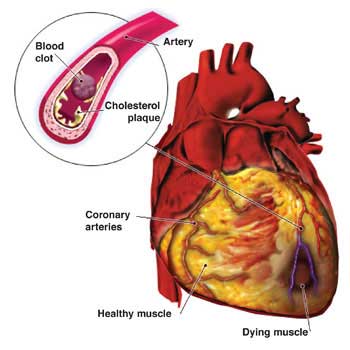
Cardiovascular Disease

*“A main cause of CVD is when the vasculature and the heart are not functioning together properly”*

Overview

Cardiovascular disease (CVD) is a damage to, or dysfunction of, the heart (‘cardio’) and vasculature. The vasculature includes all blood vessels: arteries, capillaries, and veins. A main cause of CVD is when the vasculature and the heart are not functioning together properly. The other main cause of CVD is when the nerves controlling the heart or the vasculature are not functioning properly.

The Heart

A Special Muscle

The heart is a special muscle, made of special muscle cells. In fact the heart muscle cells are unique to the heart, located nowhere else in the body. They are special because they are linked together electrically through little holes in the cell membranes so each cell may communicate with the cells around it. In effect this forms a little nervous system throughout the heart, enabling it to beat rhythmically on its own.

The heart muscle cells and supporting connective tissue are arranged to form the structure of the heart, including the chambers and valves. The human heart has four chambers: two little chambers at the top of the heart called the atria, and two larger chambers forming the bottom of the heart called the ventricles.

The Atria

The atria work to place just enough blood into the ventricles so that the ventricles may work efficiently. The concept is similar to working with a screw-driver. If the handle to the screw-driver is too small or too large for your hand, you will either squeeze too hard or not be able to squeeze hard enough to do the job. With just the right size handle, not only can you do the job, but you can do it much more easily. This concept is the same for the purpose of the atria, to put just the right amount of blood into the ventricles for maximum efficiency in pumping blood out of the heart.

The Ventricles

The ventricles’ job is to pump blood out of the heart. The larger left ventricle receives oxygen-rich blood from the lungs via the left atria and pumps blood to the rest of the body. The smaller right ventricle receives oxygen-depleted blood from the body via the right atria and pumps blood to the lungs to exchange the carbon-dioxide for oxygen.

The mechanical function of the heart, the valves, chambers, muscle walls, etc., are monitored and their function measured by a test called the echocardiogram (“echo”). An echo uses high frequency sound waves, like sonar, to image the heart and allows the doctor to see if there are any leaks or damage. The electrical function of the heart, itself, is measured by the electrocardiogram (“ECG”). The ECG is made of three waveforms: the contraction of the atria (known as the “P-wave”), the contraction of the ventricles (known as the “QRS-complex”), and the relaxation of the ventricles (known as the “T-wave”). The contraction of the atria are not able to be seen because it is overwhelmed by the contraction of the ventricles.

The Vasculature

Your arteries and veins also have muscles. These are known as smooth or involuntary muscles. The muscles of your arteries contract rhythmically also (known as “peristalsis”). The arteries have more muscle than veins, because they have to help the heart to pump blood throughout the body. The heart cannot do it all on its own, or some of your body may never receive blood. The veins have less muscle because they deal with less pressure in returning blood to the heart. Veins below the heart that have to work against gravity also have valves the help the weaker veins, when functioning normally, prevent blood from flowing back down into the legs. Also, the muscles of your legs and abdomen help to squeeze blood back to the heart.

The Autonomic Nervous System

Parasympathetic and Sympathetic Control of the Heart

But this is only part of the story of the heart. Like all other muscles in the body, every muscle is controlled by a nerve. In the special case of the heart, the heart muscle is controlled by two nerves. These nerves are the parasympathetic (P) and sympathetic (S) branches of the autonomic nervous system (ANS). The ANS may be thought of as the “automatic” nervous system controlling all the things we do not have to think about, like heart rate (HR), blood pressure (BP) and breathing. The P&S complement each other to ensure that every cell in the body receives the proper amount of blood (nutrients, oxygen, and waste removal) with each heartbeat.

These nerves act like the thermostat in your home. Depending on what you want to do, the brain (via the brain stem) determines what heart rate and blood pressure is needed for the proper amount of blood to be pumped to the body (known as “cardiac output”). The P&S nervous systems determine the proper HR and BP given the information provided by the brain and communicates this information to the heart and blood vessels.

This is like you setting the thermostat in your house. You set it and forget it. Once set, the heating and cooling system of the house automatically take over and maintain the temperature you set, when everything is working properly. If you make a change the heater heats things up, or the cooling systems cools things down. Similarly, the S nervous system speeds up HR and increases BP, and the P nervous system slows down HR and helps to lower BP. Another way to consider it is like the accelerator (S) and brakes (P) on your car. The S speeds things up and the P slows things down, and the two must work properly together to avoid accidents (like heart attacks).

Parasympathetic and Sympathetic Monitoring

The nervous control of your heart is measured by P&S Monitoring that uses your HR and breathing (respiratory activity, or RA) to determine P&S function. Your HR varies breath by breath, normally. This is known as HR-variability (HRV). As you breath in your HR increases a little and as you breath out your HR decreases a little. This is known as respiratory sinus arrhythmia (RSA), the only arrhythmia you want.

RSA is a function of what is known as the cardio-vagal response. Vagal, refers to the Vagus Nerve which is a significant portion of the P nervous system. By analyzing HRV, total (T) ANS function is measured. By analyzing RSA through RA, P nervous system is measured. Since T = S + P. Given that we can measure T and P. We can compute S from T & P as S = T – P. Now, whether you are seriously ill or not, young or old, active or resting, on medications or not, your P&S function can be measured, to determine how it effects your heart, vasculature, and all other systems of your body.

Sympathetic Control of the Vasculature

The muscles of your vasculature are controlled only by the S nervous system. More S-activity, due to stress or exercise, constricts (narrows the diameter of) your vasculature, increasing BP. Less S-activity, when relaxing, dilates (expands the diameter of) your vasculature, decreasing BP.

These three parts of your body (heart, vasculature and ANS) must work properly together to avoid heart disease.