Understanding of Pranavaha Sroto Moola in the purview of modern physiology

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INTRODUCTION

Srotas are the channels, Paths, or the space through which movement and transformation occur. They carry Prana all over the body to all bodily tissues. Pranavaha Srotas has its Moola in Hridaya and Mahasrotas according to Charaka Samhita while Sushruta Samhita states that Hridaya and Rasavahini Dhamanis as Moola. Moola of Pranavaha Srotas not only denotes the anatomical aspects but also represents the functional entities. Methods: A comprehensive literature review was done on Pranavaha Srotas in Ayurveda and the physiology of respiration according to contemporary science through searching classical texts, textbooks, and online articles from peer-reviewed journals to narrate the Anatomical, Functional/physiological aspects, and Therapeutic aspects of Pranavaha Sroto Moola. Results: Pranavaha Srotas can be considered as a functional unit that consists of the heart, brain, and alimentary canal. Respiratory physiology is directly linked to the circulatory, gastro gastrointestinal systems for the exchange of gases, absorption, transportation, excretion, monitoring, and control of all activities. Conclusion: Pranavaha Srotas is the basic system that works in harmony with all the physiological attributes of the body like circulatory, alimentary, and nervous systems.

Key words: Pranavaha Srotas, Srotomoola, Srotas, Ayurveda, Hridaya, Mahasrotas, Respiration

ABSTRACT

Introduction: Pranavaha Srotas are the first Srotas to be enlisted in Charaka Samhita. These channels carry Prana all over the body to all bodily tissues. Pranavaha Srotas has its Moola in Hridaya and Mahasrotas according to Charaka Samhita while Sushruta Samhita states that Hridaya and Rasavahini Dhamanis as Moola. Moola of Pranavaha Srotas not only denotes the anatomical aspects but also represents the functional entities.

Methods: A comprehensive literature review was done on Pranavaha Srotas in Ayurveda and the physiology of respiration according to contemporary science through searching classical texts, textbooks, and online articles from peer-reviewed journals to narrate the Anatomical, Functional/physiological aspects, and Therapeutic aspects of Pranavaha Sroto Moola.

Results: Pranavaha Srotas can be considered as a functional unit that consists of the heart, brain, and alimentary canal. Respiratory physiology is directly linked to the circulatory, gastro gastrointestinal systems for the exchange of gases, absorption, transportation, excretion, monitoring, and control of all activities.

Conclusion: Pranavaha Srotas is the basic system that works in harmony with all the physiological attributes of the body like circulatory, alimentary, and nervous systems.

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Pranavaha Srotas

Pranavaha Srotas are the first Srotas to be enlisted in Charaka Samhita.[6] These channels carry Prana all over the body to all bodily tissues. Pranavaha Srotas are spread throughout the body and they carry Prana in them.[7] Prana is the life force responsible for the existence and sustenance of life,

Moola of Pranavaha Srotas

Pranavaha Srotas has its Moola in Hridaya and Mahasrotas[6] Sushuruta Samhita states that Hridaya and Rasavahini Dhamanis as Moola of Pranavaha Srotas[6] Hridaya is the Moola Sthana for Rasavaha Srotas also. It is responsible for circulating Rasa and Rakta all over the body carrying Prana to all parts of the body. Hridaya is an inverted lotus-like structure situated in the chest.[10] The heart is the seat of consciousness, Manas, Rasa, and Rakta Dhatu as well. As Hridaya is a place where exchange occurs. Rather than considering Hridaya as an anatomical aspect, it can be denoted as a functional aspect. Therefore, Hridaya can be correlated to three organs in the body.

- The Heart,
- Brain,
- Lungs.

Hridaya as Heart

Anatomical Aspect

The heart is a muscular organ located slightly left of the center of the chest, between the lungs, and behind the sternum. The heart is a vital organ and the central component of the cardiovascular system in the human body. Hridaya is the Sthana of Vyana Vayu which circulates all over the body carrying all the products within the body.[11] Vyana Vayu is responsible for Vikshepana of Rasa and Rakta.[12]

Physiological Aspect

The heart is responsible for pumping blood throughout the body supplying oxygen and nutrients to all cells of the body and removal of metabolic waste products. The right atrium and ventricle receive the deoxygenated blood from all over the body and pump
it to the lungs. The blood gets oxygenated in the lungs supplied to the left atrium and propelled throughout the body through the aorta. Cardiomyocytes generate electrical impulses that coordinate the rhythmic contractions of the heart. The heart is also responsible for pumping blood to all the peripheral organs supplying oxygen to all cells of the body.[13] Pumping of oxygenated blood through Dashavahi Dhamanis. Therefore, the Heart can be considered a vital organ, and Moola Sthana in Pranavaha Srotas is responsible for the circulation of oxygen through blood.

Therapeutic Aspect
Cardiac and respiratory systems work in synchronization. Any malfunctioning of the heart results in the manifestation of respiratory symptoms and illness. Congestive Cardiac Failure results in pulmonary edema, leading to shortness of breath, wheezing, coughing, etc., coronary artery disease results in reduced blood flow to the heart and other organs leading to chest pain, shortness of breath, etc., Cardiomyopathy also results in dyspnoea, fatigue, fluid accumulation in lungs. Cardiac ailments are characterized by symptoms of tachycardia, dyspnoea, apnea, cough, hypertension, etc.[14] Any malfunctioning of Hridaya leads to respiratory diseases.

Hridaya as Lungs
Anatomical Aspect
The respiratory system consists of the nose, pharynx, larynx, trachea, lungs, and diaphragm. Lungs are sac-like organs located in a thoracic cavity within the chest on either side of the heart. The right lung has three lobes and the left lung has two lobes. It contains a bronchial network that bifurcates into right and left bronchi and bronchioles. It terminates as tiny air sacs called alveoli.[13]

Physiological Aspect
Functionally Lungs as their primary function is to oxygenate blood and remove carbon dioxide through the process of external respiration. When the heart supplies deoxygenated blood to the lungs, the alveolar sacs located at the ends of bronchioles are filled with air. There will be diffusion of oxygen from the inhaled air through the alveoli to the capillaries surrounding them. Oxygenated blood is transported to all tissues of the body through the heart.[15] Therefore, lungs can be considered as Hridaya-Moola Sthana of Pranavaha Srotas. Prana Vayu and Vyana Vayu are responsible for Shwasana Kriya.

Respiratory Physiology
The exchange of gases occurs through the huge surface areas of type 1 alveolar cells associated with pulmonary capillaries. As the principle of Boyle’s Law states the pressure and volume of a gas in a system are inversely related, Volume is inversely proportional to the pressure of gases therefore, when the external intercostal muscles and diaphragm contract, the volume of lungs increases which results in a reduction of pressure in gases inside the lungs. According to pressure gradient law, gases flow from higher pressure to lower pressure, thus leading to inspiration.[16]

Therapeutic Aspect
Lungs are the vital organs responsible for respiration. Its malfunctioning results in several respiratory illnesses like Pneumonia, Chronic Obstructive Pulmonary Disease, Asthma, Pulmonary Embolism, Pulmonary Hypertension, Respiratory distress, and Tuberculosis. All are characterized by difficulty in breathing, shortness of breath, cough, wheezing, chest congestion, chest pain, and fatigue.[18] The symptoms also include circulatory symptoms like cyanosis, tachycardia, pedal, and facial edema, etc. This signifies the congruence between the respiratory and cardiovascular systems in the body.

Heart and lung diseases coexist with each other. Therefore, treatment protocols must be planned to address both systems simultaneously. For example, diuretics used to treat heart failure also reduce fluid accumulation in the lungs.

Hridaya as Brain
Anatomical Aspect
The brain is a complex organ that controls the nervous system of the body located within the skull of the head.
It contains the cerebrum, cerebellum, and brain stem which includes the medulla oblongata, pons, and midbrain. Brian also contains the diencephalon, and limbic system including the amygdala, hippocampus, and cingulate gyrus.

As Hridaya is the one where continuous exchange is happening, it can be considered as the brain where there will be continuous exchange of neural stimulus.[19]

Physiological Aspect

The respiratory centre is in the medulla oblongata and the pons. These centres monitor the oxygen and carbon dioxide concentrations in the blood. Medulla oblongata is the central respiratory pattern generator that generates rhythmic signals to initiate breathing. The Medullary Rhythmicity Area consists of Medullary Inspiratory Neurons that control breathing.[20] It stimulates the contraction of respiratory muscles including the diaphragm and external intercostal muscles to produce inhalation. Pons neurons influence inspiration, with the Pneumotaxic centre limiting inspiration and the apneustic area prolonging inspiration. There are specialized chemoreceptors located at the medulla oblongata and peripheral chemoreceptors at carotid bodies and aortic bodies.[21] They detect the changes in the levels of oxygen, carbon dioxide, and concentration of pH in blood to adjust the respiratory rate accordingly. When PCO₂ increases, and PO₂ decreases it stimulates the inspiratory centre.

During inspiration, the impulses from stretch receptors (Hering-Breuer reflex) will be stimulated by the expansion of the lungs which decreases the impulses from the inspiration centre leading to expiration. The hypothalamus and limbic system send signals to the respiratory control centres. Individuals’ emotions affect the functioning of the limbic system. The sympathetic nervous system gets activated during stress and anxiety; the parasympathetic system induces relaxation.[22] The sympathetic and parasympathetic nervous system also increases and decreases the respiratory rate respectively. Therefore, the brain also plays a very vital role in respiration, and Hridaya can be considered as brain.

Therapeutic Aspect

Many illnesses of the nervous system include respiratory symptoms like breathlessness, respiratory distress, shortness of breath, cough, etc., Amyotrophic Lateral Sclerosis (ALS) - a progressive neurodegenerative disease that causes muscle weakness, paralysis, and respiratory failure. COPD, Obstructive Sleep Apnoea results in difficulty and interrupted breathing. Neuromuscular disorders like Muscular dystrophy, myasthenia gravis, and Guillain barre syndrome affect breathing patterns. Depending on the illness, various medications like cholinesterase inhibitors, dopamine agonists, bronchodilators, corticosteroids, or antibiotics are prescribed. In Ayurveda, Vata Dosha is responsible for the functioning of the nervous system and it is the main Dosha in Pranavaha Srotas. Vitiation of Vata Dosha affects both the nervous system and respiratory systems and manifests the symptoms of both systems.

Mahasrotas

Anatomical Aspect

Moola Sthana of Pranavaha Sortas is Mahasrotas, which can be considered as a Koshta or gastrointestinal tract. Among all the Koshtanga mentioned in Sushruta Samhita, Phuphusa, and Hridaya play a vital role in carrying out the functions of Pranavaha Srotas.[8] The diaphragm is a dome-shaped muscle separating thoracic and abdominal cavities. Its muscle fibers originate from the xiphoid process, lower ribs, and the lumbar vertebra (L1, L3). The diaphragm has several openings through which the esophagus, vagus nerve, aorta, thoracic duct, azygos vein, phrenic nerve, and arteries pass.[23]

Physiological Aspect

The GI Tract is not only responsible for digestion, and absorption of nutrients but also assists in respiratory function. Respiration occurs mainly due to diaphragmatic movement. The diaphragm contracts and moves downward which increases the volume of the thoracic cavity resulting in the expansion of the lungs.

The Phrenic nerve which arises from the spinal nerves of the cervical region (C3, C4, C5) innervates the
diaphragm. It provides motor innervation to the diaphragm causing its rhythmic contraction during breathing.\(^{[15]}\) Phrenic Nervem plays a very critical role in controlling breathing by increasing the volume of the thoracic cavity. It also contributes to reflex actions such as sneezing, coughing, etc.

**Role of pH in Respiration**

Respiration depends on oxygen and carbon dioxide concentration in blood, as well as the concentration of H+ ions in the blood. When there is an increase in H+ ion concentration in blood, leading to a decrease in pH (acidosis), it stimulates the respiratory centres to increase the rate and depth of breathing. This helps in the removal of excessive carbon dioxide in the blood which is majorly contributing to the formation of carbonic acid (H2CO3) in blood. A decrease in H+ ion concentration leads to a decreased rate of breathing to retain CO2 and an increase in H+ ion concentration, thereby balancing pH levels of blood.\(^{[24]}\)

**Therapeutic Aspect**

Illnesses of the Gastrointestinal system and respiratory systems can coexist and affect each other due to close anatomical proximity and shared neural and immunological pathways. Aspiration Pneumonia is caused due to inhalation of liquid, saliva, or vomit into the lungs affecting breathing. GERD also causes cough, wheezing, and exacerbation of Asthma. IBD, Crohn’s Disease, and Ulcerative colitis are closely associated with respiratory infections like bronchiectasis, etc., Cystic fibrosis affects both the digestive and respiratory systems. In Ayurveda, many digestive issues like Adhmana, Atopa, and Anaha restrict the movement of the diaphragm leading to difficulty in breathing, cough, dyspnoea, etc.

**Role of Hb in Respiration**

The concentration of Hemoglobin in blood also affects respiration. Hemoglobin is made up of Heam and Globin, where it carries oxygen molecules with the help of Fe+ ions. Globin is the protein that is nourished by all the proteins of interstitial fluids. Iron and other intrinsic factors are absorbed in intestinal mucosa only. Improper absorption of iron and folic acid leads to Iron Deficiency anemia and megaloblastic anemia respectively. This results in the reduced oxygen-carrying capacity of Heam leading to circulatory problems like palpitations, respiratory symptoms like dyspnoea, etc.,\(^{[21]}\) Deficient secretion of intrinsic factors by stomach also hampers the absorption of Vitamin B12 resulting in improper formation of hemoglobin, leading to Pernicious Anemia. Therefore, Mahasrotas plays a vital role in the absorption of nutrients which results in proper oxygen supply to all parts of the body through Hemoglobin.

The Rasa in Hridaya enters Amashaya and gets its color from Ranjaka Pitta.\(^{[20]}\) This conveys that nutrients for the formation of blood will be provided from the Amashaya with the help of Pitta Dosha, especially Ranjaka Pitta.

**Rasavahini Dhamani**

**Anatomical Aspect**

Dhamani are the channels that pulsate and carry Rasa and Rakta through them. (Rasa and Rakta Dhatus are circulated together, so Rasarakta Vikshepa term is used) They nourish the whole body as they carry Rasa, and Rakta from Hridaya to all parts of the body. Rasa carries the Sara Bhaga of the Ahara which is required for the nourishment of the body. Hridaya consists of 24 Dhamanis, out of which 10 are Urdhwagami Dhamani, 10 are Adhogami and 4 are Tiryaggami Dhamani. They can be correlated to arteries and capillaries that supply pure blood all over the body. Rasa can be correlated to Plasma within which all proteins are present which are required for the formation of hemoglobin.

**Physiological Aspect**

Functionally Dhamani can be correlated to all the capillaries through which internal respiration occurs. It is the exchange of gases that occurs through the capillaries at the cellular level which allows every cell to obtain oxygen for metabolism and expel carbon dioxide. Oxygen is used to generate energy in the form of ATP as a product of metabolism. Oxygen is the final electron acceptor in the electron transport chain facilitating the production of ATP. Carbon dioxide is the
waste product of metabolism which diffuses into the interstitial fluid and then into blood.\textsuperscript{[16]} It is transported away from the tissues with the help of Haemoglobin. Internal respiration is very important for the survival of cells and tissues, as it provides the oxygen needed to generate energy and remove metabolic waste products.

**Therapeutic Aspect**

Any injury to arteries and capillaries in the heart as well as peripheral organs leads to internal bleeding and causes complications. Internal bleeding in the brain causes hemorrhagic stroke which affects the functioning of the body. Thrombosis of arteries and capillaries also causes several respiratory symptoms. High blood pressure in arteries results in shortness of breath, fatigue, chest pain, and other respiratory issues.

**DISCUSSION**

Although Pranavaha Sroto Moola is explained as Hridaya and Mahasrotas in Charaka Samhita, Chakrapani commentary proclaims Pranavaha Srotas are present all the body. It is the first Srotas to be explained in Sroto Vimaneyea Adhyaya of Charaka Samhita. There are different opinions on the Moola Sthana of Pranavaha Srotas. Hridaya and Mahasrotas; Hridaya and Dasha Dhamani. This difference of opinion between Charaka and Sushruta Samhita opens a new perspective to critically analyze and describe Pranavaha Srotas. The Moola of Srotas indicates the functional aspects rather than the anatomical aspect of Srotas. This can be understood by critically evaluating the functions of Pranavaha Srotas at all levels.

Hridaya being the Moola of Pranavaha Srotas, can be considered as three main functional entities; the heart-circulatory system, Lungs- the respiratory system, and the brain- neural mechanism in respiration. Maha Srotas relates to the GI Tract which can be correlated to the Koshtanga/alimentary canal. This plays a vital role in the digestion and absorption of nutrients necessary for the formation of Hb. Rosavahi Dhamani is related to the transportation of oxygen and nutrients and the expulsion of carbon dioxide and other waste materials from the body.

**Dosha is involved in Pranavaha Srotas, Prana Vayu, and Udana Vayu in the respiratory system, Vayana Vayu in the circulatory system, Samana Vayu, Pachaka Pitta and Ranjaka Pitta are controlling gastrointestinal system.**

**Therapeutic Applicability of Pranavaha Sroto Moola**

The Srotas is the place where there is transportation, transformation, and absorption of nutrients/Dhatus. The important Sroto Dushti Lakshanas are explained as Ati Pravritti, Sanga, Vimarga Gamana, and Sira, Granthi, etc., Charaka Samhita has a detailed description of Sroto Dushti Karana and Lakshana.\textsuperscript{[27]}

Pranavaha Sroto Dushti is caused due to Dhatu Kshaya (emaciation), Sandharana (Suppression of natural urges), Ruksha Ahara-Vihara (consuming very dry food and performing emaciation activities), Ati-Vyayama (excessive physical exertion) during Kshudha (suppressing hunger). This leads to chronic diseases of Pranavaha Srotas.

It includes diseases like Hikka, Shwasa, Kasa, Shosha, Dourbalya, etc., When the Vayu in Pranavaha Srotas is aggravated, it enters Uras (chest) and obstructs Kapha and causes Hikka Shwasa.\textsuperscript{[28]}

The prodromal symptoms of vitiation of Pranavaha Srotas are observed in Gastrointestinal tracts like Anaha, Atopa, Parshwa Shool, Hikka, and Hridaya Peedana. The main symptoms include obstruction to breathing and ingestion of food and drinks.

The vitiation of Pranavaha Srotas can be corrected by following Shwasa Chikitsa.\textsuperscript{[29]} Shwasa Chikitsa includes Kaphahara and Vatanulomana regimens like Snehana, Svedana, Akta Lavana Taila Abhyanga, Nadi Sweda, Prastara Sweda, and Sankara Sweda.

Tamaka Shwasa is one of the Pranavaha Sroto Vikara whole main treatment principle is Virechana.\textsuperscript{[30]} This is one example where Pranavaha Sroto Dushti is corrected through a procedure involving the Gastrointestinal tract. This signifies the intricate relationship between Hridaya and Maha Srotas.

Kasa is another Pranavaha Sroto Vikara caused due to Vishama Ahara Vihara causing vitiation of respective...
Dosha which affects Pranavaha Srotas and manifests as Kasa. Vibhandha is one of the symptoms of Kasa which leads to Urdhwa Gamana of Vata causing a cough reflex. Treatment for Kasa is explained as Snehana, Svedana, Basti, Virechana, Vamana, Snigdha Ahara like Peya, Yusha, Rasa, etc., All therapies which normalize the Gati of Vata and reduce Kasa. Shodhana regimens remove the Doshas from the Koshta/Maha Srotas.

CONCLUSION

The understanding of Pranavaha Srotas should not be restricted to only the respiratory tract and lungs. It is the functional aspect that represents the circulatory, nervous, and gastrointestinal systems along with the respiratory system. It works at the cellular level also. It is the basic system that plays a vital role in keeping human beings alive. All these physiological aspects are embedded in Pranavaha Srotas only.

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