

Critical Analysis of *Raktavaha Srotas* with Special Reference to Haematopoiesis (Blood Formation)

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Abstract

Background: The concept of *Raktavaha Srotas* occupies an important place in Ayurvedic physiology, being responsible for the formation, transportation, and maintenance of Rakta Dhatu. Classical Ayurvedic texts describe *Yakrut* and *Pleeha* as the *Moolasthanas* of *Raktavaha Srotas*, indicating their central role in Rakta metabolism. Modern science explains haematopoiesis as the process of blood cell formation occurring primarily in bone marrow, studying these concepts may help establish an interdisciplinary understanding between Ayurveda and modern physiology.

Aim: To critically analyse *Raktavaha Srotas* and correlate it with haematopoiesis.

Materials and Methods: This literary review was conducted using classical Ayurvedic texts including *Charaka Samhita*, *Sushruta Samhita*, and *Ashtanga Hridaya*, along with modern textbooks of anatomy, physiology, and haematology.

Results: *Raktavaha Srotas* demonstrates conceptual similarities with the hematopoietic and circulatory systems. *Yakrut* and *Pleeha* correlate with liver and spleen functions in blood metabolism.

Conclusion: *Raktavaha Srotas* can be interpreted as an integrated functional unit comprising haematopoiesis, blood metabolism, and circulation.

Keywords: *Raktavaha Srotas*, Haematopoiesis, Blood Circulation, *Rakta Dhatu*, *Yakrut*, *Pleeha*.

Introduction

Ayurveda describes the body as an organized network of *Srotas*, which are channels responsible for transport, transformation, and nourishment of bodily elements. [1] Among these, *Raktavaha Srotas* is concerned with the transportation and maintenance of *Rakta Dhatu*. [2] According to *Charaka Samhita*, the *Moolasthanas* of *Raktavaha Srotas* are *Yakrut* and *Pleeha*. [3]

Rakta is considered essential for life and is closely associated with Prana, complexion, nourishment, and vitality. [4] Modern medicine explains blood physiology through haematopoiesis, blood composition, and circulation mediated by bone marrow, liver, spleen, heart, and blood vessels. [5]

A comparative understanding of *Raktavaha Srotas* with haematopoiesis and blood circulation may provide scientific insight into Ayurvedic physiology.

Aim

To critically analyse the concept of *Raktavaha Srotas* with special reference to haematopoiesis and blood circulation.

Objectives

1. To study the *Raktavaha Srotas* in Ayurvedic literature.
2. To analyse the role of *Yakrut* and *Pleeha* as *Moolasthan* of *Raktavaha Srotas*.

Materials and Methods

- **Study design:** Literary review study.
- **Ayurvedic sources:**
 - *Charaka Samhita*
 - *Sushruta Samhita*
 - *Ashtanga Hridaya*
- **Modern sources:**
 - Standard textbooks of anatomy, physiology, and haematology
 - Indexed journals

Methodology:

Relevant literature was collected, compiled, analysed, and comparatively interpreted.

Literature Review

Concept of *Srotas*

Srotas are defined as channels of transportation and transformation in the body. [1]

In *Charaka Samhita*, Acharya Charaka mainly focussed *Srotas* on physiological basis whereas Acharya Shushruta described the *Srotas* on Anatomical basis. [5] The frame of human body is maintained by *Sapta dhatu*. These are transported to each and every part of the body through channel called *Srotas*. The body contains numerous channels through which the dosha dhatu and mala circulate, known as *Srotas* in Ayurveda.

Raktavaha srotas

Charaka Samhita describes *Raktavaha Srotas* as channels carrying Rakta throughout the body. [3]

In *ayurveda* the formation of *Raktadhatu* and its distribution, takes into account a group of organs involved in the process of genesis directly or indirectly. From these organs, the *Raktadhatu*, after getting originated follow certain tracts or roots to reach in the channels of greater circulation. Thus the channels carrying the *Raktadhatu* from its sites of origin to the pumping place of greater circulation and from there to each and every part of the body appear to come under the heading of *Raktavaha Srotas*.

According to *Charaka*, *yakrit* (liver) and *pleeha* (spleen) is the *moolasthan* of *raktavaha srotas*. *Sushruta* also stands with the same view with *charaka* considering the *raktavaha srotas* he has mentioned that they are of two types and regarded the *yakrit*, *pliha* and *raktavahi dhamaniya* as a root of *Raktavaha Srotas*. *yakrit* and *pleeha* both are most important organs of the body. They are soft organs, formed from the *Rakta*, *Matrija* (maternal) in origin, place of *Ranjak Pitta*, *Moola* of *Raktavaha Srotas* etc.

The blood is located in liver and spleen. The *Sara* produced by digestion of *rasa* is responsible for formation of *pleeha* and *yakrit*. *Yakrit* and *pleeha* of fetus are formed from

Shonita (blood). The *Pitta* present in the *Yakrit* is responsible for converting *rasa* into *Rakta*. *Raktavaha srotas* are two, their root/chief organs are liver, spleen and *Raktavahi Dhamaniya*. *Ghanekar* has said that portal circulation may be taken for *raktavahi dhamani*.^[6]

Moolsthana of Raktavaha Srotas

Yakrut and *Pleeha* are described as *Moolasthana* of *Raktavaha Srotas*.^[3]

Srotas is a structural and functional unit of the body through which substances flow from one part to another. Each *srotas* is said to associate with two organs which are termed as *Srotomool*. it is the most vital part of the *srotas* just like the root of the tree.^[7]

According to the *Ayurveda*, *Srotomool* is considered as the place of origin from where the particular commences or gets the nutrition. In case of *Raktavaha Srotas*, *Rakta*, is mainly produced at liver and *pleeha*; hence these are considered as the root organs.^[8]

Rakta Formation in Ayurveda

Rasa Dhatu undergoes transformation into *Rakta* under the influence of *Ranjaka Pitta* situated in *Yakrut* and *Pleeha*.^[9]

Concept of raktadhatwagni

Raktadhatwagni assessment is a crucial concept in Ayurvedic medicine that pertains to the evaluation of the body's vital energies and metabolic processes, particularly concerning blood (*rakta*) and tissue (*dhatu*) metamorphosis. This assessment plays a pivotal part in understanding an existent's health status and acclimatizing individualized treatment plans.^[10] *Raktavaha srotas* play an important part in the formation of *raktadhatu*.

Rakta is formed by the action of *raktadhatwagni* on *rasa dhatu* in *raktavaha srotas*, where *teja* of *ahara rasa* and *ranjaka pitta*, along with *ushma*, act on *Rasa* to be greenishness in the *rakta*. *Rasa* is acted upon by

Raktadhatwagni along with *Ranjaka Pitta* and *Ushma*, resulting in the development of the characteristic reddish coloration of *Rakta Dhatu*. The *rasa* that comes to the heart with the help of *samana vata* is also converted by *pitta* to *rakta* and then circulates to the entire body

Panchbhoutik composition of rakta dhatu

Water is 92–93, and rest it contains oxygen, carbon dioxide, and nitrogen. The term “*agni*” in Ayurveda refers to the metabolic energy or digestive fire that controls the transformation of food into energy and Body tissues. *Raktadhatwagni* is particularly concerned with blood metabolism. For optimum health, a balanced *raktadhatwagni* is necessary because it guarantees appropriate blood volume and quality, which affects.^[11]

A balanced state of *Raktadhatwagni* is essential for maintaining normal haematological functions, as it ensures proper formation of *Rakta Dhatu*, adequate haemoglobin synthesis, efficient oxygen transport, and nourishment of subsequent *Dhatu*s, thereby supporting overall physiological homeostasis.

Modern aspect of raktadhatu formation

In modern science, *raktadhatu* is formed through the stages of erythropoiesis by the stimulation of a hormone called EPO.^[12]

Sites of Haematopoiesis

Haematopoiesis occurs in different anatomical locations during development:^[13]

- Embryonic stage: Begins in the yolk sac (primitive haematopoiesis), producing mainly erythroid and myeloid cells.
- Foetal stage: Shifts to the liver and spleen (definitive)

haematopoiesis), where multipotent hematopoietic stem cells emerge.

- Postnatal life: Primarily occurs in the bone marrow of long bones, vertebrae, ribs, sternum, and pelvis.

Role of EPO in Blood Formation

EPO is a crucial hormone that plays a key role in erythropoiesis, the process of red blood cell production. It stimulates the bone marrow to produce red blood cells in response to low oxygen levels in the blood. [14]

Stimulates Red Blood Cell Production

EPO is a glycoprotein hormone produced primarily by the kidneys, with a smaller amount produced in the liver. It acts on erythroid precursor cells in the bone marrow, triggering their proliferation and differentiation into mature red blood cells.

Regulates Erythropoiesis

EPO production is regulated by a feedback mechanism involving oxygen levels in the blood. When oxygen levels are low (hypoxia), the kidneys release EPO, stimulating red blood cell production. Conversely, when oxygen levels are sufficient, EPO production is reduced. [15]

Essential for Survival and Maturation

EPO helps erythroid progenitor cells survive and proliferate, preventing apoptosis (programmed cell death). It also plays a role in the maturation of red blood cells from proerythroblasts to reticulocytes and finally to mature erythrocytes.

Hemopoietic enzymes (ALAS, ALAD, porphobilinogen deaminase, uroporphyrinogen synthase, and enzyme ferrochelatase) are correlated with the Ayurvedic concept of *raktadhatwagni* in the formation of *raktadhatu*. Hematopoietic enzymes ensure stem cell replication, energy supply, haemoglobin synthesis, growth factor signalling, antioxidant defence, and proper differentiation of all blood

cell types. While *Raktadhatwagni* governs the digestion – metabolism of *Rakta dhatu*, ensuring its proper formation, quality, nourishment of the next tissue (*mamsa*), vitality, complexion, and overall health

Yakrit (Liver)

Yakrit is the place where *Ranjak Pitta* gives colour to the *Rasa Dhatu* and *Rakta* is formed. *Pleeha* is defined because it is a big storage of *Rakta Dhatu*. Just to understand what is the role of the platelets and monocytes. Platelets are important for clotting of blood. This is part of *Rakta Dhatu*. In the early weeks of embryonic life, primitive nucleated red blood cells are produced in the yolk sac.

During middle trimester of gestation, the liver is the main organ for production of red blood cells, but reasonable numbers are also produced in spleen and lymph nodes. *Acharya Sushruta* has clearly mentioned the *yakruta* is only site where production of *raktadhatu* takes place after being processed by *Raktagni* and *Ranjak Pitta*. [16]

As liver has these sinusoids and Kupffer cells, it is having amazing capacity to expand. The large quantity of blood can be stored in the blood vessels of liver. Its normal blood volume including both in hepatic veins and hepatic sinuses is about 450ml or almost 10% of body's total volume. In cardiac failure and peripheral congestion, the liver expands and 0.5 lit of extra blood is occasionally stored in hepatic veins and sinuses.

About 1050 ml of blood flows from portal vein into the liver sinusoid and an additional 300 ml flows into the sinusoids from hepatic artery, the total averaging 1350 ml/minute. This amounts 27% of resting cardiac output. Both these capacities of liver i.e. storage and inflowing with regards to the blood have very strongly mentioned by *Acharya Sushruta*. He has quoted the *yakruta* as *Raktashaya* by only realizing its above-described properties. Also, he has introduced the liver as a *Sthana* of

Raktadharakala which means a special type of membrane. The endothelial cells, Kupffer cells lined internally to the sinusoids are the membrane like structures which may be considered as *Raktadharakala*. Except for the iron in the haemoglobin of blood, by far the greater portion of iron in the body is stored in the liver in form of ferritin.

The hepatic cells contain large number of proteins, apoferritin which is capable of combining reversibly with iron. Therefore, when iron is available in the body fluid in excess quantities, it is stored in the liver in the form of ferritin in hepatic cells until needed elsewhere. When iron circulating in the body reaches a low level, ferritin releases the iron.

Thus, the liver act as blood iron buffer as well as iron storage medium. [17] *Ranjaka Pitta* The fire that imparts colour. It is located in the liver, spleen, stomach and small intestine, and gives colour to the blood, bile and stool. It primarily resides in the blood and is involved in most liver disorders. It is involved in the creation of red blood cells (RBC), so a dysfunction of *Ranjaka* may cause anaemia. [18] *Pleeha*(Spleen) It is the main organ where platelets are stored. According to modern physiology, red blood cells are manufactured in the bone marrow. Ayurveda has not given any reference of that. Rather, Ayurveda says that up to a specific age the sternum is the place where the *Rakta Dhatu* is prepared. And in modern physiology, there has been notice made that up to a certain age, the sternum bone marrow specifically plays for the development of red blood cells. That reference is also in the Samhita. [19]

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***Pleeha*(Spleen)**

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The spleen is an organ in the upper far left part of the abdomen, to the left of the stomach. The spleen varies in size and shape between people, but it's commonly fist-shaped, purple, and about 4 inches long. Because the spleen is protected by the rib cage, you can't easily feel it unless it's abnormally enlarged.

The spleen plays multiple supporting roles in the body. It acts as a filter for blood as part of the immune system. Old red blood cells are recycled in the spleen, and platelets and white blood cells are stored there. The spleen also helps fight certain kinds of bacteria that cause pneumonia and meningitis. [20]

Result:

A comprehensive review of classical Ayurvedic literature along with modern haematological concepts suggests a close relationship between *Raktavaha Srotas* and the physiological processes involved in blood formation and maintenance.

Classical texts describe *Yakrit* (liver) and *Pleeha* (spleen) as the *Moola* (root) of *Raktavaha Srotas*. In modern science, these organs are also known to have an important role in blood metabolism. Notably, during foetal life, both liver and spleen function as major hematopoietic organs before bone marrow becomes the primary site of blood formation. This indicates an interesting conceptual

similarity between Ayurvedic descriptions and modern embryological understanding.

Ayurveda explains the formation of Rakta Dhatu as a transformation of Rasa Dhatu, mediated by *Ranjaka Pitta*. This process may be interpreted as analogous to biochemical and physiological changes involved in erythropoiesis, including haemoglobin synthesis and maturation of red blood cells.

The functions attributed to Rakta, such as Jeevana (maintenance of life), *Varna Prasadana* (healthy complexion), and Pushti (nourishment), show similarity with the modern functions of blood, including oxygen transport, nutrient delivery, and maintenance of tissue vitality.

Symptoms mentioned under *Raktavaha Srotodushti*, such as pallor, burning sensation, skin discoloration, and bleeding disorders, demonstrate resemblance with haematological abnormalities like anaemia, inflammatory blood disorders, and haemorrhagic conditions.

Although bone marrow is recognized in modern science as the chief site of adult haematopoiesis, direct mention of marrow-based blood formation is not clearly found in Ayurveda. However, the broader concept of *Raktavaha Srotas* suggests that Ayurveda viewed blood physiology as an integrated systemic process rather than restricting it to a single anatomical location.

Discussion

The present review indicates that *Raktavaha Srotas* is not merely a description of blood vessels or circulating blood, but a wider physiological concept involving formation, transformation, transportation, and maintenance of blood.

Ayurveda describes Dhatu formation as a sequential metabolic process beginning from digested food essence (*Ahara Rasa*) to Rasa Dhatu and subsequently to Rakta Dhatu. The role of *Ranjaka Pitta* in imparting colour and

qualities to Rakta can be critically interpreted as a representation of biochemical transformations essential for blood maturation.

The mention of *Yakrit* and *Pleeha* as the root of *Raktavaha Srotas* is particularly noteworthy. Modern medicine recognizes the liver as a major organ involved in iron storage, protein synthesis, and foetal haematopoiesis, while the spleen is involved in blood filtration, immune functions, and destruction of aged red blood cells. This supports the possibility that ancient Ayurvedic scholars had identified the systemic importance of these organs through detailed clinical observation.

One apparent difference is the absence of a direct description of bone marrow as the main adult hematopoietic organ. However, Ayurveda's concept of *Majja Dhatu* may offer an indirect correlation. Though classical references mainly associate *Majja* with bone cavity filling and nourishment, its relationship with marrow physiology deserves further exploration.

The pathological aspect of *Raktavaha Srotas* further strengthens this correlation. Diseases like *Pandu*, *Raktapitta*, and *Kamala* involve alterations in blood quality and function, closely resembling anemia, bleeding disorders, and hepatic conditions respectively.

This suggests that Ayurveda approached blood physiology through a functional systems model, where organs, tissues, metabolic factors, and channels collectively contribute to the maintenance of Rakta.

Conclusion

Based on the critical review of classical and modern literature, it can be concluded that *Raktavaha Srotas* represents a comprehensive Ayurvedic framework related to blood physiology.

Its description includes not only circulation of blood but also its formation, nourishment, transformation, and pathological alterations.

The identification of *Yakrit*, *Pleeha*, and *Raktavahi Dhamani* as important components of *Raktavaha Srotas* shows strong conceptual similarity with modern haematological organs and circulatory structures.

Although Ayurveda does not explicitly describe bone marrow as the principal site of adult haematopoiesis, the concepts of *Rasa* to *Rakta* transformation, *Ranjaka Pitta*, and systemic organ involvement reflect an advanced understanding of blood formation and metabolism.

Therefore, *Raktavaha Srotas* may be understood as a functional hematopoietic and circulatory system described in Ayurvedic terminology.

Further interdisciplinary research is required to establish stronger correlations between Ayurvedic concepts such as *Majja Dhatu*, *Ranjaka Pitta*, and *Dhatu* formation with contemporary haematological mechanisms. Such studies may help bridge traditional Ayurvedic physiology with modern biomedical science.

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