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Editorial

The Experimentally Elusive Acupuncture Point

Acupuncture, an integral treatment modality of traditional Chinese medicine, has been used for at least 2500 years to treat disease. The therapy is based on stimulation of acupuncture points beginning with sharpened stones in very ancient times and advancing through the millennia to include a variety of techniques (e.g. needles, heat, pressure, aquapuncture, electricity, laser).[1] Clinicians trained in this modality, and who use it daily, know it works exceedingly well. Its clinical effectiveness has spurred extensive and successful research to prove its medical efficacy from a "Western" perspective; but what about the acupuncture point itself. Experimental investigation to define its features has proven more elusive. In this issue of AJTCVM, a research article describes both an investigation into the bioelectrical properties at acupoints and the bioengineering of a system capable of capturing those signals.[2] This article is a potent reminder that to understand and characterize acupuncture points presents a daunting array of hurdles. The complexity of acupuncture points extend beyond their physical locations in the body and must be understood in relation to tissue matrix, innervation patterns, intercellular signaling networks and increasingly bioelectrical considerations. Although answers have been sought through a number of biophysical, biochemical and advanced imaging studies, defining acupoint characteristics remains contested among researchers.[3,4]

So, what do we know about acupuncture points? They are specific areas located under the skin, that when stimulated, are associated with physiological effects. Histologically, acupoints are generally associated with larger accumulation of mast cells, nerve bundles/plexuses, blood vessels, and lymphatics compared to the surrounding tissue.[4-6] An exciting histologic finding, recently identified by electron microscopy and immunohistochemistry, is a unique population of elongated interstitial cells situated within interstitial connective tissue which are increased at acupoints.[7] These cells, known as telocytes, form an extensive three-dimensional network throughout the body, connecting histologically diverse tissue from skin into the visceral organs, and form direct contact with immunocytes (e.g. mast cells, macrophages, lymphocytes). Added to this, telocytes possess bioelectrical activity and can conduct electrical signaling along their long cytoplasmic extensions (telopods).[7] In the context of TCM, the discovery of these cells lends a fascinating anatomical substrate to the concept of Meridian pathways.

Anatomically, acupoints are predominately located along fascial planes between muscles, interstitial connective tissue, or between a muscle and bone or tendon.[4,5] Many points correlate with anatomic structures and up to 70% have been identified as motor entry points (i.e. where nerve branch enters muscle).[8] Their location in connective tissue networks has particularly garnered attention as these areas have the potential to integrate important functions such as cell signaling, bioelectrical, mechanical, and biochemical messaging, with rapid spread to remote sites of the body.[4] Some researchers have postulated that the Meridian Channels through which flows "Meridian *Qi*", are reflections of superconducting highways of least electrical resistance throughout the body. They are equated to fascial planes where extracellular ionic fluids can spread electric potentials rapidly over great distances without needing to overcome the resistance of cellular membranes.[4,9]

Advanced imaging has demonstrated acupoints are three dimensional configurations ranging from round/square to linear and are not static structures but can change in size, shape and even location over short periods of time.[6] One study provides a window to view functional acupoint anatomy where the acupuncture point that was imaged appeared as a multifaceted diamond that amazingly shifted shape and twisted around a needle upon insertion.[6] That dynamic imaging correlates with an anatomy study in which the authors demonstrated correspondence between connective tissue and acupuncture needling.[4] Through scanning electron microscopy, they verified connective tissue pierced by a needle created a tight mechanical coupling between tissue and needle; delivering a mechanical signal into the tissue. It was noted that initial attractive forces between needle and tissue may be influenced by needle material and size. This "needle grasp", that can be felt by the acupuncturist, is described in Chinese ancient text as "like a fish biting on a fishing line".[10] It is strongest at acupuncture sites and is intensified through needle manipulation. Simultaneously as the needle grasp is felt, a patient will describe the sensation of "*De-qi"* (arrival of *Qi*).[4] It is interesting to note that although measured needle grasp was stronger at acupuncture points, the authors also measured a weak needle grasp at non-acupoint sites. This may explain in part why even "sham" acupuncture leads to an effect compared to "no needle treatment" controls.

Recent studies also confirm that acupuncture points and their Meridians have biophysical properties which are different from those of non-acupuncture points. Characteristics confirmed in recent studies include: bioelectric potential, acoustic, thermal, optical, myoelectric activity, and magnetic properties.[3] Recent advances have drawn attention to the electrical properties of acupoints which is currently of interest to researchers as a possible means to explore the acting mechanisms of acupuncture.[2,3]

All cells generate and receive bioelectrical signals encoded in changes in transmembrane potential and ion fluxes.[11] Due to the minimal amounts of current, bioelectricity is measured as electrical potential.[12] Transmembrane voltage functions as an important system of cellular communication with bioelectrical signals encoding instructions for cell proliferation, migration and differentiation.[11] Electrical properties at acupoints are distinct from the surrounding tissue and are characterized by increased conductance, a reduced resistance and impedance (skin's opposition to the flow of current), an increased capacitance (ability to store electrical charge) and elevated electrical potential compared with non-acupuncture points.[2,9,12-14]

From a TCVM perspective, energy flow, is synonymous with *Qi* (sum of all body energy), and is important for understanding mechanism of action for acupuncture points. An interesting study by one group measured changes in bioelectric potential to predict increases in flow of *Qi*. They used the Five *Shu* Transport points on multiple Channels and demonstrated significant biopotential differences between acupuncture and non-acupuncture points, along with demonstrating the biopotential differences between the Transport points supported TCM theory (increasing *Qi* flow in order of brook, stream, river).[13]

Electrical characteristics of acupuncture points remains a daunting challenge to investigate due to the numerous complicating factors (e.g. sweat gland density, pressure exerted by the probe, inclination of the probe, electrode polarization, frequency, skin conditions such as dryness and thickness) involved in electrodermal readings.[3,12,14] Additionally, several properties of biologic systems make them notably different and more challenging to study compared to electrical currents: 1) biologic tissues use ions as charge carriers - electrical circuits use electrons, 2) biologic systems are extremely complex versus the simplicity of an electrical circuit, 3) many parameters do not maintain their values at varying intensities, and 4) living biologic organisms are open systems which cannot be easily isolated as is possible with electric circuits.[11] Bioelectricity, however, offers a novel way of quantitatively understanding in vivo processes, and reveals important control points that will enable unique applications in bioengineering.[11]

Trying to understand the complexity of an acupuncture point certainly presents a gargantuan task for researchers! This process is emblematic of basic science research where tools and techniques must be created as part of the investigative process. Future studies will need to design methods that simultaneously encompass the changing anatomy, multitarget and multipath mechanisms of action of these unique sites in the body.[3] I am reminded of the parable of 3 blind men trying to figure out what an elephant looks like. Each man, unable to see the whole, only has knowledge of the creature from the area they can feel, which is inherently limited. To understand the entire creature, the sum of all parts explored must be combined to see the whole!

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