Ectopic Beats and How to Approach Them

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Single Ventricular Ectopic Beat (PVC)

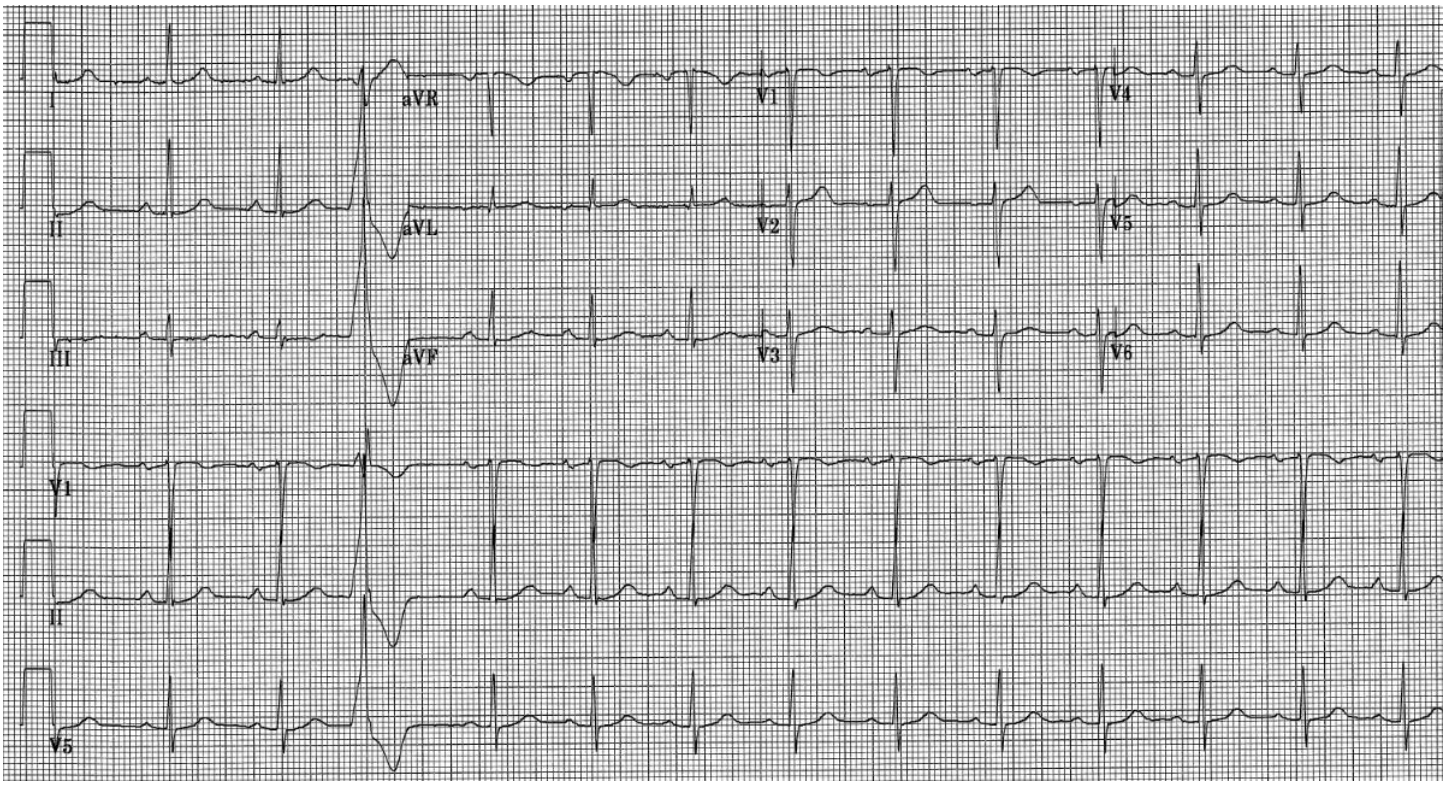

Figure 1 – Premature Ventricular Complex (PVC)

Premature ventricular complexes (PVCs) are the second most common ectopic beats seen on the ECG; premature atrial complexes (PACs) are the most common.

When you encounter a *single* PVC, there are three questions you should ask yourself:

1. **From which ventricle did this PVC originate?**
   To get the answer to that question, the PVC must appear in Lead V1. Lead V1 is the only lead on the 12-lead ECG that reliably distinguishes LEFT from RIGHT. If we look up at Lead V1 in the top line of this ECG, we do NOT see a PVC. Fortunately for us, this is a 6-channel ECG with three rhythm strips at the bottom of the tracing and Lead V1 is the first rhythm strip! That's why it is imperative to ALWAYS include at least a Lead V1 rhythm strip on every ECG. You can still capture ventricular ectopy in Lead V1 those times when it doesn't appear during its 2.5 second space in the 12-lead portion of the ECG.

   Although it is slightly obscured by the complex in Lead II below it, we can still see that this PVC has a RBBB-*like* morphology. A RBBB-like morphology means that the

PVC is NOT a true RBBB (it couldn't be if it is a PVC*) but rather that it is predominantly upright (positive). That places its origin in the LEFT ventricle.

*A true right (or left) bundle branch block *always* indicates a *supraventricular impulse* because it must enter the ventricle through the AV node and bundle of His in order to encounter the blocked bundle branch. If the impulse arises from within the ventricle or through an accessory pathway, it cannot manifest a true bundle branch block.

2. **Where within the ventricle did the PVC originate?**
   We can go a bit further on this ECG in determining where *within the ventricle* the PVC originated. To do so, we must look at the inferior leads (Leads II, III, and aVF).

   It is best if the PVC appears in all three inferior leads, but that is often not the case, and that is true for this ECG. We are able to see the PVC in Leads II and III and that is good enough. Both PVCs in those leads have tall R' waves and are thus predominantly positive, or upright. That indicates what is called an *inferior axis*. That means the impulse created by the PVC focus is traveling downward toward the left foot electrode (LF). The LF is the positive pole for all three of the inferior leads. If the impulse is traveling downward, then it must have originated up high in what is called the *outflow tract*. Both ventricles have outflow tracts, though we hear more about the *right* ventricular outflow tract (RVOT) than the *left* ventricular outflow tract (LVOT). What makes the outflow tracts significant with regards to ventricular ectopic activity is that the majority of that activity will be *benign* – and that even includes *ventricular tachycardias* originating in those areas!

   If the concept of an inferior or superior axis seems a bit confusing or pedantic, never fear! I have a **PEARL** for you!

   PEARL | Just remember that the QRS complexes of ventricular ectopy in the inferior leads (PVCs, ventricular tachycardia) *will always point to the origin of the ectopic impulses!* So, looking again at Figure 1, we see that the PVCs have tall R' waves and those tall R' waves are pointing…UP! That tells us the origin of the PVC on this ECG originated in the left ventricular outflow tract (LVOT) and is very likely benign.

3. **There is a third question that must be asked: is this PVC really a ventricular ectopic beat (PVC), or is it an aberrantly-conducted supraventricular beat?**
   The PVC does end an R-R interval that is shorter than the previous. But with more experience you will realize that the difference in the two R-R intervals is just not enough to invoke the Ashman phenomenon. But how else can we determine that the deflection is truly a PVC and not an aberrantly-conducted beat?

To answer that question, you must return to a statement (actually, more of a **PEARL**) that I wrote in Question 1. Take a moment to reread the last paragraph (the one with the asterix *). Since an aberrantly-conducted beat is – in most cases simply a bundle branch block (and usually a RBBB), the onset of the deflection should be very rapid, smooth and clean. How does a rapid onset of a deflection appear on an ECG? The onset will be very *vertical* whether it is upward or downward. It will also be very *smooth without any slurring or notches*. Let's compare (Figure 2)…

Figure 2

The left and middle snippets are from a patient with a RBBB. Note how the onset of the R waves is straight and not slurred. The third snippet is from our patient in Figure 1. Note the slurred onset of the R wave of the PVC.

One *might* say, "Check to see if there is a compensatory or a non-compensatory pause." That is not likely to be very helpful. Most cases of aberrant conduction are due to premature atrial ectopic beats – and they can cause either compensatory or non-compensatory pauses just like a PVC. Just remember: you should develop a sense of when to suspect the Ashman phenomenon and you should be able to recognize the difference in the initial depolarization of a PVC and an aberrantly-conducted beat. Fortunately, in this "Age of the Internet," it is easy to just do a search online to find hundreds of examples of each to learn from.

Multiple Ventricular Ectopic Beats (PVCs)

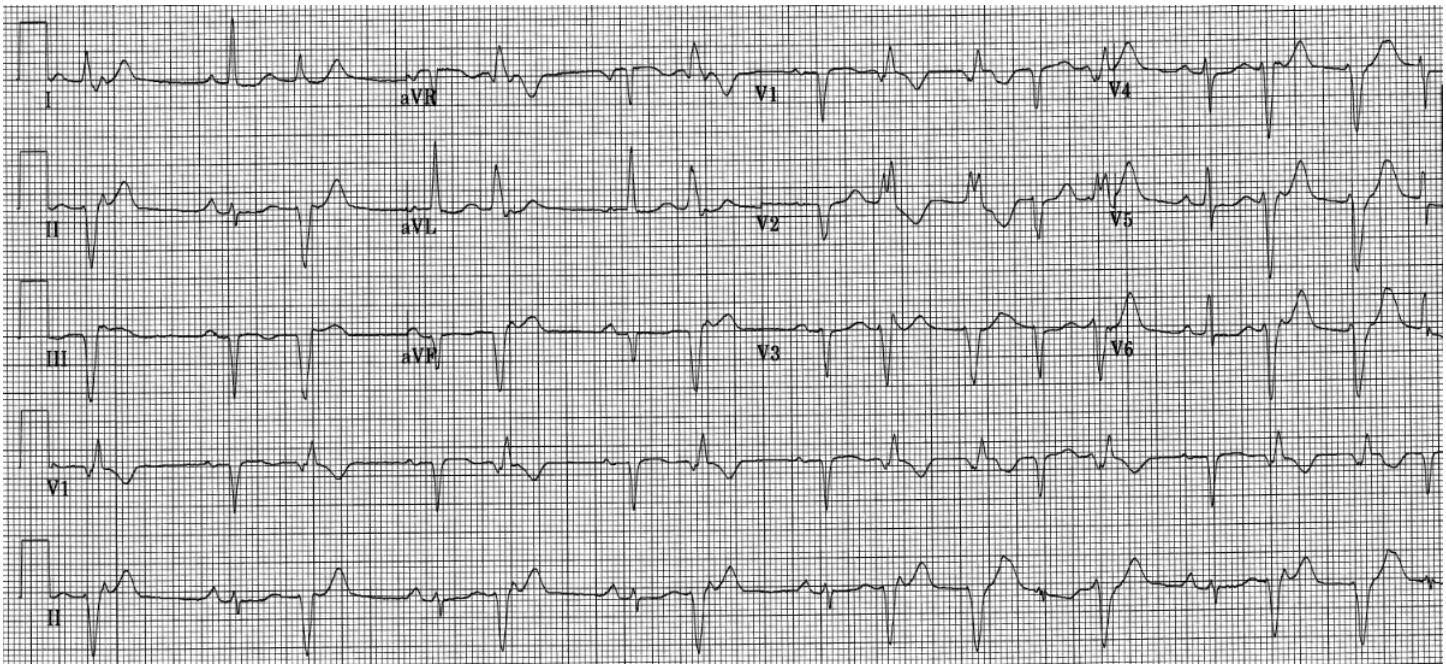

Figure 3

Here is an ECG with multiple PVCs. We begin by asking the same questions…

1. **In which ventricle are these PVCs originating?**
   We are fortunate because there are PVCs throughout this tracing, including Lead V1. The PVC in Lead V1 demonstrates a RBBB-*like* morphology (it *looks* like a RBBB but *it really isn't*), so that tells us that the PVC is originating in the *left ventricle*.

   PEARL | While not *all* PVCs or ventricular tachycardias originating in the left ventricle are dangerous and potentially lethal – *most are!* When you find that a PVC or ventricular tachycardia has originated in the left ventricle, you should be very careful in your subsequent analysis!

2. **In which part of the ventricle did this PVC originate?**
   Just as before, we look at the PVCs in the inferior leads. In this case, the PVCs are all negative, manifesting QS waves pointing downward toward the *apex*. Here is another very important **PEARL** for you:

   PEARL | Nothing good comes out of the apex!

   When the PVCs in the inferior leads are pointing upward, they are pointing to an origin of the PVC in the *outflow tract* – either the RVOT or the LVOT. Generally, an origin in the outslow tract suggests a benign prognosis – but that is not ALWAYS the case! A cardiomyopathy called *arrhythmogenic cardiomyopathy* may – on rare occasions – originate in the RVOT and it is definitely NOT a benign dysrhythmia! It

usually arises in the apex where its malignant nature would be more obvious, but it can – again, on rare occasions – come from the RVOT.

When the PVCs in the inferior leads are pointing *downward*, they point to an origin in the *apex*, or *apical area* (remember what I said about the apex!).

3. **Are these really PVCs or are they aberrantly-conducted beats?**
   We all know that the Ashman phenomenon occurs in rhythms where there is a *long* R-R interval followed by a *short* R-R interval. While that is very true, there is a problem with that: ventricular ectopy is *also* frequently characterized by a *long* R-R interval followed by a *short* R-R interval! I will cover the reason for that in another article. If you want a preview sooner, just do an online search for "Rule of Bigeminy." Suffice it to say, for now, that these truly are PVCs.

4. **When there is more than one PVC present, then there is another question one must ask: are the coupling intervals all the same?**
   The coupling interval of a PVC is the duration from the onset of the sinus-conducted QRS preceding the PVC to the onset of the PVC itself. By "onset," I am referring to the very first deflection of the QRS – which could be a q, an R or a QS.

   When the coupling intervals are all the same, that means that there is a connection between the sinus QRS and the PVC. Again, this refers back to The Rule of Bigeminy, which is another discussion entirely. But if the coupling intervals are different, then that means that there is no connection between the sinus rhythm and the PVCs – something we call *parasystole*.

   Parasystole implies the presence of an independent ventricular pacemaker firing at its own rate. This results in an AV dissociation. In our case, the coupling intervals are getting progressively shorter. They are definitely NOT remaining the same. So there is a *ventricular parasystole* occurring here. The fact that the change in coupling intervals is very gradual and characterized by a slight decrease in the intervals, implies that the sinus rate and the parasystolic rate are very close to each other. Any further discussion of parasystole would require this article to become unacceptably long, so I will stop here.

BOTTOM LINE: For a single PVC, there are three questions you should ask. When multiple PVCs are present, there are four questions you should ask. Remember them!

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