later she felt back to her normal degree of shortness of breath. She had formal lung function testing and this confirmed moderately severe emphysema, for which there is no reversibility with salbutamol. You increase her budesonide to 400 mg two puffs twice daily, rinsing and spitting out after the dosage. Elizabeth decides to try and give up smoking again. **CT**