P wave abnormalities

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ECG Education articles 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.

Yosef, aged 75 years, is a lifelong smoker. He has enjoyed good health for many years, but has experienced progressive shortness of breath, which has recently been more severe. He has never had pneumonia but has had intermittent bronchitis. He has been diagnosed in the past with emphysema, but has not been able to stop smoking. His only medications are combination fluticasone and salmeterol 250 µg/25µg, one inhalation twice a day. Yosef has decided to have a transurethral prostate resection and the anaesthetist has requested (among other tests) a routine ECG. This has been performed and the result is shown in Figure 1.

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Q1. What does the section of ECG in Figure 1 show?

This ECG shows P pulmonale present in the inferior leads shown; that is, leads II, III, aVL and aVF.

Q2. What is the P wave and what is it caused by?

The P wave is the initial signal seen with each heart beat as the electrical wave transfers from the sinoatrial node to the atrioventricular node. The initial section of the P wave is due to depolarisation of the right atrium, then there is a slight notch and the later section is depolarisation of the left atrium as the electrical wave passes through.

Each P wave should be less than 120 msec in duration (length; equivalent to three small squares) and under 2.5 mm in amplitude (height) in the limb leads and under 1.5 mm in amplitude in the precordial leads. It is normally upright in leads II, III and aVF, biphasic in lead V1 and inverted in lead aVR.

Q3. Where are P wave abnormalities best seen?

P waves are most prominent, and therefore most easily seen, in leads II, III, aVF and V1.

Q4. What is P mitrale and what is it caused by?

P mitrale is a marked notch in the middle of the P wave and is often longer than 120 msec in duration. It reflects a delay in activation of the left atrium together with left atrial hypertrophy.

P mitrale is classically associated with mitral valve stenosis, but can be seen with all causes of left atrial dilation (including mitral valve disease, aortic stenosis, hypertension and hypertrophic cardiomyopathy) and occasionally conduction defects from atrial scarring. In patients with left-sided heart disease, the notching may not be marked, although the duration of the P wave is prolonged.

Q5. What is P pulmonale and what is it caused by?

P pulmonale is a narrow P wave with an increased amplitude, usually taller in lead III than lead I. It is narrower because of delayed electrical conduction of the right atrial hypertrophy, dilation and scarring. The more damage there is to the right atria, the narrower and more increased the amplitude of the P wave. This is because the delayed conduction from the right atrium means the two atria depolarise almost simultaneously.

Causes of P pulmonale include any cause of right atrial overload or hypertrophy, classically pulmonary hypertension (e.g. congenital cardiac disease, chronic lung diseases and chronic congestive cardiac failure).

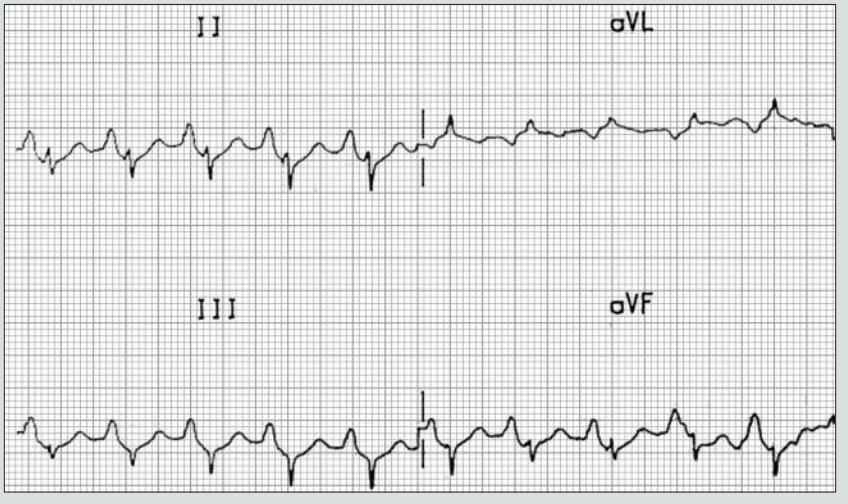

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Figure 1. Classic P pulmonale in the inferior leads.

Q6. What does the P wave look like in patients with biatrial enlargement?

The initial section of the P wave tends to be raised and narrower, there is notching in leads I and II and then an elongation of the last section with little change in amplitude. The wave is equivocal in lead VI and then becomes negative. As the electrical conduction travels from the right side of the heart to the left, the initial section appears more like that seen in P pulmonale (which is due to right atrial disease) and the final section like that seen in P mitrale (which is due to left atrial disease). An example of an ECG showing the P wave in biatrial enlargement is shown in Figure 2.

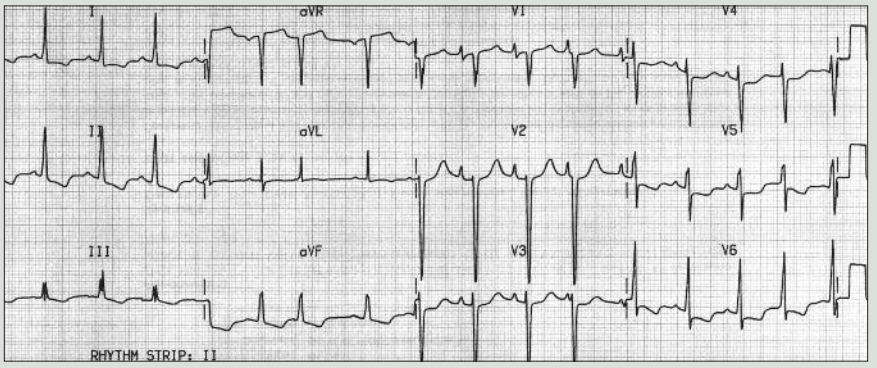

Figure 2. ECG showing P waves in a patient with biatrial enlargement. The P waves in lead V1 demonstrate enlargement of both the initial positive deflection (right atrial enlargement) and the subsequent negative deflection (left atrial enlargement). There are also features of dilated cardiomyopathy, with widespread T wave inversions and deep QRS waves in leads V1 to V3.

Q7. In what conditions are P waves absent?

P waves are absent when there is no conduction from the sinoatrial node to the atrium (e.g. sinoatrial block or arrest). They may also be absent in some types of atrioventricular nodal rhythms. If there is continuous atrial activity (e.g. atrial fibrillation or flutter) there are 'F' waves rather than discrete P waves. In patients with extreme hyperkalaemia, P waves become progressively wider and flatter.

In patients with supraventricular tachycardias, the P waves may be difficult to notice, as many coincide with the QRS waves. P waves are also difficult to see on low-voltage ECGs, such as occurs in severe hypothyroidism, pericardial effusion or the misprogramming of the voltage level.

Q8. What are the different ECG appearances of P waves associated with atrial ectopics?

Conducted atrial ectopics have P waves that are abnormal and premature (compared with the normal P-P interval), but the QRS complex is similar to that seen during sinus rhythm.

Nonconducted atrial ectopics have P waves that are premature and abnormal and are not followed by a QRS complex.

So-called 'aberrantly conducted' complexes have P waves that are abnormal and premature and are followed by abnormal QRS complexes that show a rate-dependent bundle branch block.

Outcome

Yosef saw a respiratory physician and had respiratory function testing (which confirmed severe chronic airways obstruction). His chest x-ray confirmed hyperinflation, but luckily nothing else was seen. He was encouraged to stop smoking for at least two weeks before the operation and was given nicotine patches to assist him. He was reviewed by a cardiologist and was investigated appropriately to ensure he was fit for the operation. It was decided that he was and he proceeded to have an uneventful operation. Unfortunately, he restarted smoking after hospital discharge. **CT**

Key points

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- **P waves are normally upright in leads II, III and aVF, biphasic in lead V1 and inverted in lead aVR.**
- **P waves are absent when there is no conduction from the sinoatrial node to the atrium (sinoatrial block or arrest) and in some types of atrioventricular nodal rhythms.**

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