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Commentary

Structure and Function of Cardiac Autonomic Nervous System

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DESCRIPTION

The extrinsic (central) cardiac nervous system and the ICNS are the two types of autonomic innervation of the heart. The extrinsic portion consists of the nuclei in the brain stem and along the thoracic segments of the spinal cord, as well as their axons en route to the heart. Pre-ganglionic sympathetic axons emerge from the spinal cord, synapse with second sympathetic neurons in the sympathetic chain or intrinsic cardiac ganglia, and then innervate cardiomyocytes as post-ganglionic sympathetic axons. Pre-ganglionic parasympathetic axons of the vagus nerve arise primarily from the dorsal vagus nerve and possibly the nucleus ambiguus and synapse with second parasympathetic neurons within epicardial ganglionated neurons.

Macrophotograph of the posteroinferior surface of the Left Atrium (LA) with the Right Inferior Pulmonary Vein (RIPV) stained histochemically for acetylcholinesterase. The dotted line represents the reflection of serous pericardium into epicardium. The path of epicardial ganglionated nerves from the Middle Dorsal Ganglionated Nerve Subplexuses (MDsGP) to the root of the right inferior pulmonary vein is shown. The white frame has been enlarged to show the ganglionated nerves that give rise to the nerves that run along the walls of the right inferior pulmonary vein. The small boxed area is magnified to show ganglionic cells stained immune histochemically for tyrosine hydroxylase and acetyltransferase, which are reliable neuronal markers for adrenergic and cholinergic intrinsic cardiac neurons, respectively.

The Ventral Right Atrial Ganglionated Subplexus (VRAsGP) post-ganglionated nerves extended mostly into the ventral atrial regions, and some of these nerves may innervate the sinoatrial node as well as penetrate the lower part of the interatrial septum. The post-ganglionated nerves of the Ventral Left Atrial Ganglionated Subplexus (VLAsGP) can be seen extending to the ventral inferior left atrial region, where they join the post-ganglionated nerves of the ventral right atrial ganglionated subplexus. The majority of the post-ganglionated nerves of the Left Dorsal Ganglionated Subplexus (LDsGP) pass through the left dorsal coronary sulcus and spread onto the left ventricle's dorsal surface. Although the post-ganglionated nerves of the Middle Dorsal Ganglionated Subplexus (MDsGP) traverse the coronary sulcus and spread onto the dorsal surface of both ventricles, a portion of the nerves pass superficially to the zone of the crux cordis along the coronary sulcus and approach the post-ganglionated nerves of the dorsal right atrial sGP.

The autonomic nervous system, which provides beat-to-beat adjustments in heat rate, blood pressure, and cardiac contractility, is controlled by the brain and controls cardiac responses to physical and psychological stressors. A number of cardiovascular reflexes are involved in autonomic modulation, the most important of which is the arterial baroreflex.

The acute stress response is characterized by parasympathetic activation and parasympathetic withdrawal. Furthermore, activation of the sympathetic or parasympathetic nervous systems can affect not only heart rate and blood pressure, but also the electrophysiological properties of the myocardium and its interactions with the underlying electrophysiological substrate. Experiments show that sympathetic nervous system stimulation may be pro-arrhythmic, especially in conditions of acute myocardial ischemia, and that antagonizing sympathetic activity reduces this.

Although the terminology used by neuroanatomists and electrophysiologists differs, the path of innervation to the heart is fairly consistent. The primary distinction between the previous GP nomenclature and that of sGP is that GPs are actually subsets of larger specific sGPs. A thorough understanding of these anatomic principles of cardiac innervation may aid in the development of a framework for modern therapies that directly target the ICNS.

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