Explanation of ECG Waves

Francesco Rosnati

August 6, 2024

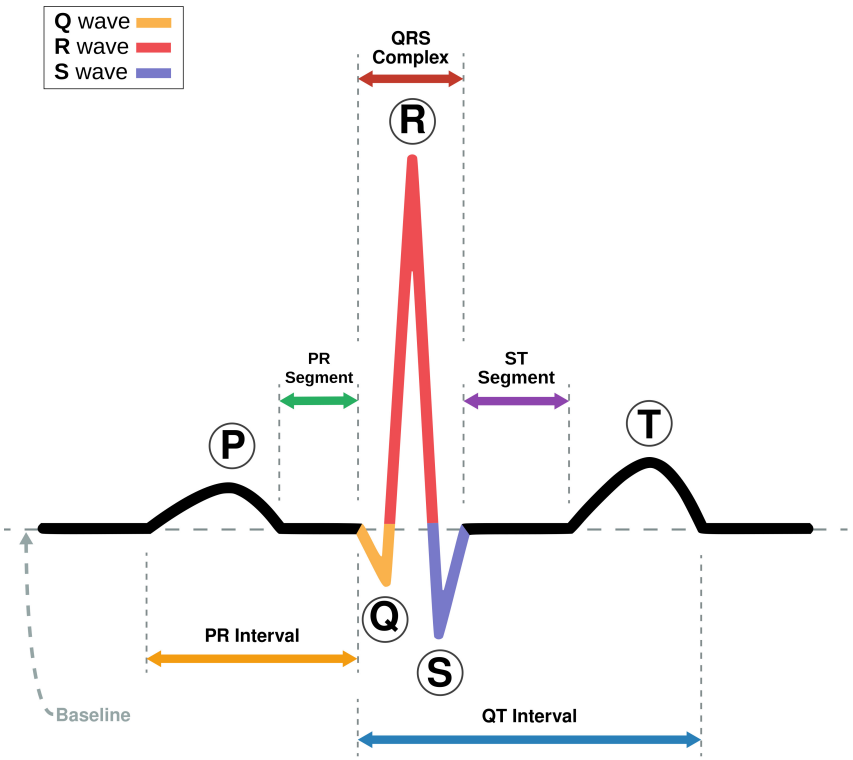

Figure 1: ECG graph

In an Electrocardiogram (ECG), the P, Q, R, S, and T waves represent different phases of the cardiac cycle, reflecting the electrical activity of the heart. Here's an expanded explanation including the roles of the sinoatrial node (SAN), atrioventricular node (AVN), Bundle of His, bundle branches, and Purkinje fibers, as well as the associated events in terms of blood flow, contraction, and expansion of the heart chambers.

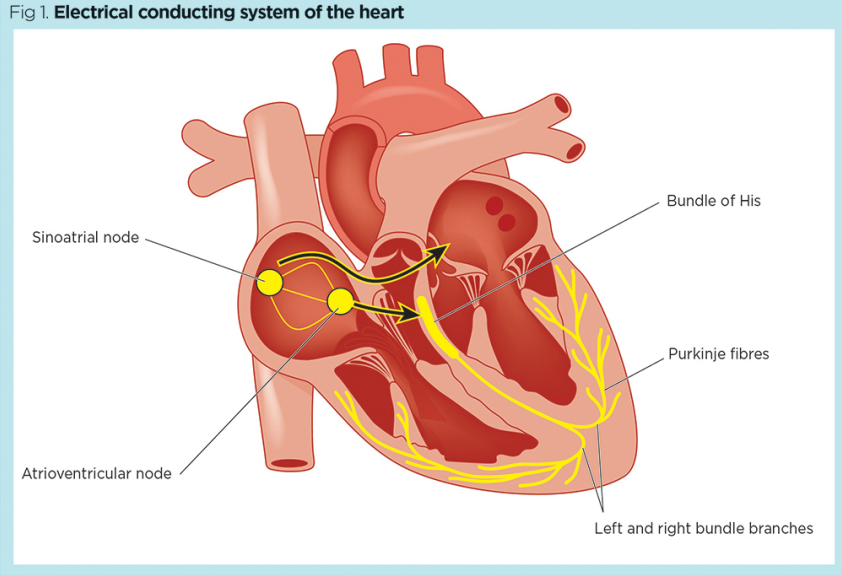

Figure 2: Electrical conducting system of the heart

P Wave

- **Electrical Activity**: Represents atrial depolarization.
- **SAN Activity**: The sinoatrial node (SAN), located in the right atrium, initiates the electrical impulse.
- **Pathway**: The impulse spreads across the atria, causing them to depolarize and contract.
- **Mechanical Activity**: Atrial contraction (atrial systole) forces blood into the ventricles.
- **Chamber Involvement**: Both the right atrium and left atrium contract, pushing blood into the right ventricle and left ventricle, respectively.

Q Wave

- **Electrical Activity**: Represents the initial phase of ventricular depolarization.
- **Pathway**: The impulse travels from the AV node down the Bundle of His.
- **Mechanical Activity**: Initiates the depolarization of the interventricular septum.
- **Chamber Involvement**: The depolarization begins at the septum, but there is minimal mechanical activity at this stage.

R Wave

- **Electrical Activity**: Represents the main phase of ventricular depolarization.
- **Bundle Branches and Purkinje Fibers**: The impulse rapidly travels through the left and right bundle branches and then through the Purkinje fibers, causing the ventricles to depolarize.
- **Mechanical Activity**: Ventricular contraction (ventricular systole) occurs.
- **Chamber Involvement**: The left ventricle and right ventricle contract, pushing blood into the aorta and pulmonary artery, respectively. The left ventricle pumps oxygenated blood to the body, while the right ventricle pumps deoxygenated blood to the lungs.

S Wave

- **Electrical Activity**: Represents the final phase of ventricular depolarization.
- **Pathway**: The impulse completes its passage through the ventricles.
- **Mechanical Activity**: Final contraction of the ventricles.
- **Chamber Involvement**: The basal parts of the ventricles complete their contraction.

T Wave

- **Electrical Activity**: Represents ventricular repolarization.
- **Pathway**: The ventricles recover from depolarization and prepare for the next cycle.
- **Mechanical Activity**: Ventricular relaxation (ventricular diastole) occurs.
- **Chamber Involvement**: The ventricles relax and start to fill with blood from the atria. The left atrium and right atrium fill with blood returning from the pulmonary veins and systemic veins, respectively.

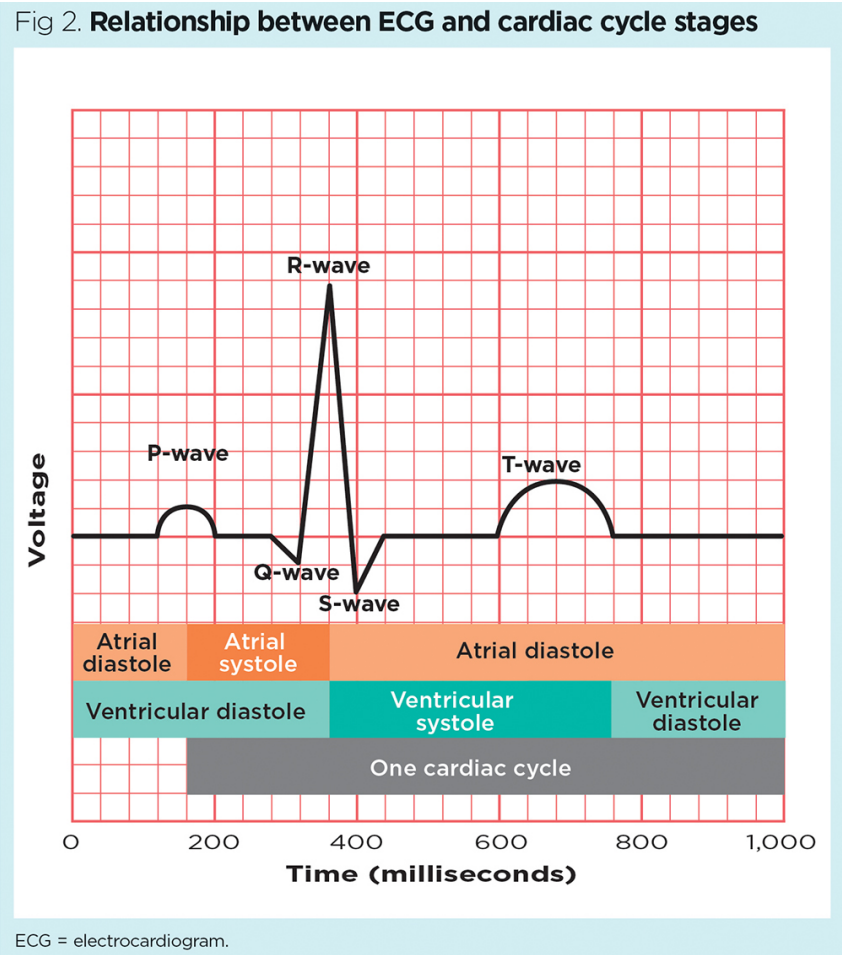

Figure 3: Relationship between ECG and cardiac cycle stages

Blood Flow & Chamber Contraction/Expansion

- **Right Atrium (RA)**: Fills with deoxygenated blood from the body; contracts during P wave to push blood into the right ventricle.
- **Right Ventricle (RV)**: Receives blood from the right atrium; contracts during QRS complex to send blood to the lungs.
- **Left Atrium (LA)**: Fills with oxygenated blood from the lungs; contracts during P wave to push blood into the left ventricle.
- **Left Ventricle (LV)**: Receives blood from the left atrium; contracts during QRS complex to send blood to the rest of the body.

By including these additional elements, we can see how the electrical activities represented by the ECG waves correspond to specific mechanical activities and pathways within the heart, facilitating the coordinated pumping of blood.