The Heart Innervation Hologram

BY RICHARD UTT

Everyone has had the "racing heart" experience which occurs immediately after a scary loud noise, a narrowly - avoided accident or a brush with death. Real or imagined, these "fight or flight" incidents trigger a number of sympathetic nervous system responses which affect cells, tissues and organs throughout the body - certainly one of the most immediate and powerful feelings is the dramatic increase in heart rate and heart strength which people describe so graphically - "my heart leapt up into my throat" or "my heart pounded so hard I thought it would break out of my chest."

The heart can react so vigorously whether the threat is real or imaginary - just visualizing a life-threatening, scary event will trigger the same changes in heart status. These immediate changes are strong evidence that the heart can respond to nervous stimulation from the autonomic centers in the thalamus, hypothalamus and brainstem. In fact, the entire process by which the heart rate (beats per minute) and stroke volume (the amount of blood pumped per beat, related to the internal volume of the heart and the strength of a heart contraction) are regulated by the nervous system is a fascinating story which is often referred to as a "classical case of homeostasis".

A brand new Applied Physiology Hologram allows the AP practitioner to peer deeply into the underlying anatomy and physiology of heart regulation, creating balance and homeo-sta-stress in this critical cardiovascular function. Since the life-giving blood which the heart provides is so important to every cell of the human body, the impacts of creating balance in this one cardiovascular activity may have profound body-wide effects.

The heart is required to be a tremendously responsive and adaptable organ - it must efficiently provide all the tissues of the body with adequate blood supply throughout our entire life. In a typical day, we may ask the heart to meet the needs of our body while resting, during moderate activity and even during a strenuous workout when our muscles need for oxygen and nutrients increases tenfold. How does the heart know when to beat faster or slower? What role does the nervous system play in creating the heart- activity homeo-sta-stress that allows it to meet the constantly-changing demands of our dynamic body?

The central nervous system (especially cardiac centers in the medulla oblongata) receives nerve impulses from the heart itself and from the special sensory receptors in the walls of the aorta and the carotid artery near the heart. The sensory receptors in these areas consist of chemoreceptors (which can sense changes in the carbon dioxide level, oxygen level or pH of the blood) and baroreceptors (which monitor the degree of stretch in the walls of arteries as blood pressure increases or decreases). Baroreceptor reflexes and chemoreceptor reflexes allow the heart to respond very rapidly to chemical and pressure changes in the blood near the heart. If blood pressure drops, oxygen levels fall, pH values decrease or carbon dioxide levels rise, the cardioacceleratory center in the medulla oblongata will stimulate the heart through sympathetic nervous pathways and the heart rate will increase. In general, the increased heart rate will have a variety of physiological effects which will increase blood pressure, increase blood pH and oxygen level, and decrease blood levels of carbon dioxide. This reflex is also a classical example of a negative feedback loop, a common physiological response which allows the body to maintain homeo-sta-stress. On the other hand, if blood pressure rises above homeo-sta-stress levels, then the cardioinhibitory center in the medulla oblongata will stimulate the heart through parasympathetic pathways (the vagus cranial nerve) that act to slow down the heart rate. When we change our behavior (suddenly jumping up to begin exercising, for example), our heart is able to rapidly respond to the changing conditions thanks to these responsive reflexes.

What about the "racing heart" response to scary situations, real or imagined? These events begin with real sensory stimuli which are routed into the cerebral cortex and "analyzed" as potentially dangerous. Of course, these sensory stimuli may be real, false (such as a scary movie) or created through visualization within the brain itself (projections into the future, worries, fears) - the physiological effect will likely be the same in all cases - the sensory data is routed to the limbic system, thalamus and hypothalamus. Within the hypothalamus are nerve centers which communicate directly with the cardiac regulatory centers in the medulla oblongata. Since the events described are "fight or flight" events, the cardioacceleratory center in the medulla will be stimulated and a flood of sympathetic nerve impulses will stream toward the heart through the spinal cord, spinal nerves and cardiac plexus. The result is a heart that "jumps" into action, dramatically increasing blood pressure and blood flow. Our heart now delivers much more blood to the brain and muscles of the body, preparing it for the "life or death" response! If this is a real life-threatening event, then we are better able to respond to it - if this is an imaginary event, then we have unnecessarily created a state of high blood pressure and cardiac stress. How often is the threat real and how often imagined? Perhaps we all need to consider the state

of our cardiac reflexes and reflect upon the acute or chronic stresses we create in our cardiovascular system through excessive fear and worries. Applied Physiology offers us a number of tools and techniques, including the Heart Innervation Hologram, which can empower us to create balance and homeo-sta-stress in the anatomy and physiology of our dynamic cardiovascular system.

Bibliography

Despopoulos, A. and S. Silbernagl. 1986. Color Atlas of Physiology. Thieme Inc. Stuttgart. Germany.

Dox, I., Melloni, B.J., and G.M. Eisner. 1979. Melloni's Illustrated Medical Dictionary. William & Wilkins Company. Maryland. USA.

Guyton, A.C. 1991. A Textbook of Medical Physiology. W.B. Saunders Company. Philadelphia, Pennsylvania USA.

Martini, F. H. 1998. Fundamentals of Anatomy and Physiology. Prentice Hall Publishers. New Jersey. USA.

Dox, I., Melloni, B.J., and G.M. Eisner. 1979. Melloni's Illustrated Medical Dictionary. William & Wilkins Company. Maryland. USA.

Guyton, A.C. 1991. A Textbook of Medical Physiology. W.B. Saunders Company. Philadelphia, Pennsylvania USA.

Martini, F. H. 1998. Fundamentals of Anatomy and Physiology. Prentice Hall Publishers. New Jersey. USA.

Netter, F.H., M.D. 1989. Atlas of Human Anatomy. Ciba-Geigy Co. New Jersey. USA.

Tortora,J. and S.R. Grabowski. 1996. Introduction To The Human Body; The Essentials Of Anatomy And Physiology Addison Wesley Publishing Company. New York. USA.

Warwick, R. and Williams, P. 1973. Gray's Anatomy. (35th British Edition). W.B. Saunders Company. Philadelphia, Pennsylvania. USA.

Wheater, P.R., Burkitt, H.G. and V.G. Daniels.

Innervation Set Up (General Procedure)

1. CL CV24 + CV14 + GV26 P/L, P/S, P/L;
2. Chakra Mode P/L, P/S, P/L;
3. CL:

GV20	Crown =	Medulla Oblongata
GV24.5	Brow =	Vagus Nerve (CN10)
CV22	Throat =	T1 Sympathetic
CV14	Heart =	T2 Sympathetic
CV8	Navel =	T3 Sympathetic
CV4	Central =	Cardiac Plexus
CV1	Root =	Spinal Cord

4. Check Heart rate, take note:
5. Speed up Heart rate by 20% P/L, P/S, P/L;
6. Correct with appropriate AP technology
7. Rest to slow rate back to original P/L, P/S, P/L;
8. Correct with appropriate AP technology again if Priority I/C

Sympathetic & Parasympathetic Innervation of the Heart (Detail):

CL CV24 + CV14 + GV26 P/L, P/S, P/L;
Chakra Mode +

CL
GV20 **Medulla Oblongata** – The medulla oblongata is the portion of the central nervous system where the spinal cord connects to the brain. Within the medulla are nerve tracts that relay sensory and motor information between the spinal cord and the brain. The medulla also contains a number of nuclei (clusters of synapses where information is processed) that control autonomic activities related to the respiratory and cardiovascular systems. The cardioacceleratory center within the medulla can increase heart rate when it receives information from baroreceptors in large arteries near the heart that indicate blood pressure is decreasing. Chemoreceptors in these same arteries can provide information to the brain about blood flow rate and gas exchange from the blood. The cardioinhibitory center in the medulla can also act to decrease heart rate when blood pressure rises above normal. These two cardiac centers in the medulla work together to help the heart meet changing conditions within the body.

CL
GV24.5 **Vagus (cranial X) Nerve** – the vagus nerve (also known as the 10th cranial nerve) is a mixed nerve, meaning it contains both sensory and motor neurons. It arises from the sides of the medulla oblongata within the cranium and ascends into the thoracic and abdominal cavity where it innervates thoracic and abdominal organs including the respiratory tract, heart, diaphragm, stomach and intestines. The vagus nerve carries parasympathetic impulses to the heart muscle from the cardioinhibitory center in the medulla which act to decrease heart rate when appropriate. Sensory impulses from within the heart are also relayed back to the medulla oblongata via the vagus nerve.

CL
CV22 **T1 spinal segment - sympathetic outflow** – The T1 spinal segment is the portion of the spinal cord which provides the neurons which form the T1 spinal nerve. This spinal nerve contains motor neurons which innervate muscles in the upper arm and forearm. It also contains sensory neurons which innervate the joints, muscles and skin of the arm. A

portion of the sympathetic motor innervation of the heart exits the spinal cord here before entering the cardiac plexus.

CL

CV14 T2 spinal segment - sympathetic outflow – The T2 spinal segment is the portion of the spinal cord which provides the neurons which form the T2 spinal nerve. This spinal nerve contains motor neurons which innervate muscles in the rib cage and around the spinal column. It also contains sensory neurons which innervate the skin of the upper chest and back. Most important for this hologram, sympathetic neurons which can stimulate the heart leave the spinal cord through the T2 spinal nerve and become part of the nearby cardiac plexus.

CL

CV8 T3 spinal segment - sympathetic outflow – The T3 spinal segment is the portion of the spinal cord which provides the neurons which form the T3 spinal nerve. This spinal nerve contains motor neurons which innervate muscles in the rib cage and around the spinal column. It also contains sensory neurons which innervate the skin of the upper chest and back. Most important for this hologram, sympathetic neurons which can stimulate the heart leave the spinal cord through the T3 spinal nerve and become part of the nearby cardiac plexus.

CL

CV4 **Cardiac Plexus** – the cardiac plexus is a cluster of neurons and synapses located near the heart and innervating the heart with motor fibers of the parasympathetic and sympathetic portions of the autonomic nervous system. Sensory fibers may also be found in the cardiac plexus, relaying information back to the central nervous system about the status of the heart.

CL

CV1 **Spinal Cord** – the spinal cord is a dense cylindrical mass of nerve cells and synapses enclosed within the bony canal created by the 26 bones of the vertebral column. Within the spinal cord are white areas, consisting of carefully insulated sensory and motor nerve cells which carry nerve impulses toward (sensory) and away (motor) from the brain. Also within the spinal cord are gray areas, made up of uninsulated portions of sensory and motor neurons - these gray areas contain the synapses where nerve impulses are transmitted between neurons, allowing for sorting, processing, filtering and reflex responses to certain stimuli. Branches of the spinal cord (called spinal nerves) allow neurons to enter or exit from the spinal cord along its length, passing through the bony intervertebral foramen on the sides of the vertebral column.