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Opinion Article

Aging and its Effect on Venous Valve Function

Isabella Russo*

Department of Internal Medicine and Vascular Biology, University of Milan Medical School, Milan, Italy

DESCRIPTION

Aging is a natural physiological process that affects nearly every system in the human body, including the vascular system. Among the most significant age-related changes in the venous system are alterations in venous valve function, which play a critical role in maintaining unidirectional blood flow from the lower extremities back to the heart. Venous valves are bicuspid structures located within the veins that prevent retrograde blood flow and their integrity is essential for efficient venous return. With advancing age, structural and functional changes in the veins and their valves contribute to increased venous pressure, venous reflux and the development of chronic venous disorders. Understanding these age-associated changes is vital for the prevention, diagnosis and management of venous disease in older adults.

The primary mechanisms underlying age-related venous valve dysfunction include structural degeneration, reduced elasticity of the vein wall and impaired endothelial function. Over time, the collagen and elastin content of the venous wall diminishes, leading to decreased compliance and increased stiffness. This compromises the ability of the veins to accommodate changes in blood volume and pressure, resulting in greater stress on venous valves. Valves themselves may undergo thickening, fibrosis and leaflet retraction, which impairs their ability to coapt properly during the cardiac cycle. Consequently, incomplete valve closure allows backward flow of blood, known as venous reflux, which is a hallmark of chronic venous insufficiency.

Aging also impacts the microcirculatory environment surrounding the veins. Endothelial cells, which line the inner surface of veins, exhibit reduced nitric oxide production and increased oxidative stress with age. Nitric oxide is essential for maintaining venous tone and regulating vascular homeostasis, while oxidative stress can damage both the vein wall and valve leaflets. In addition, chronic low-grade inflammation associated with aging promotes leukocyte adhesion and matrix remodeling, further compromising venous valve integrity. These cumulative changes contribute to the progressive decline in valve function observed in older adults.

The clinical consequences of impaired venous valve function in the aging population are significant. Patients often experience leg swelling, heaviness, pain and a sense of fatigue, particularly after prolonged periods of standing or sitting. Varicose veins are commonly observed, resulting from increased venous pressure and venous dilation. In advanced cases, skin changes such as hyperpigmentation, dryness and lipodermatosclerosis may develop. Chronic venous ulcers, which are slow to heal and prone to recurrence, represent a severe complication that significantly affects mobility, independence and overall quality of life. Older adults are particularly vulnerable due to the cumulative effects of age-related vascular changes and comorbid conditions such as diabetes and obesity.

Diagnosis of venous valve dysfunction in the elderly relies on a combination of clinical assessment and imaging studies. Duplex ultrasonography remains the gold standard, providing real-time visualization of valve structure, venous anatomy and blood flow patterns. It allows detection of reflux, valve thickening and impaired closure, which are critical for planning appropriate interventions. Other non-invasive techniques, including photoplethysmography and venous occlusion plethysmography, can provide supplementary information regarding venous hemodynamics and calf muscle pump efficiency. Early identification of valve dysfunction is important to prevent disease progression and reduce the risk of complications.

Management strategies for age-related venous valve dysfunction aim to relieve symptoms, improve venous return and prevent progression to chronic venous insufficiency. Conservative measures form the cornerstone of treatment, including the use of graduated compression stockings, leg elevation, regular physical activity and weight management. These interventions reduce venous pressure, improve circulation and enhance the function of remaining competent valves. Pharmacologic therapies, such as venoactive drugs, may provide symptomatic relief, although they do not reverse structural damage. In selected cases, minimally invasive procedures like endovenous laser therapy or radiofrequency ablation may be indicated to treat incompetent veins and restore venous hemodynamics, particularly in patients with significant reflux or varicosities.

Correspondence to: Isabella Russo, Department of Internal Medicine and Vascular Biology, University of Milan Medical School, Milan, Italy, E-mail: isabella.russo@unimi.it

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CONCLUSION

In conclusion, aging has a profound impact on venous valve function through structural degeneration, endothelial dysfunction and chronic inflammation. These changes increase the risk of venous reflux, varicose veins and chronic venous insufficiency, which can significantly impair quality of life in older adults. Early recognition, clinical evaluation and appropriate management including lifestyle interventions, compression therapy, pharmacologic support and selective interventional procedures-are essential for mitigating the effects of aging on the venous system. A deeper understanding of age-related venous changes provides a framework for preventive strategies and personalized care, ultimately enhancing vascular health and functional independence in the aging population.