



Ayurvedic Concept of *Srotas* and Modern Microcirculation: A Comparative Study

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Abstract

Life depends on the continuous movement of oxygen, nutrients, hormones, fluid, immune cells, and metabolic products between organs and tissues. Modern physiology describes these processes through the cardiovascular and lymphatic systems, interstitial exchange, and microcirculation. Ayurveda uses the concept of *Srotas* for the channels and functional pathways through which substances move, transform, nourish tissues, and leave the body. This narrative review compares *Srotas* with modern microcirculation while emphasizing the limits of a direct anatomical equation. The *Charaka Samhita*, *Sushruta Samhita*, *Ashtanga Hridaya*, and *Bhava Prakasha Nighantu* were considered alongside literature identified through PubMed, Scopus, Web of Science, and Google Scholar. *Srotodushti* patterns such as *Atipravritti*, *Sanga*, *Siragranthi*, and *Vimargagamana* can generate useful comparisons with excessive flow, obstruction, abnormal structural change, and movement outside an expected pathway. Similarly, selected functions of *Rasavaha* and *Raktavaha Srotas* overlap conceptually with nutrient distribution, vascular transport, capillary exchange,

and tissue perfusion. *Srotas*, however, includes anatomical, physiological, metabolic, and regulatory dimensions and cannot be reduced to capillaries or blood vessels. Future research should translate a defined classical phenotype into measurable questions using microvascular imaging, endothelial assessment, and systems physiology rather than claim equivalence from terminology alone.

Keywords

Srotas; microcirculation; Ayurveda; tissue perfusion; *Srotodushti*; physiological transport

1. Introduction

Every tissue relies on continuous delivery of oxygen and nutrients and on removal of carbon dioxide and metabolic waste. The circulatory and lymphatic systems provide bulk transport, while exchange at arterioles, capillaries, venules, and the interstitium determines local perfusion and cellular homeostasis [1]. Microcirculation is therefore not merely a collection of small vessels; it is a dynamic interface regulated by vascular tone, permeability,

blood cells, nerves, local metabolites, and the endothelium.

The Sanskrit root *sru* conveys flowing or moving. Classical texts use *Srotas* for pathways that support transport, transformation, nourishment, and elimination [2]. Health requires appropriate flow and exchange, whereas altered quantity, obstruction, structural change, or movement along an abnormal route can contribute to disease. This functional breadth makes comparison with microcirculation attractive, but also creates the risk of forcing a large Ayurvedic concept into one modern anatomical category.

Aim and Objectives

The study aims to critically compare the classical concept of *Srotas* with modern microcirculation and related transport physiology. It reviews the structure and function attributed to *Srotas*, summarizes microvascular regulation, analyzes defensible areas of convergence and difference, and proposes directions for interdisciplinary research.

2. Methodology of Literature Review

A narrative review was performed using the *Charaka Samhita*, *Sushruta Samhita*, *Ashtanga Hridaya*, and *Bhava Prakasha Nighantu*. PubMed, Scopus, Web of Science, and Google Scholar were searched with combinations of “*Srotas* Ayurveda,” “microcirculation physiology,” “tissue perfusion,” “*Srotodushti*,” and “vascular function.” Classical descriptions, research on microcirculation, and studies concerned with tissue transport were included. Unverified and unrelated material was excluded. The review is a conceptual synthesis and not a systematic anatomical validation study.

3. Classical Concept and Characteristics of *Srotas*

Classical Ayurveda describes the body as sustained by continuous movement through numerous *Srotas* [3]. These pathways participate in absorption, distribution, tissue nourishment, transformation, and excretion. Each named *Srotas* is considered in terms of what it carries, its functional domain, signs of disturbance, and its *Mula*. *Mula* may indicate an origin, key site, or controlling functional base rather than the beginning of a simple tube.

This framework is neither exclusively gross anatomical nor purely metaphorical. Some descriptions correspond to recognizable organs and passages; others integrate several physiological processes. *Dosha*, *Dhatu*, nutrient fractions, and waste products move or are regulated through these pathways. The meaning of a particular *Srotas* must therefore be interpreted from its substance, function, *Mula*, and clinical disturbance rather than translated by name alone.

4. Major Functional Types

Pranavaha Srotas concerns respiration and the sustaining movement of *Prana*; *Annavaha Srotas* concerns the reception and processing of food; *Rasavaha Srotas* concerns distribution of the first nutritive fraction; *Raktavaha Srotas* is related to *Rakta* and its circulation; *Mutravaha Srotas* concerns urine formation and elimination; and *Medovaha Srotas* concerns *Meda* and fat metabolism. These domains overlap with several organs and regulatory systems and should not be treated as isolated ducts.

<i>Srotas</i>	Principal functional domain
<i>Pranavaha Srotas</i>	Respiration and sustaining movement
<i>Annavaha Srotas</i>	Food reception, digestion, and nutrient passage
<i>Rasavaha Srotas</i>	Distribution of nutritive essence
<i>Raktavaha Srotas</i>	<i>Rakta</i> -related transport and circulation
<i>Mutravaha Srotas</i>	Urine formation and elimination
<i>Medovaha Srotas</i>	<i>Meda</i> and fat metabolism

5. Patterns of *Srotodushti*

Srotodushti describes disturbed channel function. *Atipravritti* refers to excessive activity or flow and may be compared, depending on context, with hypersecretion, excessive discharge, or increased permeability. *Sanga* denotes impaired or obstructed movement; possible modern examples include luminal obstruction, edema-related diffusion impairment, or reduced tissue perfusion. *Siragranthi* indicates knotting, dilation, or abnormal structural change, while *Vimargagamana* refers to movement

along an inappropriate route, such as leakage or ectopic passage.

These are pattern-level comparisons, not diagnoses. *Sanga* cannot be equated automatically with thrombosis, and *Vimargagamana* does not name one pathological mechanism. The relevant modern process depends on the affected *Srotas*, the transported substance, and the clinical presentation.

6. Modern Microcirculation

Microcirculation comprises arterioles, capillaries, and venules. Arterioles regulate resistance and distribute blood according to tissue demand. Capillaries provide a thin exchange surface for gases, nutrients, water, and solutes. Venules collect blood and are prominent sites of leukocyte adhesion and migration during inflammation. Together these vessels regulate oxygenation, waste removal, temperature, fluid balance, immune traffic, and tissue repair [4].

Microvascular behavior differs among organs. Continuous, fenestrated, and sinusoidal capillaries have different permeability, while local endothelial cells respond to the specific needs of their tissue. Perfusion also depends on systemic pressure, blood rheology, autonomic input, and local metabolic signals.

7. Areas of Functional Comparison

Rasavaha Srotas distributes nutritive essence after digestion. A cautious modern comparison includes plasma transport, capillary exchange, lymphatic return, and movement through interstitial fluid. *Raktavaha Srotas* has clearer overlap with blood-related transport and vascular function, including tissue oxygenation and hemodynamics [5]. Neither, however, is synonymous with the complete cardiovascular system.

Pranavaha Srotas includes the movement that sustains respiration and life. Pulmonary ventilation, alveolar-capillary gas exchange, oxygen carriage, and respiratory regulation provide possible modern points of study. *Mutravaha Srotas* spans renal perfusion, filtration, tubular handling, and urinary elimination. *Medovaha Srotas* may be examined alongside adipose perfusion, lipid handling, endocrine signaling, and inflammation because adipose tissue is metabolically active and microvasculature regulated.

8. Srotomula and Functional Organization

The *Mula* of a *Srotas* should not be assumed to be a single anatomical origin. It may denote a site whose injury or dysfunction has disproportionate consequences for that functional pathway. Modern physiology also recognizes control nodes: the heart drives systemic flow, resistance vessels distribute perfusion, organ-specific endothelium regulates exchange, and neural and hormonal systems coordinate demand. This shared organizational idea is more defensible than matching every classical *Mula* to one vessel or organ.

9. Agni, Ama, and Microvascular Dysfunction

Agni represents digestive and transformative competence. When transformation and *Dhatu* formation are orderly, the material moving through *Srotas* is appropriate to tissue needs. Impaired *Agni* is associated with *Ama*, a broad classical concept of inadequately processed material that may contribute to heaviness, obstruction, and disturbed function.

Oxidative stress, advanced metabolic products, inflammatory mediators, endothelial activation, and altered blood rheology can impair microvascular function [6]. These mechanisms may be used to explore aspects of *Ama* and *Srotorodha*, but none is an exact biomarker of either term. A credible study would define the classical signs prospectively and test their association with specific endothelial or perfusion measures.

10. Dosha and Regulation of Flow

Vata is associated with movement and may provide a clinical frame for circulation, neural regulation, and propulsion. *Pitta* concerns transformation and can be discussed in relation to metabolism and enzymatic activity. *Kapha* provides stability, cohesion, and lubrication. These functional comparisons are intentionally broad; *Dosha* are not equivalent to nerves, enzymes, or structural proteins. Their value lies in integrated pattern recognition rather than isolated molecular substitution.

11. Clinical Relevance

Microcirculatory dysfunction contributes to diabetic tissue injury, hypertension-related damage, chronic inflammation, delayed wound healing,

ischemia, and organ failure. *Srotas*-based assessment encourages clinicians to consider digestion, tissue nourishment, elimination, activity, and the pattern of obstruction or abnormal flow together. It cannot replace vascular examination, imaging, laboratory testing, or urgent management when ischemia, thrombosis, stroke, or organ dysfunction is suspected.

12. Maintaining Healthy *Srotas*

Ayurvedic prevention emphasizes *Ahara*, routine, activity, and correction of *Agni*. Regular, nutritionally appropriate meals and avoidance of repeated overeating may reduce metabolic burden. *Vyayama* improves vascular function, insulin sensitivity, and tissue perfusion when matched to age and capacity. These behavioral measures have a stronger and more generalizable basis than prescribing one herb for every form of *Srotodushti*.

Guduchi (*Tinospora cordifolia*), *Arjuna* (*Terminalia arjuna*), and *Triphala* are used in selected metabolic or cardiovascular contexts. *Arjuna* has been studied for cardiovascular effects [7], but herbal use should follow a defined diagnosis and account for product quality, liver or kidney disease, blood pressure, and interactions with antiplatelet, anticoagulant, antihypertensive, or glucose-lowering medicines.

13. Modern Assessment and Therapeutic Approaches

Modern management targets the cause of impaired microcirculation: exercise and smoking cessation, control of glucose and blood pressure, lipid management, restoration of perfusion, wound care, and disease-specific vascular therapy. Laser Doppler flowmetry, capillaroscopy, contrast imaging, retinal imaging, and endothelial function tests can quantify selected aspects of microvascular health. These tools may be particularly valuable in testing carefully defined *Srotodushti* phenotypes.

14. Critical Analysis

Srotas and microcirculation both emphasize movement, exchange, nourishment, and the consequences of impaired flow. The difference is equally important. Microcirculation is an anatomically and experimentally defined part of the vascular system, whereas *Srotas* is a wider functional

framework incorporating physical passages, regulatory activity, transformation, and clinical patterns. Restricting *Srotas* to blood vessels loses much of the classical concept; describing all *Srotas* as microcirculation overstates the comparison.

15. Research Gaps and Future Perspectives

Direct anatomical correlation studies are scarce, and no validated biomarker currently represents *Srotodushti*. Future work should define the affected *Srotas* and *Dushti* pattern using reproducible criteria, enroll appropriate clinical populations, and choose a plausible modern measure such as perfusion, endothelial reactivity, capillary density, or permeability. Longitudinal studies could examine whether *Prakriti* or *Rasayana*-based interventions relate to microvascular ageing. Systems biology may help integrate multiple levels of regulation, but it should be anchored in transparent clinical definitions.

16. Conclusion

Srotas offers a comprehensive Ayurvedic account of transport, exchange, transformation, nourishment, and elimination. Modern microcirculation describes small-vessel regulation and tissue exchange with anatomical and measurable precision. Useful parallels exist between selected *Srotas* functions and nutrient distribution, blood flow, capillary exchange, and organ-specific transport. *Srotodushti* patterns can also inspire research into excessive flow, obstruction, abnormal structure, and leakage. *Srotas* nevertheless extends beyond the vascular network, and meaningful integration requires hypothesis-driven comparison rather than direct equivalence.

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