

A Series About Pauses – Part 2

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Know how you sometimes push yourself so hard that you become completely exhausted? We've all been there, but did you know the same thing can happen to the conduction system of your heart? And, depending on the condition and state of the heart, it may not take much for that to happen.

This is called **overdrive suppression**. Most of you have seen it. Let's say a 24 y/o woman comes into the ER with a narrow-complex tachycardia and a heart rate of about 172 beats/minute. The rhythm is regular. She is hemodynamically stable and has no significant past medical history. The

tachycardia was of sudden onset and began at rest. You give adenosine IV push. After some irregular ventricular activity there is a short pause and then sinus rhythm with a rate of 90 resumes.

That short pause is *overdrive suppression*. Usually it is short, but it can sometimes be relatively (and disturbingly) long. Here is an example of *overdrive suppression*...

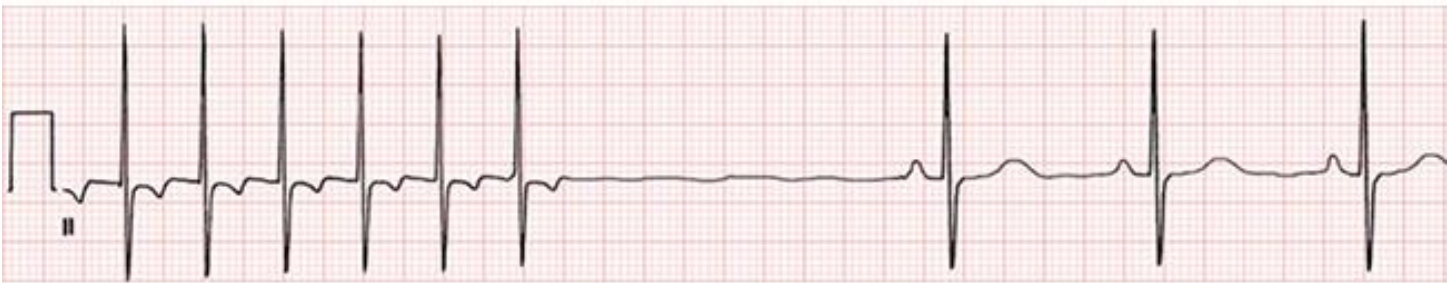


Figure 1

This rhythm strip could very well have been from the patient I just described. What causes the overdrive suppression? To understand it, you must know about an ion exchange system called **Na⁺ / K⁺ ATPase**, better known as the **Na⁺ / K⁺ pump**.

Each ventricular depolarization – each QRS – ends with too much Na⁺ *inside* the cell and too much K⁺ *outside* the cell. For the next depolarization to occur, Na⁺ must be moved out of the cell and K⁺ moved back in the cell. That is the job of the Na⁺ / K⁺ pump. Three (3) Na⁺ ions are exchanged for two (2) K⁺ ions. As you can see, there is an obvious imbalance in this exchange with more Na⁺ exiting the cell than K⁺ entering it. This creates a positively-charged, outward current. We say such an exchange is *electrogenic* because the

“imbalance” creates an electrical current. ATP – the “fuel” of the cell – is required for this exchange to happen.

PEARL: When there is a *net outward flow* of positive ions from the cell, we call that *repolarization*. When there is a *net inward flow* of positive ions, we call that *depolarization*. However, a depolarizing current does not always result in immediate full depolarization and action potential, and a repolarizing current likewise does not always result in immediate complete repolarization.

So... what happens during the tachycardia to cause the pause?

The Na⁺ / K⁺ pump does such an exceptional job, it actually overcompensates and moves too much Na⁺ out which leads to a state called *hyperpolarization*. Hyperpolarization occurs when the membrane potential of the SA node (or *any* myocyte) during Phase 4 is made far more negative than its usual membrane potential. For the SA node, that would be -60 mV. For a working ventricular myocyte, that would be -90 mV. Thus, it will take more time for the membrane potential to once again reach threshold. The pause acts just like a block and spontaneously terminates what – in this case – is likely an AV nodal reentrant tachycardia.

Overdrive suppression may appear after an episode of tachycardia, but it can appear after just a single PVC. Do you remember in Part 1 when I mentioned that a non-compensatory pause can actually last *longer* than two normal P-P intervals if the SA node is reset to a membrane potential that is more negative than usual, taking longer for the next sinus beat to reach threshold? That is essentially *overdrive suppression* – but on a much smaller scale.

Let’s put this in perspective...

Overdrive suppression following a period of rapid tachycardia can occur in the healthiest of hearts. But when it occurs after a rate in the upper 80’s or in the 90’s, there is likely some disease involving the conduction system and/or SA node.

So now you understand the pause after a period of tachycardia or, at least, an increased heart rate (it doesn’t really have to be a tachycardia > 100 beats/minute).

Part 3 in this series will appear here in one week. Look for my “oldie but goodie” post around Wednesday.