

The Dynamic Heart and Circulation

Craig Holdrege

This essay is a substantially shortened version of Craig's introduction to a book called "The Dynamic Heart and Circulation," of which he is the editor. Many of the supporting references have been removed from the text. The book will be published later this year and is aimed at teachers, health professionals, and anyone interested in learning about a Goethean approach to the human being. To order the book, contact AWSNA Publications (916-961-0927 or www.awsna.org).

The liver is a chemical factory. The kidney is a waste treatment plant. The heart is a pump. The brain is a computer.

If we lived in a more poetic age, we might say, "the heart is a rose." But a mind at home in the mechanical world of cause and effect can hardly avoid seeing the heart as a pump circulating the blood through the body.

The damaging thing about mechanical models is that they tend to be exclusive. High school or college students don't usually learn "the heart has some functions that we can interpret in terms of a pressure pump." Rather, they learn "the heart is a pump." Mechanical metaphors in science all too often become fixed and literal, losing their vibrancy and openness. This makes them easier and clearer to apply – and also less faithful to life.

The Fluid Heart

The circulatory system is dynamic. While the brain rests firmly and still in its protective casings, the circulatory system lives in rhythmic movement, mediating extremes. Most of the heart, as an organ of movement, consists of muscle fibers (myocardium). These fibers are joined in bands that "present an exceedingly intricate interlacement" (*Gray's Anatomy*).

The outer muscle fibers begin at the upper part of the heart and sweep down in counterclockwise curves to the tip (apex) of the heart (see figures 1 and 2). There they loop around and form the so-called heart vortex (*vortex cordis*, see figure 1, middle drawing). Those fibers that begin at the front (ventral side) of the heart enter the heart vortex at the back (dorsal side) of the heart while those that begin at the back sweep around to the front. These outer fibers loop around each other, creating the vortex pattern, and then

continue into the inside of the muscular wall and spiral back upward. Some of these fibers radiate into the papillary muscles that move the atrio-ventricular valves.

Fibers that lie deeper at the top of the ventricles spiral down – in contrast to the superficial fibers – clockwise. These fibers coil in more tightly and form nearly horizontal loops around the body of the ventricles before they sweep upward again to the top of the heart.

The best way to form a picture of this complex fiber arrangement is to study figure 2 and then try to recreate the spiraling with your hands. With repeated effort you begin to get a sense of the heart's dynamic structure, which the English anatomist J. Bell Pettrigrew described as "exceedingly simple in principle but wonderfully complicated in detail."

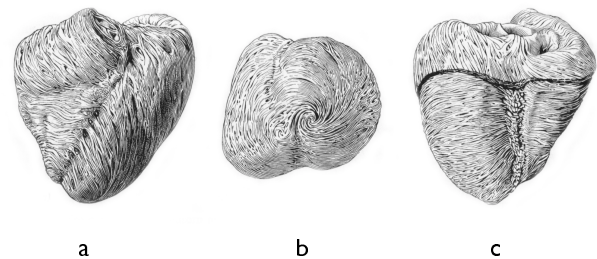


Fig. 1: The heart muscle fibers in the ventricles. a) viewed from the front (ventral), b) viewed from below; note the vortex formed by the fibers (*vortex cordis*), c) viewed from from behind; the superficial fibers are partially removed to show the deeper muscles. [after 1]

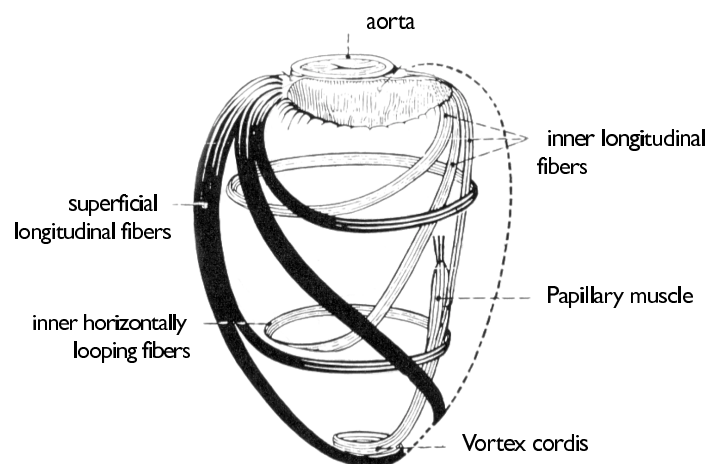


Fig. 2: Schematic representation of the spiraling heart fibers in the left ventricle. See text for description. [after 1]

Muscle consists of about 75% water. The spiraling and looping pattern of the heart fibers, including the beautiful heart vortex, is an image of fluid movement. The blood streaming through the heart also creates loops and vortices. Like the fibers of the heart, this movement is very complex and intricate. In a sense, what the blood does as a fluid has become formed in the muscular structure of the heart (see figure 3).

The direction of blood flow is radically altered by the heart. Venous blood enters the right side of the heart through the superior and inferior caval veins, which are vertically oriented (see Figures 4 and 5). From the right atrium the blood streams down into the



Fig. 3 : A cast of the left ventricle of a deer.

superior and inferior caval veins do not collide, but turn forward and rotate clockwise, forming a vortex. The blood streaming into the left atrium also forms a vortex, but it turns counterclockwise. When the atrio-ventricular valves open, the blood streams into the relaxed ventricles, again rotating, forming vortices that redirect the flow of blood. Momentarily the blood ceases its flow and then the semilunar valves (which separate the ventricles from the outgoing arteries) open and the blood streams into the pulmonary artery and the aorta.

The coiling, looping heart fibers create contractions that mirror and facilitate this streaming, looping blood flow unique to each chamber. During systole (contraction) the heart moves downward and oscillates slightly to the sides and also rotates around its own axis. During diastole (relaxation) it moves upward and rotates back in the opposite direction [2, 4]. Only the heart's interwoven spiraling muscle fibers can produce this kind of complex motion.

We see that blood flow, the form of the heart, the pattern of its fibers, and the motion of the heartbeat are intimately entwined. We can't think of one without the others. When we go back to the origin of the blood and the heart in embryonic development, it is no simple matter to say what came first. Early in its development the heart begins to form loops that redirect blood flow. But before the heart has developed walls (septa) separating the four chambers from each other, the blood already flows in two distinct "currents" through the heart. The blood flowing through the right and left sides of the heart do not mix, but stream and loop past each other, just as two currents in a body of water. In the "still water zone" between the two currents, the septum dividing the two chambers forms [1]. Thus the movement of the blood shapes the heart, just as the looping heart redirects the flow of blood.

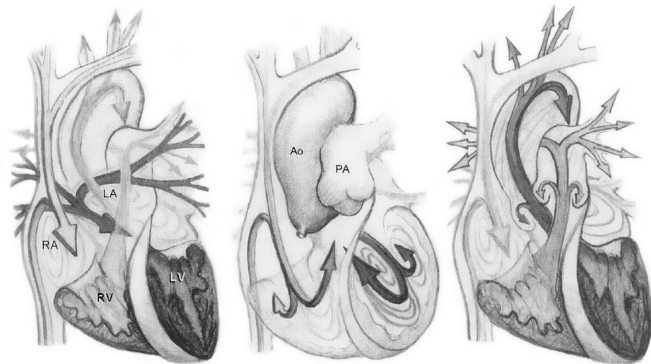


Fig. 4: Changes in blood flow direction through the heart, viewed from the front. Systole has been shown twice to show inflowing and outflowing blood. RA, right atrium; RV, right ventricle; LA, left atrium; LV, left ventricle; Ao, aorta; PA, pulmonary artery. (Drawings by P. Kilner; reprinted by permission. See [3].)

right ventricle and then back upward into the pulmonary artery, which immediately branches horizontally to the right and left to enter the lungs.

In contrast, the blood that enters the left side of the heart comes horizontally from the pulmonary veins. From the left atrium it flows downward into the left ventricle and loops upward into the ascending aorta. At the aortic arch three arteries ascend into the head and arms, while the vertically descending aorta serves the rest of the body.

So the right side of the heart brings vertically flowing blood into the horizontal and the left side of the heart brings horizontally flowing blood into the vertical. This change in orientation is clearly evident in the drawing of the cross that is formed by the caval veins and the pulmonary veins (Figure 5).

The streams of blood entering the right atrium from the

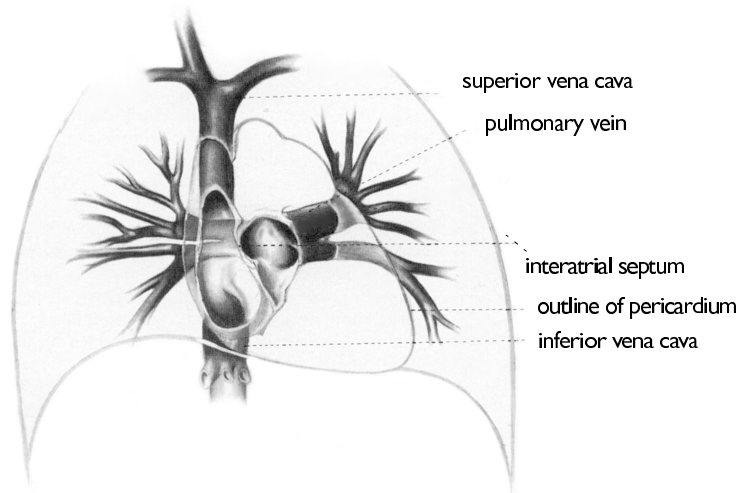


Fig.5: Crossing of the caval and pulmonary veins. [after 1]

Pulsing Interplay

The heart is the center of the circulatory system. It connects the upper and lower parts of the body as well as, through the pulmonary circulation, the outer (air) with the inner. The heart is continually adapting its activity to the needs and state of the body and person as a whole.

In strenuous activity, for example, the heart expands more in the diastolic phase (when it receives blood) and increases its beating rate, allowing more blood to pass through the heart and into the lungs and muscles. But the heart is not simply pushing this blood into the body. The lungs take in up to three times the amount of oxygen during exercise, not only because of the increased diffusing capacity of oxygen, but because both lung alveoli (where diffusion occurs) and the lung capillaries dilate, letting more blood pass through the lungs. Similarly, in the muscles the blood vessels actively dilate.

If, over an extended period of time, an organ needs more oxygen, it stimulates, via growth factors, the blood vessels in the organ to grow. This is another example of how the impulse to change and adapt comes from the periphery. The whole circulatory system, from center to periphery, is involved in getting more blood into the tissues that need it.

The blood moving through the body is continually changing. After we've eaten, for instance, the blood passes through the intestines and takes up nutrients. The blood then enters the liver, which draws out nutrients. The liver also detoxifies the blood, removing, for example, bacteria or alcohol. In each organ something unique to that organ happens to the blood. In the brain large amounts of sugar and oxygen leave the blood. The kidneys remove metabolic waste products and water, but also secrete hormones that regulate the production of red blood cells. The blood is truly a special fluid in its ability to take in and give off substances that it moves through the body. It is in unceasing change and thereby helps the body maintain its physiological balance and coherence.

Changes in the blood's pressure, viscosity, warmth, and biochemical composition are communicated to the heart by means of the nervous system, hormones, and heart and blood vessel sensory receptors. The heart therefore exists as a perceptive center for the body via the circulation. Steiner spoke of the heart as a sense organ for the organism, enabling it to perceive what transpires in the upper and lower poles of the body [5].

The heart does not just perceive what comes to it via the blood. It also alters its activity – and not only to circulate more or less blood. For example, the heart secretes a hormone in response to the changing consistency of blood.

If the blood is too viscous, the heart secretes this hormone (natriuretic peptide) into the blood, and the hormone stimulates the kidneys to secrete more water into the blood.

One further feature of the interplay of heart and peripheral circulation we shouldn't overlook is the maintenance of body warmth. Only the warm-blooded mammals and birds have completely four-chambered hearts. The internal differentiation of the heart corresponds to the organism's ability to maintain a high constant body temperature despite radically fluctuating inner and outer conditions. The beating heart muscle itself is a source of warmth for the blood, while the peripheral circulation can expand and contract to give off or contain warmth.

Into the Soul

Here are some English words and expressions relating to the heart:

Heartless	Have a heart
Heartly	Lose heart
Heartrending	Heavy heart
Heartbreaking	Warmhearted
Heartache	Coldhearted
Fainthearted	Hardhearted
Lighthearted	Heart sick (sick at heart)
Heart sore (sore hearted)	Search your heart
Wholehearted	Put your heart at rest
Heart-to-heart	Near to my heart
Take heart	You are all heart
Take that to heart	Heartfelt

The feelings associated with these expressions are often deep (heart sick, heart-to-heart) and span polarities (cold- and warm-hearted; faint- and light-hearted). What comes from the heart is authentic and whole. It's one thing to search your brain for something or to put your mind to something and a very different matter to search your heart for something or put your heart into it. The heart is literally in-dividual; it is unity and when that unity loses its center or begins to dissolve, it's, well, heartrending.

The quality of warmth is central to the heart. Someone who is heartless is cold. When we have a heartfelt concern, soul warmth streams out from us. When we take heart, warmth enkindles our courage. (Etymologically, "courage" means "heart.") And when we gesture to someone to take heart, we emphatically raise up our arm and ball up the fist in front of our chest. Taking heart means gathering at our center and from there expanding into the world through our actions.

Not only the heart moves between the polarities of contraction (systole) and expansion (diastole). Rhythmic movement between poles, and mediating and balancing between extremes, characterizes the circulatory system as a whole. The blood gathers in the heart and then flows out into the periphery, changing and exchanging with this periphery, and then moving back to the center.

When we've grasped the circulatory system qualitatively in this way, it's not surprising to discover its intimate connection to our inner life of feeling. Feelings of awe and love allow us to flow out into the world. We connect, give and learn from the world and bring the fruits of this interaction back to a center. We experience satisfaction and contentment. Our joy leads us back into the world. Or we experience fear, anger, or even hate. We draw back into ourselves when such feelings capture us, and the healthy oscillation of the soul between inside and outside, between self and other, is disturbed. Just as we can become completely isolated through hate, so also we can lose ourselves in unceasing rapture.

The healthy life of the soul depends, as does the circulation, on continual movement, on the ability to flow out and gather in. Or we can speak in terms of the other middle system in our body, the respiratory system: we need the rhythm between breathing out and breathing in.

Our soul life and physiology are inseparable. It is well known how stress (which means we are inwardly driven and contracted with little inner breathing room – our soul can't oscillate) has its physiological correlate in hypertension, where the blood, like the soul, is under abnormally high pressure. A Swedish study found that women who lived alone, had very few friends, and also no one to call on if they needed help, tended to have heart rates that varied little over the course of the day. Such low variation in heart rates is correlated with heart disease and early death. Less socially isolated individuals have a more varied heart rate.

The path to health involves seeing bodily processes as an expression or outer aspect of what we are inwardly.

Conclusion

Mechanical models may be helpful to understand partial functions of an organ or system, but when they become exclusive, the partial truth becomes falsehood. We end up making the heart much *less* than it really is. The image is that of a central power center that forces blood through the body and thereby maintains the body. This is, if you will, an ego-centric view of the heart as the forceful doer. The pump just keeps on working until it wears out – or, as in the case of the artificial heart, keeps beating even when the person has died.

Mr. Robert Tools was the first patient to receive the AbioCor artificial heart. After the operation in July, 2001, Mr. Tools recovered quite well and was able to leave the hospital. He suffered a stroke on November 11th. Patients with an artificial heart are always susceptible to strokes, because the blood more easily clots when it comes in contact with the artificial material of the valves. Normally a patient receives blood thinners to prevent clot-formation, but this was not possible in Mr. Tools' case, since he had a tendency to bleed internally.

After the stroke, Dr. Laman Gray, who carried out the surgery, reported that Tools' condition "is probably a little better than a person with a [real] heart, since we don't have to worry about the heart itself." Gray went on to comment about another patient who had received the AbioCor heart. This patient was making slow progress, due to a high fever that may have damaged his organs. But, as the reporter paraphrases Gray, "Mr. Christerson's [artificial] heart has been working well."

On November 30, Mr. Tools died due to internal bleeding. But, as the *Los Angeles Times* reported, "Tools' death in no way means the experiment failed," said Dr. Mehmet Oz Indeed, Tools' doctors noted that the heart continued to beat flawlessly even as he died." Here we see the mechanism enthroned in a sad separation from the person. The pump still continues to beat as if nothing had changed, while the person dies. And as long as you focus on the mechanism, and the pump continues to work, the experiment cannot be called a failure.

Very different is the view of the living, dynamic heart and circulation. Here we see give and take, and continual change and adaptation through interactions. We see a dynamic, perceptive center that maintains coherence and integrity. From birth till death, the living heart shares in our life as ensouled beings.

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