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Understanding of *Pranavaha Sroto Moola* in the purview of modern physiology

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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.

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

INTRODUCTION

Srotas are the channels, Paths, or the space through which movement and transformation occur.^[1] They circulate the bodily tissues/*Dhatus* to various organs. *Srotas* are the microchannels through which there will be the formation, transformation, and circulation of

various bodily tissues like *Dosha, Dhatu, and Mala*. *Srotas* has many synonyms like *Panthana, Marga, Sira, Niketa, Dhamani, Rasayani, Nadi, Ashaya, Marga, Chidra, etc.*,^[2] There are 13 *Srotas* explained in *Charaka Samhita*,^[3] 11 pairs *Srotas* in *Sushruta Samhita*.^[4] Each *Srotas* has *Varna* - like respective *Dhatus, Pramana (Anu, Sthula), and Akriti (Vritta, Deergha, or Prataana)*.^[5] Even though all *Srotas* have *Varna, Samsthana, and Akriti, Srotas* can be considered a functional or physiological aspect rather than anatomical structures. They help in the formation, oozing, transportation, absorption, and excretion of elements in the body.

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<i>Srotas in Charaka Samhita</i>	<i>Srotas according to Sushruta Samhita</i>
1. <i>Pranavaha Srotas</i>	1. <i>Paranavaha Srotas</i>
2. <i>Annavaaha Srotas</i>	2. <i>Annavaaha Srotas</i>

3. <i>Udakavaha Srotas</i>	3. <i>Udakavaha Srotas</i>
4. <i>Rasavaha Srotas</i>	4. <i>Rasavaha Srotas</i>
5. <i>Raktavaha Srotas</i>	5. <i>Raktavaha Srotas</i>
6. <i>Mamsavaha Srotas</i>	6. <i>Mamsavaha Srotas</i>
7. <i>Medavaha Srotas</i>	7. <i>Medavaha Srotas</i>
8. <i>Asthivaha Srotas</i>	8. <i>Sukravaha Srotas</i>
9. <i>Majjavaha Srotas</i>	9. <i>Mutravaha Srotas</i>
10. <i>Sukravaha Srotas</i>	10. <i>Purishavaha Srotas</i>
11. <i>Mutravaha Srotas</i>	11. <i>Artavavaha Srotas</i>
12. <i>Purishavaha Srotas</i>	
13. <i>Swedavaha Srotas</i>	

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] *Sushruta Samhita* states that *Hridaya* and *Rasavahini Dhamanis* as *Moola* of *Pranavaha Srotas*.^[4] *Hridaya* is the *Moola Sthana* for *Rasavaha Srotas* also. It is responsible for circulating *Rasa* and *Rakta Dhatu* all over the body carrying *Prana* to all parts of the body. *Maha Srotas* refers to *Koshta/alimentary*. Among 15 *Koshtanga*, *Amashaya*, *Agniyashaya*, *Hridaya*, *Unduka*, *Phuphusa*, etc. are also included.^[8] *Rasavahi Dhamani* originates in *Hridaya* and connects to all parts of the body. It carries *Rasa* to all parts of the body. *Moola* of *Pranavaha Srotas* not only denotes the anatomical aspects, also represents the functional entities. Thus, this review aims to understand *Pranavaha Sroto Moola* from a physiological perspective.

MATERIALS AND METHODS

A comprehensive literature review was done on the topic of *Srotas*, *Pranavaha Srotas* in Ayurveda as well as contemporary science through searching classical texts, textbooks, and online articles from peer-

reviewed journals in PubMed and Google Scholar. The objective of the review is to critically analyze *Pranavaha Sroto Moola* in terms of

1. Anatomical aspect
2. Functional/physiological aspect
3. Pathological and Therapeutic aspects

Critical analysis of Moola Sthana

Hridaya

Hridaya is derived from the root word 'Hrid' which means to.^[9] The one where continuous exchange happens. *Hridaya* is the source of life. It is the center that distributes *Rasa* and *Rakta* to all parts of the body. *Rasa* and *Rakta* carry *Prana* all over 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.^[15]

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.^[16] 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.^[17]

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 PCO_2 increases, and PO_2 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 Gullian 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*. Vitiating 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 Srotas 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 Nerve 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 an increase of pH in blood leading 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 Heme 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 Heme leading to circulatory problems like palpitations, respiratory symptoms like dyspnoea, etc.,^[25] 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*.^[26] 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 Dhatu* are circulated together, so *Rasarakta Vikshepana* 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.^[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 Vimaneeya Adhyaya* of *Charaka Samhita*. There are different opinions on the *Moola Sthana* of *Pranavaha Srotas*. *Hridaya and Mahasrotas*; *Hridaya and Dasha Dhamanis*. This difference of opinion between *Charaka* and *Sushruta Samhita* opens a new perspective to critically analyze or 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. *Rasavahi 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, *Vyana 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*.^[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*.^[28]

The prodromal symptoms of vitiation of *Pranavaha Srotas* are observed in Gastrointestinal tracts like *Anaha*, *Atopa*, *Parshwa Shoola*, *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*.^[29] *Shwasa Chikitsa* includes *Kaphahara* and *Vatanulomana* regimens like *Snehana*, *Swedana*, *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*.^[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*. *Vibandha* 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, Swedana, Basti, Virechana, Vamana, Snigdha Ahara* like *Peya, Yusha, Rasa*, etc., All therapies which normalize the *Gati* of *Vata* and reduce *Kasa*.^[31] *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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Declaration of generative AI in scientific writing: No generative AI is used in scientific writing

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