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Editorial

Vascular physiology: A bridge between health and disease

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ABSTRACT

A functional aspect of the vascular system is defined as vascular physiology, which covers mostly cardiovascular, cerebrovascular, renovascular and pulmonary vascular systems. Most of the system functions with perfect homeostasis under the coverage of haemodynamics. This haemodynamics maintains a steady relationship between intravascular pressure (P), overall vascular resistance (R) and circulatory flow (F). To explore more unknown facts of vascular physiology further research in experimental physiology with small animals by *in vivo*, vascular cell line research by *in vitro*, applications of bioinformatics tools by *in silico* and clinical studies are needed.

Keywords: Cardiovascular, Cerebrovascular, Renovascular, Vascular integrity, Vascular diseases

The vascular system is the network of the circulatory system in our body, comprised of blood vessels and lymphatics. This system involves oxygen delivery, providing nutrients to the living cell and controlling the body temperature regulatory system. Further, the vascular system also supports removing biological waste products and toxic substances from the body.

A functional aspect of the vascular system is defined as vascular physiology, which covers mostly cardiovascular, cerebrovascular, renovascular and pulmonary vascular systems. In our body, most of the system functions with perfect homeostasis under the coverage of haemodynamics. This haemodynamics maintains a steady relationship between intravascular pressure (P), overall vascular resistance (R) and circulatory flow (F). Hence, between the two circulatory points, the change in P can be determined by R and F (P=R x F). In addition to that, 'R' (resistance) depends on the 'r' (radius) of the vessels as per the inverse of Poiseuille's flow equation, $R = 8nL/\pi pr^4$, where 'r' is considered as the radius of the vessel, '*n*' is the viscosity of the fluid and 'L' is the length of the vessel.[1] Hence, little changes in vascular diameter significantly alter vascular physiology. Besides vascular diameter, referred to as 'lumen' diameter and vascular wall thickness, the muscular characteristics and neuronal functions through the autonomic nervous system also potentially impact vascular pathophysiology. Molecular constituents of vascular smooth muscle cells (SMCs) such as matrix metalloproteinases are crucial in altering vascular physiology. Altered vascular physiology mainly leads to arterial stiffness, commonly associated with ageing.[2] The changes in vascular physiology lead to vascular pathophysiology, which is principally based on haemodynamic principles. Vascular pathophysiology is mainly associated with changes in arterial integrity which may be either arterial wall thickness pathology or luminal diameter alterations with blocks, clots or foam cell formations with increased arterial resistance (R).

It has been observed that stiffening of the large arteries is linked to several vascular diseases and risk factors. These stiffening of arteries are normally found to be associated with different types of arterial diseases, and these are dependent on the variation of a diverse array of genes that regulate vascular growth, especially arterial growth and health.[3]

It should be noted that most vascular diseases are linked with polygenic factors like coronary artery disease (CAD) and have genetic and environmental factors. Vascular SMCs are the components of the formation of coronary arteries; hence, any vascular damage through either fat accumulation or inflammation develops phenotypic changes followed by atherosclerotic plaque formation.[4]

Carotid arterial diseases such as ischaemic stroke and cerebrovascular disease are other major vascular diseases linked with a genetic factor. Like CAD, cerebrovascular disease or stroke is also mainly due to polygenic factors. Although the number of genes or genes responsible for stroke is not found, a link between hypertension genetic factors and the locus for a gene for common stroke on chromosome 5q12 has been established.[5] Still, the most significant observation on the genetic cause of stroke is the phosphodiesterase 4D (PDE4D) gene.[6] PDE-4D induces breakdown of cGMP, resulting in alteration of cell signal transduction pathways to maintain normal physiological functions of vascular SMCs.[6]

Another exciting aspect of alteration of vascular physiology is in relation to low-oxygen microenvironment due to defects in oxygen sensing mechanisms at arterial chemoreceptors and resulting in arterial SMCs hyperplasia induced by either vasoconstriction in pulmonary smooth muscle cells or vasodilation in the systemic circulation.[7] Hypoxia-regulated changes in vascular SMCs and endothelial cells impact Ca^{2+} and K_{ATP} channels and alter normal arterial functions by increasing vascular contractile functions with altered circulatory haemodynamics.[8]

Indian physiologists should focus in depth to explore more unknown facts in vascular physiology research with the support of experimental electrophysiology *in vivo*, molecular biology on vascular cell line research *in vitro* and *silico* studies through bioinformatics tools and human physiology studies. A special emphasis should also be given to the physiological benefit of lifestyle maintenance through yoga and exercises!

(656 words)

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REFERENCES

1. Mayet J, Hughes A. Cardiac and vascular pathophysiology in hypertension. Heart 2003;89:1104-9.
2. Khodnapur JP, Das KK. Age-associated changes in vascular health and its relation with erythropoietin. Indian J Physiol Pharmacol 2021;65:119-26.
3. Agrotis A. The genetic basis for altered blood vessel function in disease: Large artery stiffening. Vasc Health Risk Manag 2005;1:333-44.
4. Khera AV, Kathiresan S. Genetics of coronary artery disease: Discovery, biology and clinical translation. Nat Rev Genet 2017;18:331-44.
5. Gretarsdottir S, Sveinbjornsdottir S, Jonsson HH, Jakobsson F, Einarsdottir E, Agnarsson U, *et al*. Localization of a susceptibility gene for common forms of stroke to 5q12. Am J Hum Genetics 2002;70:593-603.
6. Gretardsdottir S, Thorleifsson G, Reynisdottir S, Manolescu A, Jonsdottir S, Jonsdottir T, et al. The gene encoding phosphodiesterase 4D confers risk of ischemic stroke. Nat Genet 2003;35:131-8.
7. Wilson JL, Yu J, Taylor L, Polgar P. Hyperplastic growth of pulmonary artery smooth muscle cells from subjects with pulmonary arterial hypertension is activated through JNK and p38 MAPK. PLoS One 2015;10:e0123662.
8. Taggart MJ, Wray S. Hypoxia and smooth muscle function: Key regulatory events during metabolic stress. J Physiol 1998;509 Pt 2:315-25.

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