Ventricular Parasystole

1 WHAT IS IT?

In addition to the sinus node, there are many accessory pacemakers throughout the conducting system of the atria, junction and ventricles that are ready to assume the role of primary pacemaker if the sinus node should fail to do its job properly. They typically don't get the chance to fulfill this function because their rates of depolarization are slower than the sinus rate. Thus, the depolarizations initiated by the sinus node always arrive before the accessory pacemaker has reached its own threshold. The accessory pacemaker is then depolarized along with all the other myocytes after which it begins to repolarize. The instant repolarization is complete, it once again begins its spontaneous depolarization towards its threshold potential.

A ventricular parasystole is a localized ventricular focus with pacemaker capability that begins to fire independently of the prevailing (usually sinus) pacemaker. What makes the parasystolic focus different than all the other potential ventricular pacemakers is the presence of a protective *entrance block* around the parasystolic pacemaker. This entrance block makes it very difficult – though NOT impossible – for the sinus pacemaker to discharge and reset it.

Sometimes the parasystolic focus fires but it fires at a time when the surrounding myocardium has just been depolarized by the sinus impulse. The tissue is refractory so the parasystolic impulse does not conduct. That doesn't bother the parasystolic focus which will continue firing at its regular rate. It will eventually find the myocardium non-refractory and will transmit an impulse. The longer interval containing the parasystolic depolarizations that were unable to conduct will be a multiple of the basic parasystolic interval (but again, it doesn't have to be precise to the exact msec).

Parasystoles of all types begin and end spontaneously. Although they are generally quite benign and require no treatment, the resulting pattern on an ECG can appear quite complex and is usually a cause of significant concern to the person reading the ECG.

2 TERMS, DEFINITIONS AND ABBREVIATIONS YOU SHOULD KNOW IN ORDER TO UNDERSTAND THIS TOPIC...

msec - millisecond

Coupling Interval – Most PVCs are the result of a reentry phenomenon following a sinus-conducted beat. This causes the interval from the previous sinus-conducted beat to the PVC to be relatively

constant. This interval is called the coupling interval and it is measured from the *beginning* of the PVC to the *beginning* of the previous QRS complex. If there are a number of PVCs, the coupling intervals do not have to be exactly the same number of msec, but they should not vary by more than a few msec of each other.

Parasystolic Interval – The shortest interval between two parasystolic ventricular ectopic beats. Thisis sometimes referred to as the *inter-ectopic interval*.

Fusion Beat – A fusion beat occurs when there are two separate impulses in a cardiac chamber at the same time. In the case of ventricular fusion beats, a sinus beat will have entered the ventricles around the time an ectopic ventricular focus has fired but before the ectopic focus has been able to depolarize the whole ventricle. The resulting QRS complex is a combination – or *fusion* – of the two impulses. If one impulse has managed to excite more of the ventricle than the other, the fusion beat will resemble it more. Fusion beats occur at the time you would expect to see both a sinus beat and the beginning (or end) of a parasystolic interval.

Manifest – Everything on an ECG is either *manifest* or *concealed*. If you can see it printed on the ECG paper, it is *manifest*. If you cannot see it printed on the paper but you know or assume it is present, it is *concealed*. If you see a P wave printed on the ECG paper, it is a *manifest* P wave. However, although we know that the SA node is firing and producing those P waves, we cannot see it; therefore, the firing of the SA node is a *concealed* event. The term *manifest* is always used in the same manner; on the other hand, be careful of the term "concealed." It can have more than one meaning in electrocardiography.

To Map Out – To measure the potential location of a deflection along the length of a rhythm strip or ECG lead using ECG calipers.

Entrance Block – An entrance block protects a pacemaker focus from the influence of the SA node or other firing pacemakers and prevents the premature discharge of the focus. The focus is still able to conduct out into the myocardium, however.

Exit Block – An exit block prevents a focus from discharging into the surrounding myocardium. It can be present whether or not an entrance block is present.

3 WHAT CAUSES IT?

Parasystole – whether atrial, junctional or ventricular – occurs when the conditions for an entrance block develop around the focus of an accessory pacemaker. There are no specific conditions causing this – it is usually a confluence of circumstances.

4 How do I recognize it?

1. The first thing that will grab your attention is the fact that there are *two or more wide-complex PVCs* mixed in with the regular sinus-conducted beats.
2. The next thing you should do is note the *coupling intervals* of the PVCs. If they are all approximately the same, there is no parasystole occurring.
3. If the coupling intervals are all different, then there is a parasystolic focus firing.
4. Next, look at all the QRS complexes for *different morphologies*. Decide which beats are sinus-conducted beats and which beats are PVCs. Once you have done that, are there any other beats that appear different from the PVCs and the sinus beats? If so, these are most likely *fusion beats*.

Determine the *basic parasystolic interval*. Under usual circumstances, this will be the shortest interval between two parasystolic beats. Any longer interval between two parasystolic beats should be a *nearly* exact multiple of the basic parasystolic interval. Again, the parasystolic intervals do not have to be exact – they can vary by 40 - 80 msec.

5 What could cause confusion in the diagnosis?

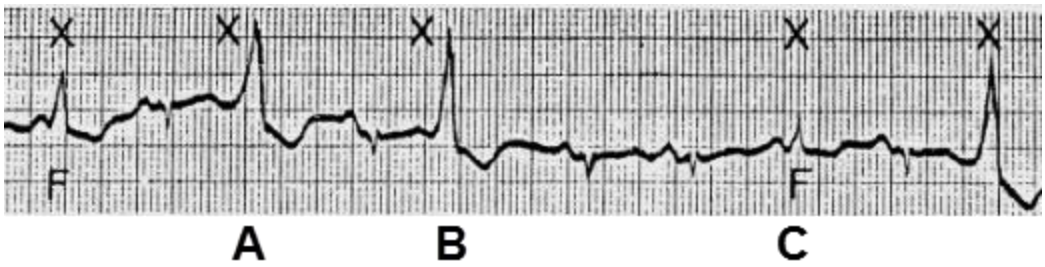
1. ***Sometimes none of the manifest parasystolic intervals represent the basic parasystolic interval.***
   Sometimes the parasystolic intervals are different lengths but do not appear to be multiples of each other. This is usually because you are not seeing the actual basic parasystolic interval. While each of the parasystolic intervals you are seeing is indeed a multiple of the true parasystolic interval, those longer manifest parasystolic intervals are not multiples of each other. You will still recognize the parasystole by the varying coupling intervals.

In this example, interval A and interval B are not multiples of each other, but each is a multiple of the true basic parasystolic interval C. Sometimes, in a relatively short rhythm strip, you will only see the longer, seemingly unrelated intervals. In those instances, you must determine a possible *common denominator* for each interval. Determine the duration of each interval. The number of parasystolic discharges in each interval will be an integer because the parasystolic focus cannot fire 1 ½ times per interval, for example.

Start with the shortest interval and divide it by two and see if the resulting integer will divide into the other intervals. If not, then divide the shortest interval by three and see if that works. Just work your way up the integers until you find an integer that works for all the parasystolic

intervals and that will be the basic parasystolic interval. Only rarely will you have to go beyond three.

2. ***Intermittent Parasystole***
   Eventually the parasystolic focus will simply stop firing, but sometimes it stops and then starts up again. When it starts up again, the interval from the last time it fired to the first ectopic parasystolic impulse of the new episode is almost never a multiple of the previous or new basic parasystolic interval and there will be no common denominator. We call this *intermittent parasystole*. So whenever you have *a long parasystolic interval that is not a multiple of the basic parasystolic interval*, you have an instance of intermittent parasystole. *Intermittent parasystole is benign and requires no treatment* – just like regular parasystole.



In this example, the parasystolic beats are noted with an "X" next to them. Those parasystolic beats that coincide with sinus beats and result in fusion complexes are noted with an "F." We can see a long interval between the third parasystolic beat and the fusion beat that eventually follows it (interval BC). If you measure the basic parasystolic interval of the first group of parasystolic beats (interval AB) and then map out the parasystolic beats going to the right, you will see that interval BC is not a multiple of interval AB. This indicates an intermittent parasystole. Note that *runs of parasystole frequently begin with a fusion beat*.

Although parasystolic foci are protected by an entrance block, they can – and *do!* – develop a momentary *exit block*. An exit block may last for just one beat or it may last for several beats. An exit block of a parasystolic focus is manifested on the ECG by the *lack of a parasystolic beat where you would expect to see one and there is no obvious reason why it should not have appeared on time (i.e., there is no reason for the surrounding myocardium to be refractory)*. You can distinguish a parasystole with an exit block from an intermittent parasystole by the fact that the long interval encompassing the missing beat due to an exit block will still be a multiple of the basic parasystolic interval.

6 COULD I MISTAKE IT FOR SOMETHING ELSE AND HOW WOULD I DISTINGUISH IT?

The most common mistake is confusing parasystole with increased myocardial irritability. Increased ventricular ectopy due to myocardial irritability usually manifests with *multiform* (formerly called

multifocal) PVCs. The ectopic ventricular beats of a ventricular parasystole should all look about the same. However, fusion beats may give the impression of other ectopic foci. Using your calipers, measure the basic parasystolic interval and then map out all the parasystolic beats including the places where you would expect a parasystolic complex to appear but there is none. If there is none present, try to determine the reason for it – was there a preceding complex that may have left the surrounding myocardium refractory? Note if the caliper point falls on a possible fusion beat.

Parasystole usually requires no treatment, but there is one exception: *digitalis toxicity*. Whenever you see a parasystole, check to see if the patient is taking digoxin and be certain the patient isn't digtoxic.

7 PEARLS

Whenever a myocyte with pacemaking capability is prematurely depolarized (i.e., depolarized before it can reach its own threshold potential) we say it is *discharged* and *reset*. The two events (the *discharge* and the *resetting*) are usually simultaneous – but they don't have to be! Sometimes the pacemaking site is "stunned"; that is, it requires a bit more recovery time after the premature depolarization/repolarization and there is a brief delay before its spontaneous depolarization resumes. This can happen to the sinus node as well as any of the accessory pacemaking sites throughout the His-Purkinje system.

Here is a diagrammatic representation of the sinus node firing at a regular, fixed rate (each vertical bar represents a *P wave* and the horizontal bar is the *baseline*):

Here is the same type of diagram but this time there is a PAC that interrupts the regularity of the rhythm. PACs are usually able to enter the SA node, depolarize it and reset its timing from the moment it manages to repolarize:

As you can see, the short P-P interval is terminated by the PAC. It is not a multiple of the other spontaneous depolarizations. However, once the spontaneous depolarizations resume after the shorter interval, they continue at their regular, fixed rate. *Resetting has occurred <u>simultaneously</u> with the depolarization/repolarization of the sinus node*.

Next is a diagrammatic representation of the sinus node having been depolarized by a premature atrial complex (PAC) but in this case, there has been some "stunning" of the SA node which causes it to take a little more time to recover before it is able to resume spontaneous depolarization and its regular rhythm:

As you can see, there is a short P-P interval caused by the PAC which is followed by an interval that is longer than the usual P-P interval; however, following that longer interval, the sinus node resumes its normal regular rate and rhythm. In this case, *discharge of the sinus node was not simultaneous with the resetting of the pacemaker*. Also, whenever the SA node is prematurely discharged and reset – either by a PAC or by retrograde conduction from a PJC or PVC, it may resume its regular rhythm at a *different rate*. This happens because the premature discharge sometimes (but not always) causes a change of pacemaker focus within the SA node itself.