3 Neural Transmission of Acupuncture Signal

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Summary Acupuncture, one of the most prevalent methodologies of Traditional Chinese Medicine (TCM), has been used in Asian countries for curing numerous diseases for thousands of years. However, the true mechanisms underlying the effectiveness of acupuncture are still under debating. The meridian model based on TCM has been used so far, for guiding the practice of acupuncture. In this model, acupuncture is believed to treat the diseased organ of the patient by balancing the Yin and Yang conditions that are regulated by an energy substance (Qi) flowing constantly through the whole meridian, a network connecting all the organs of the body. Therefore, in the acupuncture treatment, it is crucial to select special acupoint(s) along the meridian that links the diseased organs, as well as to modulate the Qi flowing in the meridian through the induction of the needling sensation (De-Qi). On the other hand, a neurobiological model established in the recent decades, has supported the notion that an important mechanism of acupuncture in curing diseases is mediated by the nervous system. Stimulation by needles at acupoints is considered to initiate acupuncture signals through the nerve fibers (e.g., \(A_\beta\) and \(A_\delta\)) innervated at the deep tissue near the acupoints. The acupuncture signal is transmitted through the central nervous system, which activates and integrates with the neurons located in broad areas, such as those in the cortex, limbic system, brainstem, spinal cord, which in turn, regulate other systems. The nerve-mediated model provides us a better explanation regarding the biological mechanisms of acupuncture signal transmission in the body which has been broadly documented by both in vivo and in vitro studies under controlled conditions. In this chapter, we will review in particular, the research concerning the influence of acupuncture-elicited signals in the nervous system and how the neural pathways mediate the therapeutic effects of acupuncture.

Keywords acupuncture signal, afferent nerves, autonomic nervous system, central nervous system, transmission
3.1 Introduction

Acupuncture therapy has been practiced in China and other Asian countries for more than two thousand years. Modern clinical research has confirmed the impressive therapeutic effect of acupuncture on numerous human ailments, such as controlling pain, nausea, and vomiting. However, the biological mechanisms of acupuncture are still under debate. In Traditional Chinese Medicine (TCM), the mechanism of acupuncture therapy is explained by a meridian model. According to this model, acupuncture is believed to treat the diseased organs by modulating two conditions known as Yin and Yang, which represent all the opposite principles that people find in the universe, both inside and outside the human body. Yin and Yang complement each other, and are subjected to changes between each other. The balance of Yin and Yang is thought to be maintained by Qi, an energy substance flowing constantly through the meridian, a network connecting all the organs of the body. The illness, according to this theory, is the temporary dominance of one principle over the other, owing to the blockade of the Qi from flowing through the meridian under certain circumstance. The axiom of “No stagnation, No pain” in TCM summarizes this concept. Thus, the goal of acupuncture treatment is to restore the balance of Yin and Yang conditions in the diseased organ(s). This theory has been considered to be useful to guide this ancient therapy, such as carrying out diagnosis, deciding on the principle, and selecting the acupoints. However, neither Qi nor meridian can be detected under a controlled condition in the animal model or in humans, using current scientific technology. Thus, the meridian-mediated theory is still a mystery.

In the past 50 years, extensive efforts have been taken to explore the biological mechanisms and its significance in acupuncture, using modern technologies. The successful results of the tests, ranging from animal experiments to clinical analysis, clearly support the neurobiological hypothesis of acupuncture in regulating multiple systems including the hormonal and immune system. Hypothetically, the acupuncture signal is initiated at the acupoints surrounding the nerve terminals, and is transmitted to the intro- and super-spinal regions, following the afferent nerve fibers. In the central nervous system, the acupuncture signal is believed to regulate the activity of the neurons in certain brain areas (i.e., the cerebral cortex, the limbic system, the hypothalamus, the brainstem descending control system, etc.) by directly or indirectly controlling the activity of the target organs through the efferent nerve and neural-endocrine mechanism. Indeed, through controlled experiments, a chain of events triggered by the mechanical stimulation at the acupoints with needling or its electrical equivalent (electro-acupuncture) can be traced. For instance, in the human or animal model, the acupuncture-induced unit discharges of neurons could be recorded using electrophysiological methods, the level of synthesized and/or the release of a neurotransmitter or its receptor can be measured by biochemical assays, and the activity of a brain area owing to acupuncture can be monitored by noninvasive functional imaging methods, thus, investigating the association of acupoint-brain activity. The fact that acupuncture