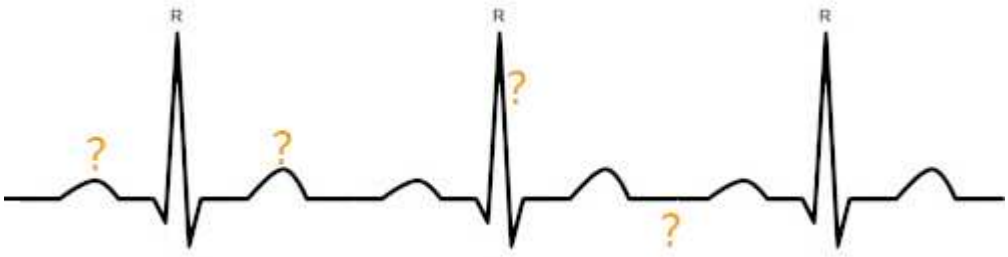
Newsletter from JoR Measurement

ECG signal with sinus rhythm - Do we have a good signal?

A cardiologist obviously have all the necessary understanding, but for all those who measure ECG within applications such as psychophysiology, we offer a brief description. The purpose is to be able to answer basic questions: Do we have a normal sinus rhythm? Should an ECG look like this? Can we rely on these data in our analysis? Without this control, in the worst case, one can draw incorrect conclusions.



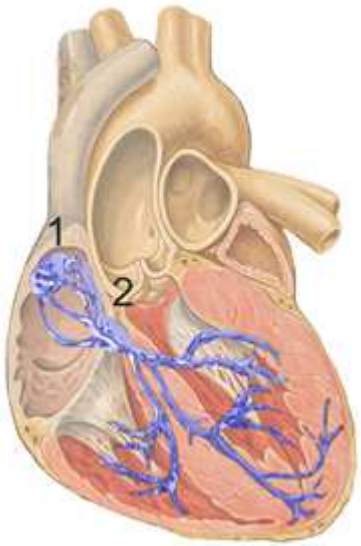
The key to HRV measurements is to make sure you have a "sinus rhythm". But how do you know that?

Mechanics of the Heart

The left ventricle of the heart pumps - by contracting - oxygenated blood to all the cells of the body via the aorta, and the right ventricle pumps oxygen-depleted blood into the lungs, therefore one can say that the heart consists of two synchronized pumps. Each pump has an atrium and a chamber. This anatomy helps fill the chambers with blood to optimize pumping power. Between the atrium and the chamber, there are also valves that act as check valves, so that the blood is not pushed back to the atria when the chambers contract.

*Pressure over the heart = Systemic resistance * Cardiac output*

Electrical control system of the Heart



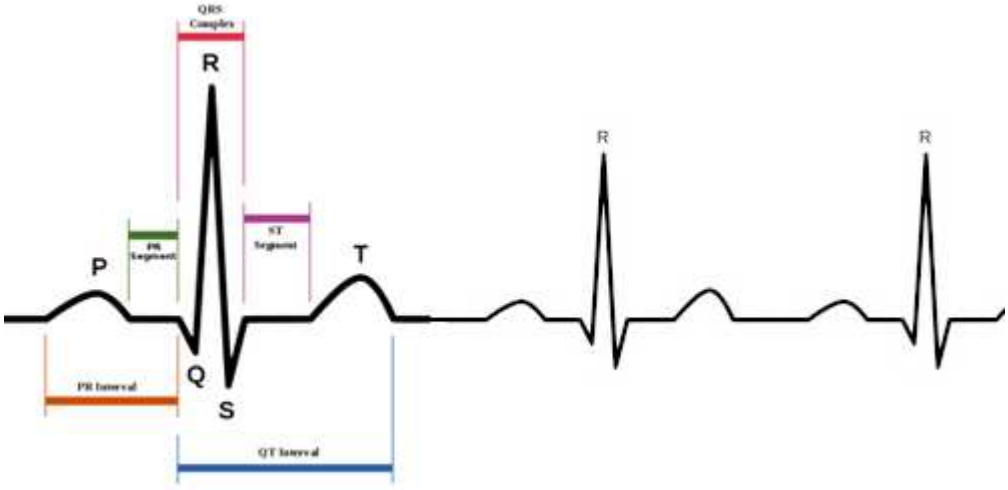
Unlike skeletal muscles initiated by will-controlled nerve impulses, heart muscle cells are triggered by impulses from autonomous pacemaker cells. This is a special type of cell that depolarize and repolarize completely by themselves and

act like a clock. These are the cells that determine the heart rate.

Simply put, the hearts electrical impulse conduction starts in the SA node, then the pulse is conducted through special paths to the AV node, while the atria is activated and begins to fill the ventricles with blood. After a slight delay in the AV node, the impulse is passed down and activates the ventricles, which depolarizes and pump out the blood to the body via the aorta and oxygen-deficient blood to the lungs via the pulmonary artery.

In the other parts of the conduction system: the AV node, bundle of HiS, Purkinje fibers etc, there are also automonous pacemaker cells, which have their own rate of autonomicity. These are normally slower than the SA node, but sometimes these cells - outside the SA node - can initiate a heart contraction on its own and disturb the normal sinus rythm. This is called an ectopic beat, which is easily distinguished on the ECG because the impulse conduction goes the wrong direction with wrong timings.

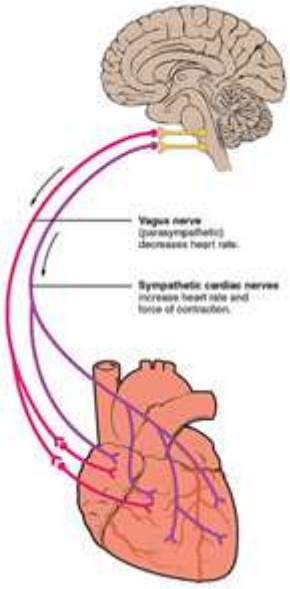
Easy interpretation of lead II ECG



* The P wave corresponds to the atrial contractions; it should be positive in lead II and precede R wave.
* The R wave corresponds to the chamber contractions.
* The T wave corresponds to relaxation of the chambers.

The logic here is simply that a normal atrial activation should be reflected by a normal P wave, and a normal chamber activation reflected by normal QRS wave etc.

How does pacemaker cells work?



Basically, the basic charge and discharge of the pacemaker cells works much like nerve and muscle cells, ie. by in particular, Na+, K+ and Ca2 + ions flowing or pumping in different directions through the cell membrane and thereby changing the cells electrical potential relative its environment. This is controlled by transport channels which are gated by the electrical potential difference across the cell membrane.

One difference, however, is that pacemaker cells do not require an external trigger for a new depolarization, but they start spontaneously a new cycle and thus keep the pace themselves!

The cyclic process is modulated by both hormones and the autonomic nervous system. Among other things, the sympathetic and parasympathetic nervous system connects directly to the SA and AV nodes in the heart.

Some tips for quality assurance of ECG prior to

When doing HRV analysis, it is implicit that it's the SA nodes variability that is affected by the sympathetic and parasympathetic nervous system in the way that is presumed during HRV, rather than variability caused by noise or ectopic beats. It is therefore an important part of the quality assurance that you do not get ectopic beats (strokes that are not initiated by the SA node) in the analysis, since it will then give a variability which will be misinterpreted as ANS variations.

The easiest way to quickly get an overview of their measurement is to transform ECG into HR or RR, since you there often easily see deviations. Ectopic strokes as well as other artifacts often give deviations in the RR intervals between individual strokes that are greater than what is "normal SA variation". This technique can also be used in automated BIOPAC scripts, by first creating a gating signal that marks "abnormal RR variation" with suspected ectopic beats or other artifacts, and then selectively applying interpolation only in the problem areas.

READ MORE ABOUT ECG

Tip: Download BIOPAC's "Introductory ECG Guide"

ECG GUIDE

Don't miss the Biopac T4 Human Physiology Conference!

12-14 Aug 2019 @ University of California, Santa Barbara, USA

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Don't hesitate to contact us at biopac@jor.se with a short description of your situation and we are happy to give you tailored advice! We also have research systems with more features.

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