Commentary

The importance of the interstitial channel and the flow

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Several tracks have been found on the body of Gephyrocharax Melanocheir fish, revealing an interstitial fluid (ISF) flow (interstitial flow) along the interstitial channels. Similar tracks have been found also in rats and pigs recently, using sodium fluorescein injecting into the low hydraulic resistance channel along meridians. Earlier experiment was carried on human body by injecting radioactive tracer $^{99m}TcO_4$ into the acupoints. Fourteen tracks of $^{99m}TcO_4$ were observed by γ camera coincident with the acupuncture meridians in traditional Chinese medicine (TCM).

Meridians are special longitudinal lines on the human body on which acupoints are located for acupuncture. There are fourteen main meridians and hundreds of collaterals that branch from the meridians to form a net in which Qi, a type of vital substance, runs in the net. Based on the TCM theory and our findings, I elucidate that Qi is free ISF, and the meridians would be the interstitial channels for ISF flow. The hydraulic resistance of the channel is lower and was named low hydraulic resistance channel (LHRC) which has been measured by a biophysical method before. Meridians in TCM play important roles in health and the formation of a disease when it has a problem, which could be acted by the physiology of interstitial channel and flow of ISF. What is the importance of the interstitial channel and the flow?

1. Body fluid flow out of capillary and continue flow in the interstitium. 80% of them flow back to blood vessel while others drain back through lymph system. But how ISF enter into the lymph vessel? As initial lymph has the similar pressure with ISF, the fluid should accumulate to a higher pressure and open the violet on lymph vessel to come in. So more fluid should be gathered on somewhere of the tissue where lymph vessel existed. Such structure was just what we found which is important to keep the circulation of the body fluid.
2. In multicellular organism, nutrients should be transported from digested organ to each cell. Blood system is usually thought to be responsible for the function while the living creatures without blood system or not well-developed transport nutrients through interstitial flow which is called lymph flow somewhere. The interstitial flow is the residue of lymph flow in early evolution and still work after cardiovascular system is well developed just as the traffic in a city where the normal roads are still busy even if the highway is well developed.
3. By classic anatomy, fascia tissue plays a role of providing mechanic force and separating tissues. With our new findings, it is also a channel for interstitial flow. The new system consists of large main channels and small collaterals which consist of a huge water network to irrigate tissues everywhere. All disciplines about biology and medicine should consider the influence coming from the new system. Cellular microenvironment is important for the living and being functional of the cells. The environment is actually composed of interstitium including ISF which can regulate the environment by its flowing and then influence the cells. All the traditional therapies acupuncture, moxibustion, cupping etc. exhibit their effects through the mechanism.
4. The flux of the interstitial flow is the key index for its regulating effect which is determined by

the hydraulic resistance and pressure gradient. The resistance is controlled by the geometry of the interstice and the content of the interstitium and the pressure gradient could be caused by the volume of filter out of blood from capillary and the pressing force on the tissue. Acupuncture stimulate nerve and active muscles by neural reflection which change the interstitium. Moxibustion expand blood vessel and increase the flux of ISF from capillary. Massage and cupping produce positive or a periodic force on tissues, making pressure gradient to drive ISF flow.

5. Interstitial flow can not only carry nutrients and wastes but biological information coding by proteins as well. The long-distance transport of the information may have the function of keeping balance between the organs and even control the development during embryonic development. Swartz's group in Switzerland found interstitial flow as a guide for lymphangiogenesis and can induce myofibroblast differentiation and collage alignment. More experiments should be carried out to prove the functions, particularly the regulation of remote tissues or organs.
6. There are meridian syndromes described in TCM. After blocking the interstitial flow along the meridians in mini-pigs and rats, a series of symptoms had been observed corresponding the classic theory. For example, blocking a meridian by injecting hydrogel into the channel induce hyperalgesia which may be caused by the accumulation of metabolite containing many H^+ chemicals which then induces a depolarization of nerve terminals
7. Health is the aim of human being. There are many techniques in ancient China called Qigong and in India called Yoga relating to the opening the channels and draining the interstitial flow. Muscular tension is usually the reason to close the interstitial channel and stop the flow as the interstitial channel located between muscles. Qigong and Yoga can relax the muscles by mental silence and the regulation of body shape. Chinese physical art like Taijiquan perform a slow and smooth movement of body which can push ISF flowing in the channels.

Along with the discovery of the interstitial channel and the flow, many phenomena happened in TCM and physical exercises in the East can be understood. An era of revolution in medical theory and application is coming.