

CONCEPT OF CARDIO VASCULAR SYSTEM IN AYURVEDA: A CONCISE REVIEW

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ABSTRACT

Though the references to the heart are available in the ancient Indian Literature including the *Vedas* and *Puranas*, the collection of facts and the presentation efforts have been made in the present context. The *Ayurveda samhitas* have described anatomical and physiological concepts of *Srotas* (channels) broadly. *Srotas* mainly regulates process of circulation in human body. *Rasa* (plasma, lymph) has its primary seat in *Hridaya* (heart). Due to the integrated function of *Vyana vayu* (biological functioning entity) the *Rasa dhatu* (tissue entity) is continuously circulating throughout the entire body. *Srotas* are describe as structural and functional unit of the body designed to carry all specific materials, hormones, enzymes, molecules, massages, impulses, emotions and thoughts. It is such a minute supply that is not seen but visible by their action or by functioning that occurs. As in texts *Dhamni* (artery) and *Sira* (vein) are more resembled with *Srotas* by functioning level as of transportation but these three are different from each other. Though they are innumerable but for convenience they are divided into several. *Acharya Charaka*, *Sushrut* and *Astang Hridaya* mentions *Hridaya* and the ten *Dhamanis* as the *Moola* (Root/cardinal organs) of this *Srotas*. On comparison of both the aspects we find that heart and blood vessels are the major component of both cardio vascular system and *Rasavah Srotas* (channels circulating plasma, lymph). So, in this article is an attempt was made to elaborate the concept of *Rasavaha Srtas* in detail and its resemblance with cardiovascular system, and was also tried to point out the physiological involvement of some other organs to the system.

Key words: Dhamni, Hridaya, Rasvah Srotas, Sira, Srotas, Srotomoola.

INTRODUCTION

Many Fundamental principles and concepts are explained in *Ayurveda*, Concept of *Srotas* is one of them. *Srotas* are the transporting channels including *Dhatu*s like blood, and nutrients which are undergoing for a transformation. The *Srotas* not only perform various physiological functions but disturbance in *Srotas* may also impart some pathological manifestation, therefore it is very essential to understand physiological concepts of *Srotas*. Each *Srotas* is attached to a specific anatomical structure called *Moola* (The Root)^[1]. *Srotomoola* is the most vital part of the *Srotas*, just like the root of the tree. The normal functioning of the particular group of channels (*Srotas*) is depends upon its *moolasthan*. But in reference to *Srotas*, they are the two cardinal organs, directly or indirectly related with scattered *Srotas* of the body. Any abnormalities in these peripheral *Srotas* ultimately can effect on the *Moola* (Root/cardinal organ)^[2]. *Rasavaha srotas* is one of the important among all the *Srotas*, which is related to *Rasadhatu* formation and transportation. It includes *Hridaya* (heart), *Sira Jala* (network of veins), *Dhamani Jala* (network of arteries), *Rasayni Jala* including the *Lasika Granthi* (network of capillaries and lymphatic)^[3]. According to *C. Dwarakanatha*, lymphatic channels are termed as *Rasavaha srotas*. Therefore the concept of *Rasavaha Srotas* in *Ayurveda* may be correlated with functions of heart and blood vessels. It has become the need to study the fundamental and applied aspects of *Ayurveda* in depth with comparison to the science of today. This review highlights to make a concept about understanding the *Rasavaha Srotas* in present scenario.

SROTAS

It is derived from the Sanskrit root '*sru srawane*' meaning to exudates, to ooze, to filter and to permeate^[4]. The term *Srotas* means a channel through which *poshak dhatu* (unstable tissue) passes to form *sthayi dhatu* (stable tissue). A *Srotas* is a physical and energetic pathway, through which water, food and air enter the body, while feces, urine and sweat leave the body similarly three *Doshas* (biological functioning entity) move within it. All the bodily substances cannot form or decay without *Srotas*, because they are capable of circulating the transformed *Dhatu*s^[5]. According to some authors the *Srotas* may be interpreted as micro-vascular carrier, which is specialized for exchange of the materials. The exchanges of materials between interstitial fluid and intra capillary substance move through highly specific pores. They are innumerable in number^[6], which explains that every cell in the body is possibly a *Srotas*. *Acharya Charak* has described 13 *Srotas* in female there is one more i.e. *Artavwaha Srotas* in *Garbha prakaran*, where as *Acharya Sushrut* has told 11 *srotas*, but they are paired. They resembles in color to its *dhatu*, are variable in size *anu* (small) or *sthula* (large) and also variable in shapes like *vritta* (circular), *dirgha* (long), *pratana* (branched)^[7].

RASAVAHA SROTAS

Acharya Charak and *Vagbhat* has mentioned *Hridaya* and Ten *Dhamnies*^[8], whereas *Acharya Sushrut* mentioned *Hridaya* and *Rasvahi Dhamnies* as *moola* of *Rasavah srotas*. So, exploring these references made by major three *Acharya*, these components may undergo with Cardio vascular System. To understand the concepts of cardio vascular system of body, we should first understand the concept of *Hridaya*, *Srotas*, *sira* and *dhamani*. After digestion and absorption, the food is converted into *Ahara Rasa* (juice extract) which carries the nutrients to all the tissues of the body. It passes from intestines into blood vessels and then to the heart by the action of *saman vayu* (biological functioning entity)^[9]. From the heart, it is pumped out forcefully and circulated continuously all over the

body, through its main blood vessels, by the action of *Vyan vayu* into millions of capillaries. *Charaka* has emphasized that the cardiac muscles do not get tetanized ever throughout the mechanism of *Rasa Rakta Samvahan*(circulation)^[10]. However this view gives a suggestion about characteristic feature of cardiac muscles having long Action Potential and plateau phase^[11]. The circulation is controlled by autonomic nervous system i.e. by *vyana vayu* mainly and also by *samana vayu*^[12]. From capillaries, *rasa* penetrates all the tissues and cells of the body, the fluid from the tissues is brought back to the heart by capillaries and veins. The organs and channels through which this *Rasa Samvahana* (circulation) takes place are collectively termed as *Rasavaha srotas*^[13].

COMPONENTS OF RASVAHA SROTAS

HEART (Hridaya)

'*Hridaya*' is derived from three verbs (as per *Satpath brahman* and *Brihad aranyak*). '*Hrun*' which means to abduct, '*Dad*' which means to donate and '*in Gatou*' self generated rhythmicity for contraction and relaxation^[14]. The heart thus means an organ which draws fluid including blood from all over the body and then supplies it to all the parts of the body^[15].

Emryology:

The heart originates from the essence of *Shonita*(blood) and *Kapha*(biological functioning entity) and develops into a muscular organ^[16]. Genetically, in the development of the heart maternal influence dominates. Hence in an individual with *Hridroga*(diseases related to heart), it is particularly important to inquire regarding *Hridroga* on the maternal side. Heart become more obvious by the 4th month of *Garbha utpatti krama* (stages of fetal development)^[17]. According to *Charak*, it starts functioning in the third month of fetal life^[18].

Anatomy and Physiology of Heart:

a. In the Vedas:

Rigveda- In Rigveda, the term *Hridaya* has used at several places. The term *Hridaya* appears to be derived from the word *Hrid*. In a sutra of *Rigveda*, the word *Hridaya* is mentioned along with the description of the various body parts and their diseases. The *Hridaya* is also described by the synonym like *Guhya*^[19].

Atharva veda- The word *Hridim*, *Pundarika*, *Devakosha*, and *Kosha* have described for *Hridaya*. Terms like *Hamsa* and *Sindhu* have also been used as synonyms of *Hridaya*^[20].

Vaidik mantra - It is said that the *Hridaya* lies in the thorax below the *Kantha* (neck) and above the *Nabhi* (umbilicus). Simultaneously it is also said that *Sira*(head) and *Hridaya* are the two different structures in the body.

Samveda- As a part of *Hridaya* the word *Virata* is described and it is said that *Virata-Purusa* holds the earth with ten fingers^[21].

Satapath Brahman- Words such as *Hridayam*, *Puritata*, *Stombhaga* and *Aditya* etc used for Heart. The word *Hridayama* originates from the root word *Hrid*. *Hridaya* is derived from three verbal roots i.e. *Hri*, *Da* and *Ya* having the meaning of receiving, giving and moving, respectively.

Kanthopnishad- *Atma* and *Paramtma* both reside within the *Hridaya*. Some terms have also been mentioned for *Hridaya*, like *Guhya*, *Dehinin* and a tree of *Ashvattha*.

Chandogya upnishad- The terms like *Pundarika* and *Omkara* has used for *Hridaya*. *Hridaya* has defined as synonyms to *Atma*, and it is believed that *Hridaya* is the seat of *Brahma*.

Mandukya Upnishada- *Hridaya* has been defined as a hollow structure having various cavities inside. It is mentioned that *Guhyacara* (great almighty) resides in the cavity of *Hridaya*.

Mahabharat- A very nice description regarding *Hridaya*, *Nadis* (vessels) and the seat of *Atma* and *Prana*, have been given in *Shanti-parva*^[22].

Bhagavat Gita- It also showed a clear-cut difference between the heart and the brain, while emphasizing on the importance of concentration, *Lord Krishna* is quoted to have said *Arjuna* that *Hridaya* is the seat of God of all the human beings^[23].

Padma Purana - *Hridaya* is said to be like a lotus and *Nadis* emerges out from this *Hridaya*. *Rasa* (circulating fluid) is propelled in these *Nadis* by *Prana Vayu* and all these *Nadis* filled with *Rasas* traverse all over and saturate the entire body. Further *Ranjaka-Agni* which is there in the *Nadis*, metabolizes the circulating *Rasa* and converts it into *Rudhira* or blood. Almost similar description is found in *Skanda-Purana*.

Brahmopnishad the term *Hridaya* serves the very purpose of the physiological functions of the heart. The word *Hridaya* consists of three verbs i.e. *Hri* which means to bring back forcibly (venous return) *Da* to donate (pumping function of the heart) *Ya* means to move or to circulate.

b. In the Samhitas:

Charaka has accepted heart to be the seat of consciousness, which is primarily a function of brain. Even a small injury to the heart results in fainting and serious injury leads to death^[24]. The heart is more active during the day. It provides *Rasa*, *Rakta* and *Oja* to entire *Srotas* of the body through *Siras* like that of the mountain ranges, which provide water, nutrition and life to the entire world through rivers^[25].

Sushruta has observed that the heart is placed in the thoracic cavity in between nipples and extends up to the cardiac end of stomach, spleen and lungs on the left side of the heart, and its right side there is liver and gall bladder. He observed *Hridaya* like a red lotus having its apex downwards^[26]. Further he represented that *Hridaya* is a place of consciousness and when it is enveloped by the illusive effects of *Tama* (darkness), person goes to sleep^[27]. *Sushruta* illustrated that circulation of *Rasa* occurs in such a manner, it propagates transversely as *Shabd* (sound), upwards as *Archi* (fire) and downwards like *Jala* (water)^[28]. So it gives an indication about hemodynamics phenomenon of the heart and to observe relation of velocity against diameter of vessels and pressure gradient within it^[29].

Astang Hridaya has represented heart, as a seat of mind where as the seat of *Satva* in another verse^[30]. *Arundatta* in his commentary on *Astang Hridaya* depicted the heart as a fleshy muscular organ, resembling a red lotus bud and hangs with its apex downwards; from which vessels and capillaries spread all over the body^[31]. In the *Astang Samgraha*, *Sharira sthana* detailed description of the heart has been mentioned. Size of the heart is *Dvyangulam*; located in thorax between two breasts, if it is injured, causes sudden death. It is like a lotus, hollow organ and special place of *Chetana*^[32].

A very authentic description about autorhythmicity of heart has explained in *Nadigyanam*^[33] gives a clue to interpret the electrophysiological properties of the heart i.e. autorhythmicity, excitability and conductivity. As per *Bhela Samhita*, *Rasa* gets ejected out of the heart and moves all over the body, after that returns to the heart through the blood vessels called *Siras* which originate at heart^[34]. *Sharangadhara* has also explained a synonymous view. The description of cardiovascular system as a closed circuit is the specific contribution of *Bhela* which was actually re-invented by William Harvey in 17th Century^[35].

c. Circulation of Oja:

Oja (component of blood which provides immunity) gets circulated from the heart through blood vessels^[36,37]. *Hemadri* has described different types of *Ojas*, among which the *Rasatmaka Oja* can be considered as substances of complement system, antibodies; *Dhatutejorupi Oja* can be considered as he tissue macrophages or all WBCs present in tissues; and *Shonita rupi Oja* as the WBCs in blood^[38]. Blood is also called the 'fluid of health' because it protects body against diseases as it contains *Oja* (immunoglobulins, and WBCs),^[39].

BLOOD VESSELS

The *Atharvaveda* refers *Dhamanis* are, ducts with thick walls are like arteries; *Siras* are ducts with thin wall are equivalent to veins and still finer ducts are referred to as *Snavas* similar to capillaries. In *Arthedashmahamooliya adhayaya*, *Charaka* has illustrated specific characteristic of *Dhamani*, *Srotas* and *Sira* i.e. '*Dhmanadhmnyah Sravanat Srotamsi Saranatsira*'^[40]. The order in above verse has an important significance; the first word is about *Dhamani* i.e. '*dhmanaddhamanyah*'. It indicates that where the pulsation can be felt that is called as *Dhamani*. It is that tract which produces sound and this can be felt or seen only in arteries, not anywhere else in the body. The second word is '*Sravanat Srotamsi*' here *Sravan* means exudates, oozing; and the last word is, '*Saranatsira*', the word *Sarana* means moving, flowing. The *Sira* are that which carry the *Rakta* from capillaries to heart, when we look into the references we find veins carry the deoxygenated blood with fewer nutrients in them. Some of *Acharya* mentioned that all these are same, but *Sushruta* has different opinion, as *Dhamni*, *Srotas* and *Sira* have different character, number and function, so they are different^[41]. On the basis of their function they can be assumed as Arteries, Capillaries or Veins.

a. Artery (Dhamani):

Sushruta has explained *Nabhi* is the site of origin of both *Dhamani* and *Sira*. But in another chapter he says that *Dhamnies* originates from Heart. *Charaka* has also mentioned that the *Dhamanis* arise from the *Hridaya*. *Charak* said that 10 *Dhamani* arises from *Hridaya*^[42], in another chapter *Charaka* has outlined that *Dhamnies* are 200 in number and says one should understand it by their own interpretation^[43]. *Sushruta* has mentioned, among the *Dhamani* arising from the *Nabhi*, ten spread upward, ten downward and four in transverse directions. *Bhavprakash* and *Astang Sangraha* have same view^[44].

Urdhvaga Dhamanis spreading upward, receiving sensation of sound, touch, sight, taste and smell; inspiration, expiration, laughing, yawning, sneezing, talking, shouting and such other functions^[45]. *Adhogami Dhamanis* spreading downward procure flatus, faces, semen, and menstrual blood etc. downward. It serve throughout the body and nourish the body supplying nutrient materials to the *Dhamani* spreading in upward and transverse direction, and separate urine, faces and sweat^[46]. Each one of the four *Tiryagga Dhamani* spreading transversely divide into hundred and thousand of branches further and so becomes innumerable; by these, the entire body appears to be full of aperture; The sensation of touch both comfortable and uncomfortable, are perceived by these only. All 24 *Dhamnies* perform their functions throughout life^[47].

b. Capillary (micro Srotas):

Sushruta has described *Srotas* have pores on their walls, through which they supply *rasa* to all parts of the body, very much like the minute passages present in a lotus stem. Likewise, *Vagbhata* has compared *Srotas* to the extremely fine passages and pores present in the lotus stem^[48]. It is also said that variability of the substances occurs due to *Srotas* itself. Exchange of substances can take place at the capillary level only, which also helps in fluctuating status of the substances in the body. Due to this reason the capillaries can be connected to *Srotas*^[49]. *Ayurveda* has also appreciated this observation and mentions '*asankhya paramanu*' and '*Srotomaya sharir*'. Each cell has a specific structure to its need and each performs a different function but basic requirements are same i.e. each cell requires the supply of nutrition and removal of their waste products for maintenance of life. The channels which perform these two functions are micro channels that are blood capillaries, lymph capillaries and cell membrane. These micro channels are highlighted as *Srotas* in *Ayurveda*^[50].

c.Vein (Sira):

Total 700 *Sira* are present in the body, can constrict and relax. Embryological development of *Sira* is from *Pitraja* (paternal) element in fetus, so somewhat it is a hard structure^[51]. *Sira* is formed as a byproduct of *Rakta dhatu* and nourished from it^[52] 'Saran' is a main function of *Sira*, in which secretion and exudation is not expected from its walls. This structure is made to hold the fluid in such a way that it will not exude or ooze out. Main *Siras* are 40 in number and are grouped into four categories^[53]. They are *Vatavahini*, *Pittavahini*, *Kaphavahini* and *Raktavahini*, they all divide and re-divide in to total 175 branches. For example-*Raktavaahini Sira* grows towards locations of *Raktasthaan* i.e. liver and spleen and divide in to 175 branches.

In nutshell, we see the nutrient portion of properly digested food after being absorbed from the intestines by lacteals gets divided into two portions, one portion reaching *Hridaya*^[54] the other portion being conveyed to the *Yakrit* (liver) where it is acted upon by *Ranjaka Pitta*, gets converted into *Rakta* and reaches the *Hridaya* later on to join the *Rasa*^[55]. So *Rasa* and *Rakta Dhatu* are always found to be circulating together, the *Rasa* portion being watery carries with it the *Rakta* which is slightly thicker. In modern parlance, the fluid portion of blood i.e. plasma is comparable to *Rasa Dhatu* and the formed element portion of blood to *Rakta Dhatu*. So, this *Rasa cum Rakta* has the nutritive elements required for all the *Dhatu*s of the body and supplies them during its circulation.

DISCUSSION AND CONCLUSION

The *Rasavaha Srotas* is the main *Srotas* or called as First *Srotas* that supply Nutrients to all parts of the body through blood circulation. Here we see blood circulation include both *Rasa* and *Rakta Samvahan* (circulation). *Rasavaha Srotas* mainly give *Poshana* (nutrition) to *Rasa Dhatu* as well as *Rakta Dhatu*. Liver and spleen are considered as root of *Raktavaha Srotas*^[56], because synthesis of blood cells occurs in liver and spleen during third to fifth month of intrauterine life (hepatic phase of haemopoiesis) and both the organs act as blood reservoir. Along with liver and spleen, *Raktavaha Dhamani* (blood vessels) has also been considered as root of *Raktavaha Srotas*. It means that *Raktavaha Srotas* includes both haemopoietic system and a part of cardiovascular system i.e. *Raktavahi Dhamani* (blood vessels). Liver synthesizes haem, clotting factors and proteins of plasma and some nutrients (Vitamin B12 and folic acid) are stored in liver also, most among these enhance haemopoiesis. Due to some diseased condition if red bone marrow fails to take part in haemopoiesis, then even liver and spleen start haemopoiesis in adults, called extramedullary haemopoiesis^[57]. Thus it shows some organs like liver and spleen also play an accessory role in cardio vascular physiology. These descriptions show that a very detailed physiology of blood (*Rasa* along with *Rakta*) circulation and its applied aspect have been discussed by the ancient *Ayurvedic* scholars, and the scientific explanations in this article may be helpful in its understanding.

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