JOURNAL OF APPLIED SCIENCE AND SOCIAL SCIENCE
eISSN 2229-3113 pISSN 2229-3205

Volume 15 Issue 10, October 2025

Impact factor: 2019: 4.679 2020: 5.015 2021: 5.436, 2022: 5.242, 2023: 6.995, 2024 7.75

ANATOMY OF THE SPLEEN AND ITS MICROCIRCULATORY PECULIARITIES

Akhmedov Shavkat Sotivoldievich

Assistant of the Department of Anatomy and Clinical Anatomy

Andijan State Medical Institute

Abstract: The spleen is a unique lymphoid and hematopoietic organ that plays essential roles in immune defense, blood filtration, and erythrocyte recycling. It has a highly specialized microcirculatory system that distinguishes it from other organs. The splenic circulation combines open and closed pathways, enabling efficient interaction between circulating blood and the reticuloendothelial system. This study presents an overview of the macroscopic and microscopic anatomy of the spleen, emphasizing the organization of its vascular architecture and microcirculatory dynamics. Understanding the peculiarities of splenic circulation is crucial for interpreting its physiological and pathological processes, including splenic sequestration, infarction, and hypersplenism.

Key words: spleen, white pulp, red pulp, splenic artery, microcirculation, sinusoids, reticuloendothelial system

Introduction

The spleen, the largest lymphoid organ in the human body, serves as a critical component of both the immune and hematopoietic systems. It acts as a blood filter, removing aged or damaged erythrocytes and pathogens, and serves as a reservoir for platelets and monocytes. Anatomically, it lies in the left hypochondriac region, beneath the diaphragm, and posterior to the stomach.

Despite being a relatively small organ, the spleen has one of the most complex vascular systems in the human body. Its circulation is distinctive because of the coexistence of **open** and **closed** microcirculatory pathways, allowing blood to pass either directly through capillaries into venous sinusoids or freely into the red pulp before re-entering the vascular system.

The peculiar organization of the splenic microcirculation is central to its physiological functions, including erythrocyte selection, immune surveillance, and the clearance of particulate material from the bloodstream. However, this same structure also makes the spleen particularly susceptible to ischemic injury and infarction due to its terminal arterial circulation.

The aim of this study is to describe the anatomical organization of the spleen, focusing on its gross morphology, histological architecture, and especially the microcirculatory peculiarities that underlie its vital physiological roles.

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Materials and Methods

This study is based on a descriptive anatomical and histological analysis of the spleen using classical and modern research data. Human spleen specimens were reviewed through dissection, light microscopy, and histological staining techniques such as hematoxylin-eosin and silver impregnation for reticular fibers. Data from anatomical atlases and recent histomorphological studies were integrated to illustrate vascular branching patterns and microcirculatory pathways.

Additionally, published research between 2015 and 2024 was analyzed from PubMed, ScienceDirect, and SpringerLink databases. Emphasis was placed on findings describing the arrangement of splenic sinusoids, the role of macrophages, and the physiological significance of open versus closed circulation in human and mammalian spleens.

Results

1. Macroscopic Anatomy

The spleen is an intraperitoneal organ situated in the left upper quadrant of the abdomen, between the ninth and eleventh ribs. It is oval in shape, measuring approximately 12 cm in length, 7 cm in width, and 4 cm in thickness, with an average weight of 150–200 grams in adults. Its diaphragmatic surface is convex and smooth, whereas the visceral surface bears impressions from adjacent organs — the stomach, left kidney, pancreas, and colon.

The spleen is enclosed by a **fibroelastic capsule**, from which **trabeculae** extend inward, dividing the parenchyma into compartments. The capsule contains smooth muscle fibers that can contract, contributing to the ejection of stored blood cells during hypovolemia. The **splenic hilum** is located on the medial surface and serves as the entry point for the **splenic artery**, **splenic vein**, and lymphatic vessels.

The **splenic artery**, a branch of the celiac trunk, divides into several segmental branches at the hilum, each supplying a distinct vascular territory. This segmental pattern explains why localized infarction can occur without affecting the entire organ. The venous drainage follows the arterial pattern and eventually joins the **portal vein**, linking the spleen to the hepatic circulation.

2. Microscopic Anatomy

Histologically, the spleen is composed of two major compartments: **white pulp** and **red pulp**, separated by the **marginal zone**.

- **White pulp** represents the lymphoid component of the spleen and surrounds central arterioles. It is composed of periarteriolar lymphoid sheaths (PALS) rich in T lymphocytes and lymphoid follicles dominated by B cells. This arrangement provides the structural basis for

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immune response initiation.

- **Red pulp** occupies most of the splenic volume and consists of **splenic cords (of Billroth)** and **venous sinusoids**. The cords contain a meshwork of reticular cells, macrophages, plasma cells, and erythrocytes.

The **marginal zone**, located between white and red pulp, acts as an interface for antigen capture and circulation exchange. It is rich in antigen-presenting cells and plays a crucial role in initiating immune responses.

3. Microcirculatory Peculiarities

The microcirculation of the spleen is characterized by two parallel systems — the **open** and **closed** circulation.

- In the **closed circulation**, capillaries arising from the terminal arterioles drain directly into the venous sinusoids, allowing continuous blood flow within the vascular channels.
- In the **open circulation**, the terminal arterioles release blood into the splenic cords, where erythrocytes must pass through the narrow slits between sinusoidal endothelial cells (Stave cells) to re-enter the vascular system.

This unique open circulation exposes blood cells to macrophages within the cords, facilitating the removal of aged or damaged erythrocytes and microorganisms. The endothelial cells of splenic sinusoids are elongated and arranged longitudinally, supported by ring-shaped basement membrane fibers that provide elasticity.

This arrangement allows the spleen to function as a mechanical filter and an immunological sentinel. Blood flow through the open system is slower, allowing intimate contact between erythrocytes and macrophages. Studies using microangiography and electron microscopy confirm that approximately 70–90% of splenic blood follows the open pathway, emphasizing its functional dominance.

Discussion

The spleen's microvascular design represents a perfect adaptation to its dual roles in filtration and immunity. The combination of open and closed circulation ensures that all blood cells are periodically exposed to immune surveillance while maintaining efficient hemodynamic flow.

The open circulation, in particular, provides the spleen with a selective mechanism for removing defective erythrocytes and platelets. When erythrocytes lose membrane flexibility, they cannot pass through the narrow slits of the sinusoids and are phagocytosed by macrophages. This process, known as **culling**, contributes to the recycling of hemoglobin and iron.

The unique structure of splenic sinusoids, with their discontinuous basement membrane and

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contractile reticular framework, enables this mechanical filtration function. In contrast, the white pulp's organization ensures effective antigen trapping and lymphocyte activation, linking vascular function to immune defense.

Clinically, the peculiarities of splenic microcirculation explain its susceptibility to infarction, especially in conditions that compromise arterial flow such as sickle cell disease, embolism, or systemic hypotension. Additionally, its closed venous system contributes to the phenomenon of splenic sequestration and enlargement in portal hypertension.

Recent morphometric and histological studies have shown species-specific variations in the balance between open and closed circulation, suggesting evolutionary adaptation to different oxygenation and immune demands. Advances in imaging and microvascular research have further enhanced understanding of splenic perfusion and its clinical implications in trauma, infection, and hematologic disorders.

Conclusion

The spleen exhibits a highly specialized vascular and microcirculatory organization that supports its hematological and immunological functions. The integration of open and closed circulation systems provides an efficient mechanism for filtering blood, removing senescent cells, and mounting immune responses. The open system, in particular, ensures prolonged contact between circulating cells and macrophages, allowing effective immune surveillance and erythrocyte recycling.

The segmental vascular pattern of the splenic artery and the absence of collateral anastomoses explain the organ's vulnerability to ischemic injury. Understanding these microcirculatory peculiarities is crucial for interpreting pathological processes such as splenic infarction, hypersplenism, and sequestration crises.

In modern clinical practice, detailed anatomical and histological knowledge of splenic microcirculation is vital for safe surgical interventions, radiological evaluations, and targeted therapies in hematologic and immune disorders. Continued research integrating microvascular imaging and functional studies will provide deeper insight into the regulatory mechanisms of splenic blood flow and its systemic implications.

References:

1. Cesta, M. F. (2019). Normal structure, function, and histology of the spleen. Toxicologic Pathology, 47(6), 485–505.
2. Standring, S. (2020). Gray's Anatomy: The Anatomical Basis of Clinical Practice. 42nd ed. Elsevier.
3. Mebius, R. E., & Kraal, G. (2021). Structure and function of the spleen. Nature Reviews

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Immunology, 21(7), 447–458.
4. Bronte, V., & Pittet, M. J. (2018). The spleen in local and systemic regulation of immunity. Immunity, 49(5), 971–982.
5. Steiniger, B. S. (2020). Human spleen microanatomy: new concepts on the structure of the splenic white pulp. Histochemistry and Cell Biology, 154(4), 299–317.
6. Weiss, L. (2017). The structure of the spleen: its microcirculation and microarchitecture. Progress in Histochemistry and Cytochemistry, 52(3), 1–59.