Everything You Always Wanted to Know About Q Waves…

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There are basically four causes of Q (or q) waves you should be aware of:

1. Normal, septal q waves
2. Q waves due to positioning of the heart or a change in electrical axis
3. Q waves due to conduction delays in an area of ischemia
4. Q waves due to infarcted myocardium

Let's take a closer look at each one of these…

Normal, Septal q Waves

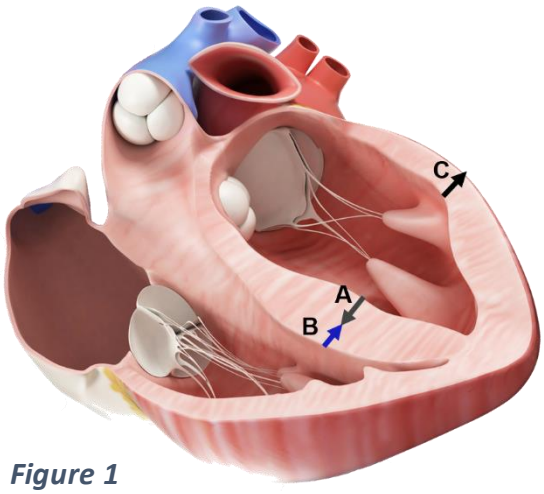

Figure 1

Before we begin this section, look closely at Figure 1. You should note that the ventricles are situated more ANTERIOR/POSTERIOR and only *slightly* RIGHT/LEFT. When you look at vector A (Figure 1), it is traveling more anteriorly than to the right. Vector B is traveling more posteriorly and vector C is also traveling more posteriorly. Always remember that the interventricular septum actually separates *anterior* from *posterior*, rather than right from left. Instead of using the terms *right* and *left* to indicate *direction*, I will use ***anterior*** and ***posterior***.

Under normal circumstances, the first activation of the ventricles by the supraventricular impulse occurs on the left side of the septum, just a little bit past the midpoint toward the apex (**A**). Obviously, the only way it can travel initially is anteriorly (the cavity of the left ventricle is located posterior to it). This anterior-directed depolarization of the interventricular septum doesn't last long, however. There are two forces opposing it: the anterior (right) side of the interventricular septum is activated immediately after the posterior (left-sided) activation (**B**). During this time, the initial impulse will travel very rapidly to the lateral wall of the left ventricle which must depolarize in a posterior direction (**C**). So now we have two impulses in the interventricular septum that will collide in the middle of the septum and extinguish each other, plus another impulse traveling posteriorly through the thick, muscular lateral left ventricular wall adding another posteriorly-directed force.

PEARL

Lead V1 is the second most rightward lead on the 12-lead ECG. Lead aVR is by far the most rightward lead. It's even more to the right than Lead V6R.

So, the small initial r wave in Leads V1 and V2 is evidence of that initial anteriorly-directed activation of the left side of the interventricular septum. It is small because it is opposed by two posteriorly-directed forces.

PEARL

Remember that the ventricles are not really RIGHT/LEFT chambers; they are more ANTERIOR/POSTERIOR chambers. So the impulses traveling through the interventricular septum are really directed ANTERIOR-TO-POSTERIOR and POSTERIOR-TO-ANTERIOR.

But this section is about the *septal q wave*, so why am I discussing a septal r wave? It's the *same* impulse – the *same* vector. The electrodes for Leads V1 and V2 are located anteriorly on the chest wall and see that initial, *momentarily unopposed* septal impulse traveling *toward* them. They inscribe a positive deflection but it doesn't last long because two opposing forces appear immediately afterward. However, Leads I, aVL, V5 and V6 see the same impulse, but it is traveling *away from* those lead electrodes. Thus, those leads will inscribe an equally small q wave. That is the *septal q*. It is totally normal and, in fact, you should always be glad to see it. It indicates that at least the initial depolarization of the ventricles is proceeding normally!

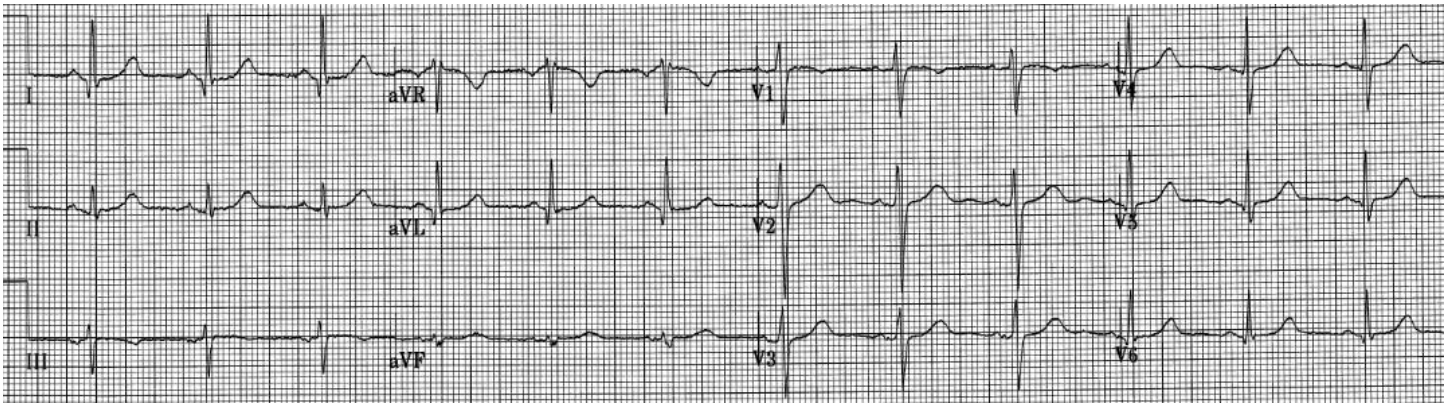

Figure 2

The septal q wave is always less than 40 msec (one small square). In fact, it's usually *much* less than 40 msec and can even be difficult to see at times. Here is an example of septal q waves in the left-sided leads (Figure 2); look closely in the left-sided leads (I, aVL, V5 and V6).

However, the septal q's can be very difficult to see at times. In Figure 3, they are present only in Leads aVL and V6:

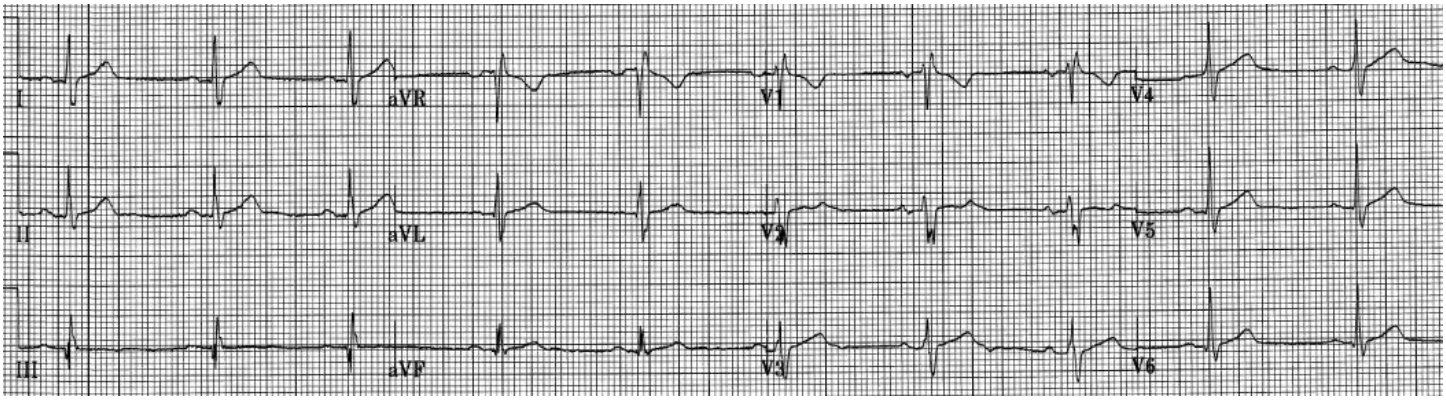

Figure 3

See what I mean? Yes, there really *are* septal q waves in those two leads. If you suspect those are septal q waves but aren't sure, just look for septal r waves in Leads V1 and V2. If present – and they almost always are – then you can be much more certain that you are indeed seeing septal q waves in Leads aVL and V6.

Sometimes the septal q waves are not in the lateral leads in the frontal plane. If the mean QRS axis (ÂQRS) is close to vertical, the septal q waves may be found in the inferior leads (II, III and aVF) instead. That is still NORMAL!

PEARL

How do I know if the mean QRS axis (ÂQRS) in the frontal plane is vertical? Look for large R waves in the inferior leads and much smaller R waves in Leads I and aVL.

On the next page is an example of septal q waves in the inferior leads:

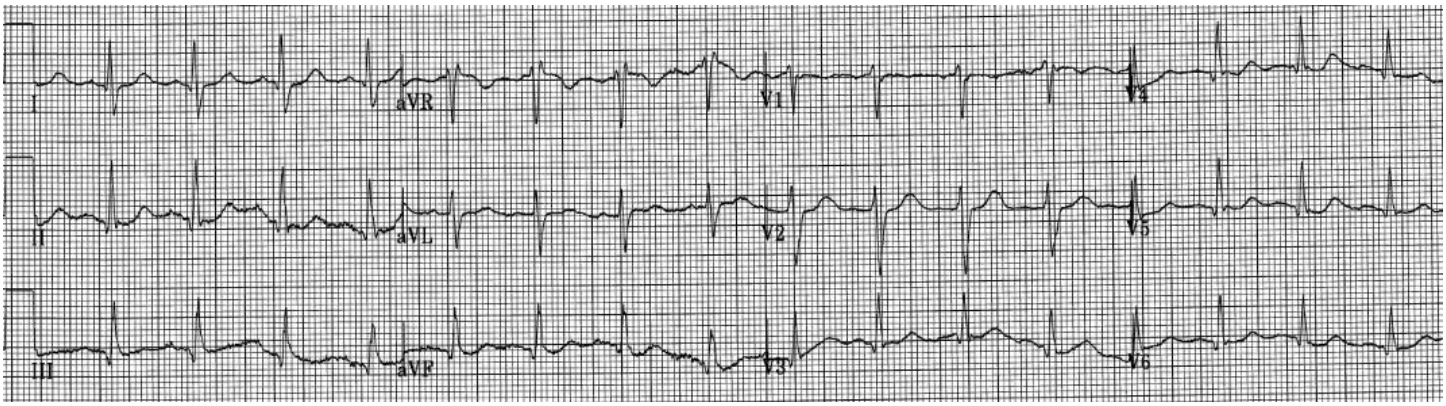

Figure 4

Figure 4 demonstrates *septal q waves in the inferior leads*. Note that the R waves in the inferior leads (II, III and aVF) have a greater amplitude than in Leads I and aVL, i.e., there is a mean QRS axis that is approaching the vertical. (Remember: Lead I has a significant S wave whose negative voltage should be subtracted from its R wave. That will make the R wave much smaller in amplitude.) The switch from lateral leads to inferior leads takes place in the frontal plane. It does not appear to affect the appearance of the septal q waves in Leads V5 and V6 which are in the horizontal plane.

PEARL

Although the small r waves in Leads V1 and V2 are SEPTAL r WAVES (caused by Vector #1), the r wave in Lead V3 is NOT! Only Leads V1 and V2 have septal r's; the r (or R) wave in Lead V3 is caused by a different vector (Vector #2) and represents an APICAL r wave.

Q waves due to positioning of the heart or a change in electrical axis

Sometimes a Q (or q) will appear where you least expect it. Such a case includes the "pseudo-septal q wave" of Lead aVL. This is a false septal q wave that appears in Lead aVL during complete left bundle branch block (cLBBB).

There should be no septal q waves in the presence of a cLBBB because there is a delayed arrival of the supraventricular impulse in the left ventricle. The initial activation of the interventricular septum is from anterior-to-posterior (right-to-left) during cLBBB. That presents a depolarization wave traveling toward the left-sided leads which would result an initial positive deflection in those leads. Such a deflection would be concurrent with the R wave and would not be seen as a separate deflection.

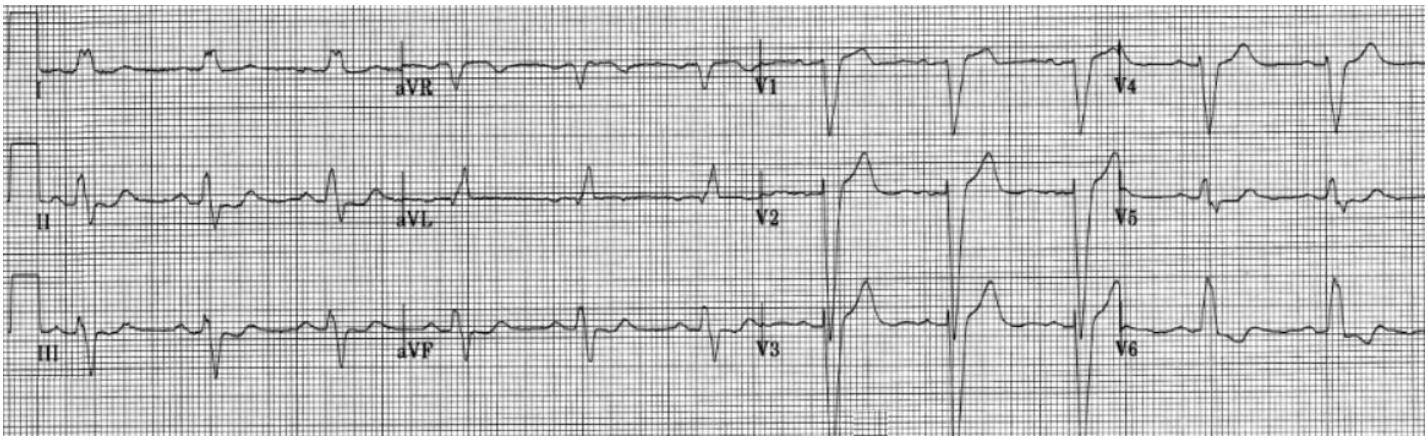

Figure 5

If you look at Lead aVL in Figure 5, you will see a small "septal q wave." *Don't be fooled!* **There can be no septal q's or septal r's in cLBBB!** (Yes, I *know* there are small r waves in Leads V1 and V2 – I'll get to *that* in a moment.)

Remember that with cLBBB, the interventricular septum is activated from anterior-to-posterior (right-to-left). When the mean electrical axis of the heart becomes more horizontal the vector responsible for the anterior-posterior activation of the septum may point more inferiorly than +60° and thus present an initial negative deflection in Lead aVL.

PEARL

How do I know if the heart's axis is more horizontal? A horizontal orientation will present with a much larger amplitude of the R waves in Leads I and aVL than in the inferior leads. The QRS complexes in Leads I and aVL in Figure 5 don't look large but it is all relative. Also, you must understand that amplitude depends not only on the height of the R wave but also the width, i.e., the area enclosed within the deflection!

Now about those "septal r waves…" Just as there can be no septal q waves during cLBBB, there can be no septal r waves. What you see in Lead V2 is the detection of anterior forces due to the closeness of its electrode to the surface of the heart and is likely of right ventricular origin. That is called the *proximity effect*. Although it is a small r – *it is not a septal r*. A septal r can only reflect a posterior-to-anterior (left-to-right) force (Vector #1).

Q Waves Due to Conduction Delays in an Area of Ischemia

Depolarization impulses travel slowly through ischemic tissue. Because of this delay in conduction, the recording electrode overlying the ischemic area may record the depolarization impulse in the opposite, normal area of the heart. This will present as a Q wave.

Normally, infarction Q waves appear hours to days after the infarction is completed. Early in my career I began noticing Q waves in leads with ST elevation in acute chest pain patients who insisted that their pain began within an hour of their arrival in the ER. Others began noticing it as well. We then found out that these early Q waves were due to an ischemic conduction delay and not infarction. They usually disappear with reperfusion (or even before).

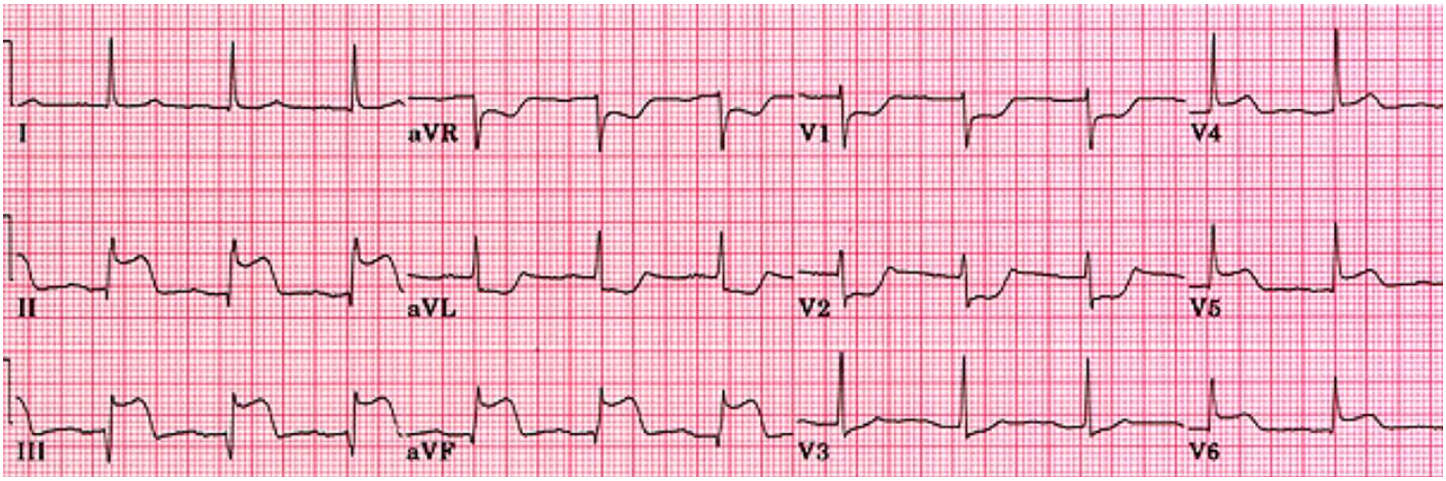

Figure 6

Here is such an ECG. Note the presence of Q waves in leads with acute ST elevation. Reperfusion has not occurred. Also note the tall R waves in the leads with the Q waves and ST elevation. At this point, there has been no infarction! These early Q waves do *not* preclude revascularization!

Q Waves Due to Infarcted Myocardium

Infarcted tissue does not conduct action potentials. Similar to the situation with ischemic tissue, a recording electrode overlying the infarcted tissue will only detect the depolarization impulses in the opposite, normal side of the heart. And, as with ischemia, a Q wave will be recorded.

Q waves due to infarction are called *pathological Q waves*. They should measure at least 40 msec in duration and 1/4 to 1/3 the height of the QRS complex. Of the two criteria, the duration of 40 msec or more is by far the most important.