The Real Q Wave
An Arrhythmia Challenge
Q waves in Ventricular Ectopics
Situations Vacant
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Arrhythmia Challenge

Q Waves in Ventricular Ectopics

Arrhythmia Challenge – The Answer

Situations Vacant

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Chief Cardiac Clinical Physiologist

University Hospital Lewisham, Cardiology Department

Grade: Band 6/7 (Depending on experience)
Band 6 £30566pa–£40406pa
Band 7 £46522pa–£56374pa
Full-Time 37.5pw
Ref: SS/1418

Our friendly, busy and dynamic Cardiac Department is looking for an enthusiastic and committed Cardiac Physiologist to join our expanding multi-disciplinary team at University Hospital Lewisham.

The Department currently performs a wide range of investigations including Echocardiography, Transoesophageal Echo (TOE’s), Pharmacological Stress echocardiography, ECG stress testing, 24-hour holter / BP monitoring. We also provide pacemaker implant service and pacemaker follow-up clinics. In addition we specialise in inherited cardiac disease clinics.

The Trust has recently submitted a bid to develop cardiology services as part of the upgrade of the general fluoroscopy service.

Applicants must possess a Bsc in Clinical physiology, and be RCCP registered and be working towards BSE proficiency in Echocardiogram accreditation.

The applicant will be expected to provide mentor and supervisory support to junior physiologists. Pacemaker skills are strongly desirable, training can be provided.

Applicants for Band 6 post would suit newly qualified physiologists who will be supported in their role to progress to Band 7 gaining high quality experience in pacing and echo to achieve BSE or BPEG qualifications.

Hours are 37.5hrs per week (AfC) Monday to Friday (Sat or B/H cover may be required)

For further information and/or to arrange an informal visit, please call
Lorna Carby, Cardiac Physiologist Manager on extension 6094
Or Richard Partin, Service Manager for Medicine on ext 6205

Previous applicants need not apply.

For an application pack, please contact the Trust Staffing and Medical Education Department, Education Centre, University Hospital Lewisham, Lewisham High Street, London SE13 6LH Tel: 0208 333 3320 (24 hours answeringphone). Please quote reference number KC09565

Closing date: 7th July 2010
Interview date: 22nd July 2010

Why not visit our website: www.uhl.ac.uk
The Real Q Wave

The seemingly widespread belief amongst cardiac physiologists is that the Q wave represents two key facts:

1. in lead II the Q wave is depolarisation of the septal portion of the ventricle
2. the Q wave is considered pathological if it’s height in lead II is 25% or more of the height of the succeeding R wave.

Enthusiasts of the Q wave might also state that where a QS wave is indicates an old myocardial infarction.

These facts are interpretations based upon observations and measurements. If we rely upon interpretations rather than understanding the underlying principles of the Q wave, we can lead ourselves into the area of potential clinical misdiagnosis. To truly understand the Q wave and provide accurate interpretations, it is necessary to re-evaluate our understanding of the electrophysiology of the Q wave.

For instance, what if we examined a 12 lead electrocardiogram from a 20 year old patient with no history of cardiovascular disease and measured Q waves of 4 mV in depth in the antero-septal region? This seems implausible based upon our Q wave facts. Such observations do appear in athletic individuals and are regarded as a normal deviation (Fig 12 & 13). In this instance interpretation could also lead to an inappropriate diagnosis of old myocardial infarction. Which begs the question - what is the real Q wave?

The Q wave is an electrocardiographic representation of a depolarisation wave in respect of its direction and magnitude to a recording electrode. It is named a Q wave because it conforms to a specific rule - it is the first negative component of ventricular depolarisation (Figs. 1 – 4).

It is important to remember that, potentially, any portion of the ventricular myocardium may generate a Q wave. The electrocardiographic simplified linear rule of depolarisation demonstrates that a wavefront travelling away from a recording electrode generates a negative electrocardiogram deflection (Fig. 5). As the septum is the first major component of the ventricular myocardium to receive the depolarisation wavefront, it is expected this will be the first component of the ventricular depolarisation on the electrocardiogram.

Missing Q waves

‘Fact 1’ stated that a Q wave in lead II represents septal depolarisation. However experience informs that a Q wave is not always present in lead II. Does this signify that septal depolarisation did not occur? These observations can be, once again, explained by the simplified linear rule. The electrocardiograph is unable to record a vector or an angle of depolarisation wavefront that is at right angles to the recording electrode. These vectors generate a flat line on the electrocardiogram (Fig. 6).

How does this relate to the 12 lead ECG to demonstrate absent Q waves? To answer this question, we need to consider the cardiac or mean frontal plane axis. We expect a 12 lead ECG without any abnormalities to demonstrate an axis of between -20 to +110 degrees. One explanation for this degree range is the anatomical and electrophysiological position of the heart in the chest. The assumption is made that a typical heart’s apex points towards the V5 chest position. However, the heart’s apex may be located at a different anatomical position; in effect the heart can spin on its frontal axis. It is this that gives rise to the degree range of normality.

This movement of the apex is related to the concept of the ‘vertical’ and ‘horizontal’ heart (Fig. 7). By definition, a vertical heart demonstrates an axis at the upper range of normal with a dominate Q wave in aVL and absent Q waves in I. A horizontal heart is at the lower range of normal with a dominate Q wave in III and absent Q waves in the II and aVF (Figs 8 & 9). Most hearts typically lie between these two states and the 12 lead ECG will demonstrate the presence or absence of Q waves to varying extents.

The precordial Q wave

In addition to the heart rotating on its frontal axis; we must also be mindful that the heart can apparently
rotate on its horizontal axis. This concept refers to the ‘clockwise’ or ‘counterclockwise’ rotation. In a 12 lead ECG with no abnormalities we expect to observe Q waves in V4 to V6. These rotations are able to generate Q waves in V1 to V3 or be a cause of their absence in V4 to V6 (Figs 10 & 11).

What is the cause of Q waves in the V1 to V3 chest leads? We are now in a position to understand the answer to this question. Q waves are associated with depolarisation away from the recording electrode. This suggests that for Q waves to exist there must be an irregularity with the depolarisation wave in the anterior region, either the loss of the electrical functional myocardium due to necrosis or

the anterior depolarisation wavefront is at right angles at the recording electrode.

The Q wave is therefore associated with the depolarisation of the posterior aspects of the myocardium. This depolarisation is normally hidden by the depolarisation of the anterior myocardium.

Are our initial Q wave facts correct? Fact 1 can be regarded as an observation with an interpretation. A more accurate statement would be ‘in lead II the first negative component is termed a Q wave and is expected to relate to septal depolarisation’. Facts 2 and 3 could be regarded as ‘pathological only in specific circumstances and caution should be exercised when suggesting this interpretation’.

When interpreting the Q wave, it is important to remember that the commonly held reasons for Q waves do not apply to all clinical situations. As cardiac physiologists, we are the experts in the interpretation of our investigations and need to understand beyond simple explanations for diagnostic observations.

Further reading

Peter Lewis
Chief Clinical Physiologist, Cwm Taf NHS Trust
Senior Lecturer, University of Glamorgan

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SEND ENQUIRY, ADOBE PDF or MICROSOFT WORD DOCUMENT TO ADMIN@SCST.ORG.UK
Articles for August Edition should be submitted by 17th July 2010
A 63 year old female was referred for 24 hour ambulatory ECG monitoring after her GP noticed an irregular pulse during a routine blood pressure check. What do the rhythm strips show? Answer on page 7.
Q Waves in Ventricular Premature Beats

The ECG below was recorded from a 63-year old woman who was known to have suffered a myocardial infarction some years previously. It shows sinus rhythm with left bundle branch block and two pairs of ventricular ectopic beats (the 2nd and 3rd beats and 5th and 6th beats).

Diagnosing previous myocardial infarction in the presence of left bundle branch block is known to be difficult, although not impossible. Evidence of myocardial necrosis in this case is provided by the presence of a late notching of the S-wave in V3, the so-called Cabrera sign\(^1\), and an rSR' complex in aVF\(^2\).

However, more striking evidence of previous infarction is provided by the presence in the ventricular ectopic beats of abnormal q waves in the inferior and chest leads.

It has been known for some time\(^3\), from anatomical evidence obtained at autopsy, that ventricular premature beats in which a q wave is followed by an R wave (ie not a QS complex) can indicate the presence of myocardial infarction even when there are no abnormal q waves in the sinus QRS complexes. This sign may be particularly useful in diagnosing previous MI in the presence, as here, of left bundle branch block\(^4\).

I wish to thank Kayleigh Heslop, trainee cardiac physiologist at the University Hospital of North Durham, for sending me this ECG.

References


Dave Richley, The North of England Cardiovascular Network
The ECG’s show frequent unifocal ventricular ectopics due to ventricular parasystole.

Ventricular parasystole, which literally means a beat beside the dominant beat, occurs when a ventricular ectopic focus is able to discharge regularly without interruption by the dominant rhythm. Therefore when the ectopic focus discharges, it will capture the ventricles provided the ventricles are not refractory from stimulation by the dominant rhythm (in this case sinus rhythm). The ectopic focus is protected from stimuli following the normal conduction pathway by a form of entrance block that prevents the normal cardiac impulse reaching the ectopic focus.

The resulting electrocardiographic features of ventricular parasystole are:

- Varying coupling intervals between the ectopic beat and the preceding sinus beat.
- Inter ectopic intervals that are multiples of a common factor (the rate at which the ectopic focus discharges).
- Fusion beats (i.e. a QRS complex that is a composite of the ectopic beat and the sinus beat) due to simultaneous activation of the ventricles by the ectopic focus and the normal sinus beat.

These features are highlighted on the following rhythm strips. In the first strip the interval from VE2 to VE3 is twice the interval from VE1 to VE2. The second strip highlights the varying coupling intervals between the ventricular ectopic beats and the preceding sinus beats.

Parasystole is usually considered to be a rare phenomenon with a reported prevalence of 0.13% from routine electrocardiography. The most common form of parasystole involves a ventricular ectopic focus (50%), with 20% of patients having an atrial ectopic focus and 20% having an atrioventricular ectopic focus. The majority of parasystolic rhythms reported have been in patients with heart disease, although parasystole has been reported in patients with otherwise normal hearts, and parasystolic rhythms per se appear to carry no significant risk. However Itoh et al reported two cases of ventricular parasystole associated with ventricular tachycardia, with one patient undergoing successful catheter ablation of the ectopic focus.

References:

Lawrence Green
Cardiac Physiologist, Grantham Hospital
Highly Specialist Cardiac Physiologist

Band 7 £30,460 - £40,157 per annum
37.5 hours per week

The position of Highly Specialised CP would be required primarily to provide technical support to the EP, ICD, pacing and invasive services. Training, development and supervision of your CP colleagues will also be a key requirement of the post. The post holder will be able to develop and provide a managerial role, deputising for the Senior Chief CPs in charge of the relevant areas.

As a department we implant ICDs, CRT-P and CRT-D and utilise remote monitoring for the follow up of a lot of our patients. ICD/CRT implant support only required for sign-off. Complex ablation performed and Ensite Velocity for 3D mapping. HF service run with Cardiologist and Regis Professor. Research undertaken.

Aberdeen Royal Infirmary is a highly regarded teaching hospital (approx. 850 beds) situated within the City of Aberdeen in the Grampian region and is also the regional referral centre (for EP) for cardiac patients in Highland and Tayside regions. The Department provides technical support to Cardiology patients in the Shetland Islands as well as those in Orkney with regular clinics on the Island. Aberdeen is a vibrant University City with plenty to do from pubs to the Theatre. To the North and South there is beautiful countryside, to the East is Aberdeen beach, dunes and sea and to the West are the spectacular Grampian and Cairngorm Mountains. There are good air and rail services from Aberdeen to National and international destinations. Its also the driest area of Scotland!

Interested applicants for the Band 7 post should currently hold a Senior / Specialised Cardiac Physiology post with BSc or HNC (and relevant experience), HRUK, IBHRE and experience in EP (preferred), Pacing, ICD and Cath Lab. Relocation expenses available depending upon circumstances.

Informal enquiries to Mr Chris Redfern, Senior Chief CP (EP/ICD) on 01224 551062

To apply please e-mail Grampian.Recrutiment@nhs.net or telephone (01224) 556692 (24 hour Jobline) quoting Ref No DK0/11141-2.