Heart Essay, Research Paper

HEART

The human heart is a specialized, four-chambered muscle that maintains BLOOD flow in the CIRCULATORY

SYSTEM. Located in the thorax, it lies left of the body’s midline, above and in contact with the

diaphragm. It is situated immediately behind the breastbone, or sternum, and between the lungs, with its

apex tilted to the body cavity’s left side. In most people the apex can be felt during each heart

contraction. At rest, the heart pumps about 59 cc (2 oz) of blood per beat and 5 l (5 qt) per minute,

compared to 120-220 cc (4-7.3 oz) per beat and 20-30 l (21-32 qt) per minute during exercise. The adult

human heart is about the size of a fist and weighs about 250-350 gm (9 oz).

Blood supplies food and oxygen to the cells of the body for their life needs and removes the waste

products of their chemical processes. It also helps to maintain a consistent body temperature, circulate

hormones, and fight infections. The brain cells are very dependent on a constant supply of oxygen. If the

circulation to the brain is stopped, death ensues shortly. Since heart attacks are the number-one cause

of death in the United States, the heart gets a great deal of attention.

The role of the heart was long considered a mystery and often given elevated importance. Some thought it

was the seat of the soul. Others thought it was the center of love, courage, joy, and sadness. Primitive

man must have been aware of the heartbeat and probably recognized the heart as an organ whose malfunction

could cause sudden death.

The Hippocratic De Corde, which probably dates from the time of ARISTOTLE, describes the construction of

the heart’s valves. LEONARDO DA VINCI made exquisite drawings of the heart, but it was not until the

publication of William HARVEY’s De Motu Cordis (1628) that the heart’s specific role in relation to

circulation was widely understood.

STRUCTURE AND FUNCTION OF THE HUMAN HEART

The heart’s wall has three parts. Muscle tissue, or myocardium, is the middle layer. The inner layer, or

endocardium, that lines the inside of the heart muscle consists of a thin layer of endothelial tissue

overlying a thin layer of vascularized connective tissue. The outside of the heart, the epicardium, is in

intimate contact with the pericardium; this serous membrane is a closed sac covering the heart muscle’s

outside wall. Within the sac, a small amount of fluid reduces the friction between the two layers of

tissue. In addition to muscular and connective tissue, the heart muscle contains varying amounts of fatty

tissue, especially on the outside. Both anatomically and functionally, the heart is divided into a left

and a right half by the cardiac septum. Each half contains two separate spaces: the atrium (pl. atria),

or auricle, and the ventricle. The upper reservoirs, or collecting chambers, are the thin-walled atria,

and the lower pumping chambers are the thick-walled ven!

tricles. The total thickness of the ventricular walls is about three times that of the atria; the wall of

the heart’s left half is approximately twice as thick as that of the right half. The thickness of the

heart muscle varies from 2 to about 20 mm (0.1 to 0.8 in). This thickness is correlated with the maximum

pressure that can be attained in each chamber.

FLOW OF BLOOD THROUGH THE HEART

The right atrium receives oxygen-poor blood from two major veins: the superior and inferior vena cava,

which enter the atrium through separate openings. From the right atrium the blood passes through the

tricuspid valve, which consists of three flaps, or cusps, of tissue. This valve directs blood flow from

the right atrium to the right ventricle. The tricuspid valve remains open during diastole, or ventricular

filling; however, when the ventricle contracts, the valve closes, sealing the opening and preventing

backflow into the right atrium. Five cords attached to small muscles (papillary muscles) on the

ventricles’ inner surface prevent the valves’ flaps from being pushed backward. From the right ventricle

blood is pumped through the pulmonary, or semilunar, valve, which has three half-moon-shaped flaps, into

the pulmonary artery. This valve prevents backflow from the artery into the right ventricle. From the

pulmonary artery, blood is pumped to the lungs, where it gives up ca!

rbon dioxide and receives oxygen, and then is returned to the heart’s left side through four pulmonary

veins (two from each lung) to the left atrium and then through the mitral valve, a two-flapped valve also

called a bicuspid valve, to the left ventricle. As the ventricles contract, the mitral valve prevents

backflow of blood into the left atrium, and blood is driven through the aortic valve into the AORTA, the

major artery, which supplies blood to the entire body. The pulmonary valve, like the aortic valve, has a

semilunar shape and a unidirectional function.

CORONARY CIRCULATION

The blood supply to the heart muscle is furnished mainly by the CORONARY ARTERIES, which originate from

the aorta immediately after the aortic valve. These vessels pass through the fatty tissue beneath the

pericardium and then branch out into the heart muscle.

The coronary veins transport the deoxygenated blood from the heart muscle to the right atrium. The

heart’s energy supply is almost completely dependent on these coronary vessels. Only the tissues lying

directly beneath the endocardium receive a sufficient amount of oxygen from the blood within the cavities

of the heart.

REGULATION OF THE HEARTBEAT

The heart muscle pumps the blood through the body by means of rhythmical contractions (systole) and

dilations (diastole). The heart’s left and right halves work almost synchronously. When the ventricles

contract (systole), the valves between the atria and the ventricles close, as the result of increasing

pressure, and the valves to the pulmonary artery and the aorta open.

When the ventricles become flaccid during diastole and the pressure decreases, the reverse process takes

place: through the valves between the atria and the ventricles, which are now open again, blood is drawn

from the atria into the ventricles, and the valves to the pulmonary artery and the aorta close.

At the end of diastole the atria also contract and thus help to fill the ventricles. This is followed by

systole. The electrical stimulus that leads to contraction of the heart muscle originates in the heart

itself, that is, in the sinoatrial node (SA node), or pacemaker. This node, which lies just in front of

the opening of the superior vena cava, measures no more than a few millimeters. It consists of heart

cells that emit regular impulses. Because of this spontaneous discharge of the sinus node, the heart

muscle is automated, and a completely isolated heart can contract on its own, as long as its metabolic

processes remain intact. The electrical stimulus from the SA node becomes propagated regularly over the

muscle cells of both atria and reaches the atrioventricular node (AV node), which lies on the border

between the atria and the ventricles. The stimulus continues into the bundle of His. This bundle proceeds

for about a centimeter and then divides into a left and a right!

bundle branch. The two bundle branches lie along the two sides of the heart’s septum and then proceed

toward the apex. The small side branches that come off are the Purkinje fibers, which conduct the

stimulus to the muscle cells of the heart’s ventricles.

The Purkinje fibers differ from the cardiac muscle cells and conduct the stimuli more rapidly. However,

the AV node conducts the stimulus relatively slowly. As a result, the heart chambers contract regularly

and evenly during systole, and ventricular contraction does not coincide with that of the atria; so the

pumping function is well-coordinated. Potentially, the whole conduction system is able to discharge

spontaneously and can take over the function of the SA node. The rate at which the cells of the SA node

discharge under normal circumstances is externally influenced through the autonomic nervous system, which

sends nerve branches to the heart. Through their stimulatory and inhibitory influences they determine the

resultant heart rate. In adults at rest this is between 60 and 74 beats a minute. In infants and young

children it may be between 100 and 120 beats a minute. Tension, exertion, or fever may cause the rate of

a healthy heart to vary between 55 and 200 beats a minu!

te.

The output of the heart is expressed as the amount of blood pumped out of the heart each minute: the

heart minute-volume (HMV). This is the product of the heart rate and the stroke volume (SV), the amount

of blood pumped out of the heart at each contraction.

EVOLUTION OF THE HEART

The hearts of primitive vertebrates apparently had only one atrium and one ventricle. Since their body

temperature and metabolic rate fluctuated with the environmental temperature, they did not need as

efficient a circulatory system as mammals and birds. The two-chamber heart is retained by modern fish,

but oxygen-rich blood does not mix with oxygen-poor blood, because the blood is aerated at the gills and

goes directly into systemic circulation, not to the heart. As the primitive lung evolved in amphibians,

two circulatory systems arose. The problem of mixing oxygenated and deoxygenated blood was resolved in a

number of amphibians such as the FROG, in which the single atrium is divided into two separate chambers.

Thus there is only a slight mixing of the bloods in these three-chambered hearts. This adaptation appears

to help the frog when it is under water, since the skin provides oxygen when the lungs cannot be used. In

SIRENS a partial division takes place in the ventricle !

as well.

As animals became larger and more active on land, they needed more pressure to provide faster flow. The

sides of the heart were separated when a septum formed to divide the ventricle into two chambers. Birds

and mammals have completely separate chambers and have more blood per tissue weight and more pressure,

because the tissues of birds and mammals (warm-blooded vertebrates) require a constant perfusion of

oxygen-rich blood in order to maintain their high metabolic rates and constant body temperature.

HEART EXAMINATION

The closure of the heart valves and the contraction of the heart muscle produce sounds that can be heard

through the thoracic wall by the unaided ear, although they can be amplified by means of a STETHOSCOPE.

The sounds of the heart may be represented as lubb-dupp-pause-lubb-dupp-pause. The lubb sound indicates

the closing of the valves between the atria and ventricles and the contracting ventricles; the dupp sound

indicates the closing of the semilunar valves. In addition, there may also be cardiac murmurs, especially

when the valves are abnormal. Some heart murmurs, however, may also occur in healthy persons, mainly

during rapid or pronounced cardiac action. The study of heart sounds and murmurs furnishes valuable

information regarding the condition of the heart muscle and valves. The heart sounds are recorded with

the aid of sensitive microphones (phonocardiography), so that anomalies of the heart or the valves can be

analyzed. The conduction of the contraction stimulus can!

also be recorded on the body surface by an ELECTROCARDIOGRAPH. This measures the differences in

potential (in microvolts) that exist between a number of fixed points on the limbs and the chest wall.

The electrocardiogram (cardiogram, ECG) that is obtained in this way furnishes information about the

rhythm of the heart, the conduction of the stimulus, and the condition of the heart muscle. Other methods

that have been devised to examine the heart are the mechanical recording of the heartbeat,

echocendiography and radioisotopes, X-ray analysis of the heart’s form and movements, and X-ray contrast

studies of the blood flow through the heart and the coronary vessels.