

## Science Meets Eastern Medicine: Connective Tissue, “Qi” and Network Connectivity

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Western scientific and medical approaches so far have not been able to explain many concepts central to traditional Chinese medicine. We propose that this is largely due to Western science’s focus on parts, rather than whole systems. We further propose that the complex systems idea of network connectivity provides the necessary framework for bridging this conceptual gap. Recent scientific advances in the study of acupuncture and connective tissue [1-4] have provided tools for discussing and testing these ideas.

Chinese medicine theory postulates that a network of “meridians” exists within the body through which flows a form of energy and/or communication termed “qi”. The meridian network is thought to interconnect both physical and functional aspects of the body. Health is believed to be characterized by an optimal amount and flow of qi through the meridian network. Both excess and deficiency of qi, as well as “blockage” of qi are thought to be associated with disease. Despite the increasing use of acupuncture and Chinese medicine in the Western world, the nature of this core concept of qi remains elusive.

Recent evidence suggests that a correspondence exists between acupuncture meridians and the body-wide network formed by connective tissue [5]. The functional role of connective tissue is not fully understood. However, a diverse set of structural, chemical and electrical phenomena are potentially mediated through connective tissue. Thus the connective tissue network may support an important, yet so far poorly recognized, body-wide communication system corresponding to meridians and qi.

The study of complex systems reveals that the right degree of connectedness / relatedness is essential for effective function [6]. Too strong (too many) or too weak (too few) connections are detrimental for the functioning of the system. The specific degree of coupling between particular components that is desirable is related to the nature of the system’s function. In health, the “right” amount of interconnections within connective tissue may support connective tissue network functionality, corresponding to an optimal flow of qi. Too few or too many interconnections, on the other hand, may be associated with network dysfunction and a “connectivity” disorder. Potential correlations between connective tissue function and traditional Chinese medical diagnosis and treatment could therefore

serve as a basis for research that will clarify the conceptual basis of Chinese medicine as well as contribute to the understanding of health.

Testing the concept of connective tissue network connectivity using computational modeling requires prior quantitative understanding of connective tissue anatomy from the point of view of structural continuity, amount and density of interconnections. Ultrasound imaging and statistical methods commonly used in geostatistics (variograms) provide useful tools to obtain and analyze images of connective tissue *in vivo* [7]. We have shown in 3-d renditions of ultrasound images of subcutaneous tissue that echogenic longitudinal bands in 2d ultrasound images correspond to collagenous sheets seen with conventional histology. This method will potentially allow comparative analysis of connective tissue structure in different syndromes described in traditional Chinese medicine and thus begin to investigate the concept of connective tissue connectivity in relation to health and disease.

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