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Review Article

RAKTADHARA KALA AND VASCULAR STRUCTURAL CHANGES IN ATHEROSCLEROSIS: AN AYURVEDIC AND MODERN ANATOMICAL CORRELATION

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ABSTRACT

Rachana Sharir, a fundamental branch of Ayurveda, provides a comprehensive understanding of the structural and functional components of the human body through unique concepts such as *Kala*- the membranous coverings that compartmentalize bodily tissues. Among the seven *Kalas* described in classical texts, *Raktadhara Kala* is particularly significant as it is responsible for the formation, containment, and proper circulation of *Rakta Dhatu* (blood tissue). This *Kala* is believed to line the blood vessels, ensuring the integrity and function of the circulatory system. Atherosclerosis, recognised as a major cause of cardiovascular morbidity and mortality in modern medicine, is characterised by progressive structural alterations in the arterial walls, primarily due to lipid deposition, inflammatory processes, and endothelial dysfunction. From an Ayurvedic anatomical perspective, these pathological changes can be analysed through the lens of *Raktadhara Kala*. Disruption or vitiation *(Dushti)* of *Raktadhara Kala* may lead to improper containment and flow of *Rakta Dhatu,* predisposing to conditions analogous to atherosclerosis. This article aims to provide an in-depth analysis of atherosclerosis by correlating its pathogenesis with the concept of *Raktadhara Kala* and its modern equivalent, the vascular endothelium. The discussion explores the mechanisms of *Kala Dushti* (membrane pathology), *Srotorodha* (obstruction of channels), and *Dhatu* vitiation (tissue dysfunction) as central factors in disease manifestation. By drawing parallels between classical Ayurvedic concepts and contemporary vascular pathology, the study seeks to bridge traditional and modern understandings, ultimately contributing to a more holistic approach to cardiovascular health.

INTRODUCTION

Ayurveda describes the human body as a composite of *Dosha, Dhatu,* and *Mala*, supported structurally by various anatomical entities. Among these, *Kala* represents specialized membranous structures that line internal cavities and support physiological functions.

"धात्वाशयांतरस्थस्तु यः क्लेदस्त्वधितिष्ठति।
देहोष्मणा विपक्वश्च स कलेत्यभिधीयते" ॥ (शा० प्र० 5/9)

According to Acharya Sharagdhara, the moist substance *(Kleda)* that resides in between the *Dhatus* (body tissues) and their respective seats *(Ashayas),* and which undergoes transformation (digestion/ maturation) by the heat of the body *(Dehoshma),* is known as *Kala*. It is the membranous layer formed from *Dhatu* essence, situated between *Dhatu* and *Ashaya*[1], performing protective and functional roles. There are total of 7 *Kalas* mentioned in classical texts, viz., *Mamsadhara, Raktadhara, Medodhara, Shleshmadhara, Purishdhara, Pittadhara & Shukradhara*[2]. Out of which *Raktadhara kala* is responsible for holding and supporting *Rakta Dhatu*, facilitating its circulation within *Sira* and *Dhamani*. [3]

Atherosclerosis is a chronic inflammatory and degenerative condition of arteries in which the inner lining (endothelium) gets damaged; lipids, especially low-density lipoprotein (LDL) accumulate in the vessel wall. This leads to the formation of atheromatous plaques composed of fat, fibrous tissue, and calcium. These plaques reduce blood flow, make vessels stiff

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and can rupture, leading to thrombosis (clot formation) [4]. So, atherosclerosis is characterised by

1) Thickening of arterial walls
2) Lipid accumulation
3) Reduced lumen diameter

This study aims to provide a comprehensive understanding of the structural alterations observed in atherosclerosis by interpreting them through the Ayurvedic concept of *Raktadhara Kala*. By correlating the pathological changes of the vascular endothelium with the vitiation of *Raktadhara Kala*. This work attempts to establish a meaningful and integrative link between classical Ayurvedic anatomy and modern vascular science, thereby enhancing the conceptual clarity and clinical applicability of both systems.

AIM AND OBJECTIVES

Aim

To study the role of *Raktadhara Kala* in the structural pathology of atherosclerosis.

Objectives

1. To describe *Raktadhara Kala* as per classical Ayurvedic texts.
2. To analyse vascular anatomy in modern science.
3. To correlate *Kala Dushti* with atherosclerotic changes.
4. To explore clinical implications in Ayurvedic management.

MATERIALS AND METHODS

1. Review of classical Ayurvedic texts such as Sushruta Samhita, Sharangadhara Samhita, etc.
2. Analysis of modern anatomical and pathological literature on the vascular system.
3. Conceptual comparative study

Concept of *Raktadhara Kala*

द्वितीया रक्तधरा मांसस्याभ्यन्तरतः,

तस्यां शोणितं विशेषतश्च सिरासु यकृत्प्लीह्नोश्च भवति ॥ **(सु. शा. ४/१०)**

Raktadhara Kala, the second among the seven *Kalas* described in Ayurveda, is primarily situated within the *Mamsa Dhatu* (muscle tissue) and is responsible for the containment and circulation of *Rakta Dhatu.* It is especially associated with the vascular system, being prominently present in the walls of *Dhamani* (arteries) and *Sira* (veins), as well as in highly vascular organs such as the liver *(Yakrit)* and spleen *(Pleeha)*.[5]

वृक्षाद्यथाभिप्रहतात् क्षीरिणः क्षीरिमावहेत् ॥

मांसादेवं क्षतात् क्षिप्रं शोणितं संप्रसिच्यते ॥ **(सु. शा. ४/११)**

Sushruta illustrates its presence through the analogy that just as latex exudes from an injured milky tree, blood oozes from incised muscle, thereby indicating the existence of a subtle structural layer responsible for holding and transporting blood.[6] Although described in relation to muscle, *Raktadhara Kala* is considered to be microscopically present throughout the *Dhatus* and *Upadhatus*, except in structures such as the external skin, hair, and nails.

From a modern anatomical perspective, it closely corresponds to the endothelial lining of blood vessels and sinusoids. Scholars such as Ranjitray Desai have further emphasised that capillaries are composed of a single-layered structure analogous to *Raktadhara Kala*, whereas in larger vessels, it constitutes the innermost layer (tunica intima), supported externally by muscular and connective tissue layers. The extensive distribution of this Kala within muscle tissue also contributes to its characteristic reddish appearance, thereby reinforcing its structural and functional significance in maintaining vascular integrity and blood dynamics.[7]

Location: Rooted in *Yakrit* (liver) and *Pleeha* (spleen)

Present within *Sira* (blood vessels)[8]

Modern Understanding of Vascular Anatomy

In modern vascular anatomy, every blood vessel (especially arteries and veins) is made up of three distinct layers, each with specific structure and function:

1) Tunica Intima
2) Tunica Media
3) Tunica Adventitia

Tunica Intima (Inner Layer): This is the innermost layer, directly in contact with blood. It is composed of a single layer of endothelial cells (simple squamous epithelium), a thin basement membrane and subendothelial connective tissue.

Function

- It provides a smooth, frictionless surface for blood flow.
- Regulates vascular permeability (exchange of nutrients, gases, and waste).
- Plays a role in vasodilation and vasoconstriction through chemical mediators.

Tunica Media (Middle Layer): This is the thickest layer, especially in arteries. It contains smooth muscle fibres & elastic fibres.

Function

- Controls the diameter of blood vessels.
- Maintains blood pressure and flow regulation.
- Helps in vasoconstriction and vasodilation.

Tunica Adventitia (Outer Layer): This is the outermost protective layer, composed of connective tissue (collagen fibres), nerves, and small blood vessels (vasa vasorum).

Function

- Provides structural support and protection.
- Anchors vessels to surrounding tissues.[9]

Pathology of Atherosclerosis

Atherosclerosis is a chronic, progressive disease of the arterial wall, mainly affecting medium and large arteries, characterised by the formation of lipid-rich plaques that narrow the lumen and disturb blood flow. It is a slow, long-term disease in which arteries gradually become narrow and hard due to the buildup of fatty substances. It usually begins with damage to the inner lining of blood vessels (endothelium), which can result from high blood pressure, smoking, diabetes, or elevated cholesterol levels. Once this lining is injured, harmful cholesterol particles (especially LDL) enter the vessel wall and get oxidised. This triggers the body's defense system, causing immune cells to come and "eat" these fats. However, instead of clearing them, these cells turn into foam cells, leading to the formation of early lesions called fatty streaks. Over time, more fat cells and fibrous tissue accumulate, forming a plaque inside the artery wall. This plaque gradually thickens and reduces the space through which blood can flow, leading to decreased oxygen supply to organs like the heart or brain. In advanced stages, the plaque may become unstable and rupture, suddenly forming a blood clot (thrombus) that can completely block the artery. This can result in serious conditions like a heart attack or stroke.[10]

Ayurvedic and Modern Concepts Correlation

Raktadhara Kala described in Ayurveda can be closely correlated with the endothelial lining of the tunica intima in modern vascular anatomy, as both function as essential inner layers responsible for maintaining and regulating blood flow. *Raktadhara Kala* is said to hold and contain blood within its channels *(Dharana karma),* which parallels the continuous endothelial lining that prevents leakage and ensures the integrity of blood vessels. This lining also provides a smooth, frictionless surface for circulation, similar to the role of Kala in facilitating unobstructed movement of *Rakta*. Additionally, both act as selectively permeable barriers- *Raktadhara Kala* allowing appropriate exchange between *Dhatus*, while the endothelium regulates the passage of nutrients, gases, and waste products between blood and tissues. Furthermore, both structures play a protective role in maintaining internal balance; when vitiated, *Raktadhara Kala* leads to *Raktaja vikara*, just as endothelial dysfunction results in pathological conditions like atherosclerosis and thrombosis. Thus, functionally and conceptually, the endothelial lining of the tunica intima serves as a modern anatomical counterpart of *Raktadhara Kala*.

Atherosclerosis can be correlated with the Ayurvedic concept of disease formation as a multifactorial process involving not only *Raktadhara Kala* but also disturbances in *Medo Dhatu, Srotas*, and *Vata Dosha*. The pathology begins with dysfunction of *Raktadhara Kala*, which can be compared to endothelial injury, leading to impaired regulation and containment of blood. Simultaneously, there is *Medo Dhatu Vriddhi*, representing excess and abnormal accumulation of lipids within the vessel walls, similar to plaque formation. This accumulation causes *Srotorodha* (obstruction of channels), which hampers the normal flow of *Rakta* and other nutrients. As the obstruction progresses, *Vata Dosha* becomes aggravated due to the blockage and dryness within the channels, leading to irregular movement and increased pressure on the vessel walls. This aggravated *Vata* further contributes to complications such as plaque instability, rupture, and thrombus formation. Therefore, atherosclerosis can be understood as a combined manifestation of *Raktadhara Kala Dushti, Medo Dhatu Dushti, Srotorodha,* and *Vata Prakopa*, all of which together disturb the normal circulation and ultimately lead to serious cardiovascular events.

Clinical Significance

The understanding of *Raktadhara Kala* in relation to atherosclerosis provides a deeper and earlier insight into vascular disorders at the level of the vessel lining. When *Raktadhara Kala* becomes vitiated, it reflects early changes similar to endothelial dysfunction, which is the starting point of atherosclerosis. This understanding helps in early diagnosis of vascular disorders, even before visible plaque formation, by identifying subtle signs of impaired blood flow and *Kala dushti.*

It is also important in preventing disease progression, as recognizing damage at the kala level allows timely intervention to stop further deposition of *Meda* (lipids) and development of *Srotorodha* (blockage). By maintaining the integrity of *Raktadhara Kala*, the progression from mild dysfunction to severe arterial narrowing can be slowed or prevented.

Further, this concept supports planned and targeted therapies. Treatment can be directed specifically towards improving the quality of *Rakta (Raktaprasadana),* clearing channels *(Srotoshodhana),* and balancing *Meda* and *Vata*, rather than only focusing on symptomatic relief. This leads to a more root-cause-based and individualised approach in managing atherosclerosis.

Additionally, it has significant application in detoxification *(Panchakarma).* Therapies like *Virechana* and *Basti* can be selected to remove accumulated *Dosha* and impurities affecting *Raktadhara Kala,* thereby restoring its normal function. Thus, understanding *Raktadhara Kala* not only helps in early detection and prevention but also plays a key role in planning effective therapeutic and detoxification strategies in vascular diseases like atherosclerosis.

DISCUSSION

The correlation between *Raktadhara Kala* and vascular changes in atherosclerosis provides an integrative view of disease pathology. *Raktadhara Kala,* responsible for the containment and regulation of *Rakta*, closely resembles the endothelial lining of tunica intima, and its dysfunction can be correlated with endothelial injury- the initiating event in atherosclerosis. However, the pathology extends beyond this, involving *Medo Dhatu Vriddhi* in the form of lipid accumulation and plaque formation, leading to *Srotorodha* (obstruction of channels) and impaired circulation. This obstruction further aggravates *Vata Dosha*, contributing to plaque instability, rupture, and thrombus formation. Thus, atherosclerosis can be understood as a combined manifestation of *Raktadhara Kala Dushti, Medo Dhatu Dushti*, *Srotorodha*, and *Vata Prakopa*. Clinically, this highlights the need for a comprehensive management approach focusing not only on lipid control but also on restoring vascular integrity, clearing channels, and balancing doshas through appropriate Ayurvedic interventions.

CONCLUSION

The correlation of *Raktadhara Kala* with the endothelial lining of blood vessels offers a meaningful bridge between Ayurvedic principles and modern vascular anatomy. Atherosclerosis can be comprehensively understood as a multifactorial process involving *Raktadhara Kala Dushti* (endothelial dysfunction), *Medo Dhatu Vriddhi* (lipid accumulation), *Srotorodha* (vascular obstruction), and *Vata Prakopa* (progression and complications). This integrative perspective emphasizes that vascular diseases are not merely structural abnormalities but result from combined disturbances in tissue integrity, metabolism, and flow dynamics. Such understanding supports a holistic approach to management, focusing on prevention, early intervention, and restoration of physiological balance through Ayurvedic principles along with modern insights, thereby offering a broader and more effective framework for addressing atherosclerosis.

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