AUTONOMIC REGULATION OF THE HEART: APPENDIX

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ELECTRICAL CONDUCTION SYSTEM: ANATOMICAL REFERENCES

Sinoatrial node:
Located high in the right atrial wall, near the entry of the superior vena cava into the right atrium.

Atrioventricular node:

Located in the triangle of Koch – an area in the superficial endocardium of the right atrium, bounded by the coronary sinus, the membranous interarterial septum, the septal leaflet of the tricuspid valve, and the tendon of Todaro (this “tendon” is part of the fibrous skeleton of the heart and is not always present).

Bundle of His/atrioventricular bundle:

This extends down the length of the interventricular septum through the central fibrous body of the fibrous skeleton. The bundle forms two branches of the **Purkinje fibers.**

Purkinje fibers:

Purkinje fibers have the fastest action potentials in the heart. These fibers travel in the ventricular subendocardium then penetrate the myocardium to cause muscle contraction. The right branch travels in the interventricular septum and supplies the right ventricle myocardium; the left is in the subendocardium of the left ventricle.

ECG: SOME EXPLANATIONS
How Does the Heartbeat Look on An ECG?

The electrocardiogram records electrical voltage changes from one cycle to the next. When there is an electrical current in the heart, a small trace of it can be read from electrodes on the skin. Electrophysiology and related pathologies are clearly a topic of its own but here is a basic outline:

The cycle begins with the P wave followed by QRS followed by T waves.

P wave: The atria are depolarized, which then causes atrial contraction. After the P wave, atrial pressure increases. Blood is pumped through the open atrioventricular (av) valves (tricupsid & mitral) into the ventricles. The semilunar valves (pulmonary and aortic) are closed, preventing backflow and keeping the blood in the heart.

QRS waves: this happens 0.16 seconds after the onset of the P waves. Depolarization of the ventricles, causing ventricular contraction, is followed by increased ventricular pressure. This phase is ventricular systole (more on that in a minute). The semilunar (pulmonary and aortic) valves open, and blood flows into the pulmonary and systemic circulation; the av valves are closed, preventing backflow into the atria. Not everyone has three distinct recordable waves, and they are usually considered as a group.

Q wave: depolarization of the interventricular septum.
R wave: early ventricular depolarization
S wave: final ventricular depolarization

Ventricular T wave: this is the repolarization of the ventricles. The ventricular muscle relaxes and pressure drops. The semilunar valves (pulmonary and aortic) close to prevent back flow into the ventricles. At first, the av valves are still closed, but when the ventricular pressure drops below the atrial pressure, these valves open, and blood begins flowing from the circulation into the atria, and from the atria into the ventricles.

What is the Relationship Between The ECG And Systole/Diastole Rhythm?

The terms "diastole" and "systole" (relaxation & contraction) usually refer to the action in the ventricles. The atria have their own rhythm of diastole and systole; there is some overlap with the ventricular action.

DIASTOLE (ie ventricular diastole) includes three phases: This is from the end of the T wave until the peak of the R wave

1. **Isovolumic ventricular relaxation**. The ventricles are relaxed. The atria are also relaxed. Blood pressure falls. The semilunar valves close to prevent backflow into the heart. The av valves are also closed – the volume of blood in the ventricles doesn't change.
2. **Late ventricular diastole**: Blood pressure continues to drop. To start with, the atria are also in diastole (ie relaxed); when the ventricular pressure is lower than the atrial pressure, the av valves open and there is a passive filling with blood; blood moves from the circulation to the atria, and from the atria to the ventricles. The semilunar valves remain closed. During this phase of diastole 75% of ventricular filling occurs.
3. **End diastolic volume** – also known as the atrial "kick": the ventricles are still relaxed (diastole) but the atria contract (atrial systole). This contraction supplies the ventricles with the last 25% of the blood. The av valves remain open, the semilunar valves remain closed.

SYSTOLE (ie ventricular systole): This is from the peak of the R wave until the end of the T wave.

1. **Isovolumic contraction**. 0.2-0.3 seconds. The atria are relaxed (atrial diastole) and ventricles begin to contract; the av valves close to prevent backflow into the atria. The volume of blood in the ventricles (130 ml) is constant (no blood flowing in or out).

2. **Ventricular ejection phase**. Ventricle pressure is greater than pulmonary trunk & aorta pressure, so the semilunar valves are pushed open and blood moves into the pulmonary and systemic circulation. ***Stroke volume*** = amount of blood pumped out of the heart – this is the same in both circulations, even though the pulmonary trunk is lower pressure than the aorta. Some blood (50-60 ml) remains in the ventricle (this is *"end systolic volume"*)

Autonomic Regulation of the Heart

Extra Material

Orianne Evans SCCO The Intelligent Heart June 2022

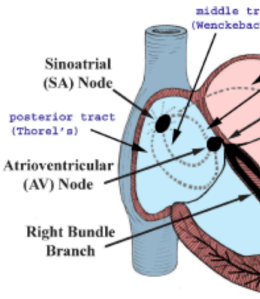
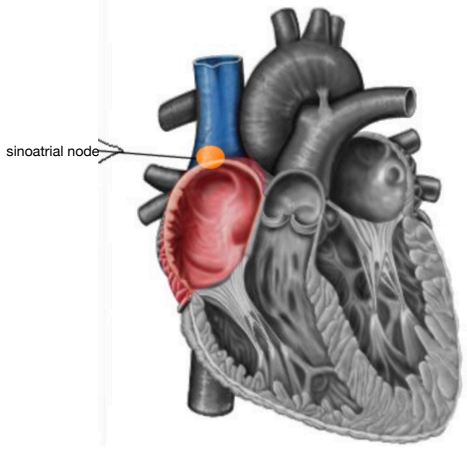
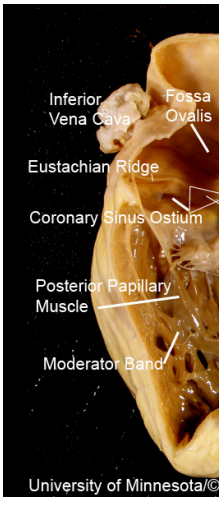
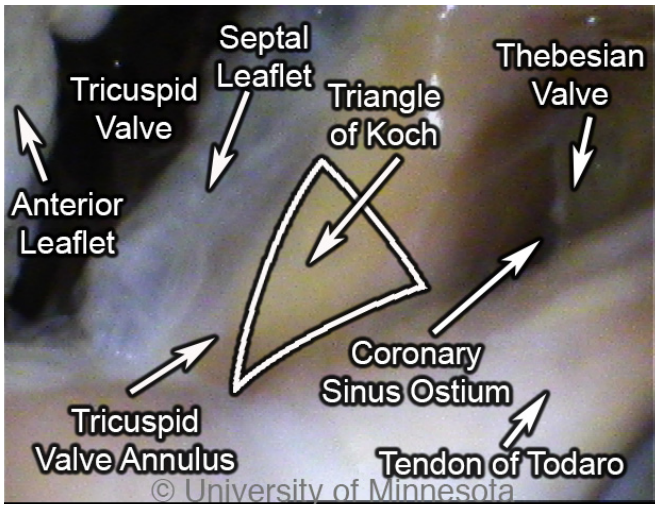


Figure 1. The conduction system of the he
the sinoatrial (SA) node, then propagates t
shown as dashed lines). The atrial depolar
atrioventricular (AV) node, passes through
then to the Purkinje fibers which make up t
subsequently all ventricular muscle becom







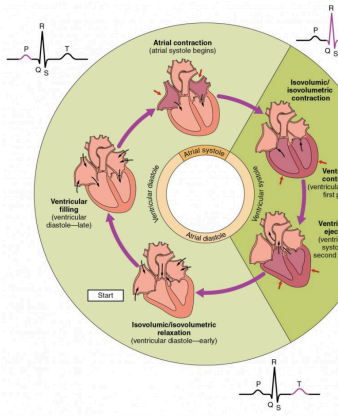


Figure 1. The cardiac cycle begins with atrial systole and progres
ventricular systole, atrial diastole, and ventricular diastole, when th
begins again. Correlations to the ECG are highlighted.

OpenStax CNX.