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• Commentary

The indeterminable resilience of the fascial system

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ABSTRACT

The most recent information on fascial tissue indicates that there are not fascial layers, but polyhedral microvacuoles of connective tissue, which connect the body systems and, by hosting specialized cells, permit several functions, such as motor, nervous, vascular and visceral. These microvacuoles (a repetition of polyhedral units of connective fibrils) under internal or external tension change shape and can manage the movement variations, regulating different body functions and ensuring the maintenance of efficiency of the body systems. Their plasticity is based on perfect functional chaos: it is not possible to determine the motion vectors of the different fibrils, which differ in behavior and orientation; this strategy confers to the fascial continuum the maximum level of adaptability in response to the changing internal and external conditions of the cell. The present commentary deals with this concept, providing clinical examples of different disease patterns, providing contrary examples in which this adaptability does not occur, and lastly suggesting considerations for the approach to manipulative therapy of the fascial tissue. The fascial continuum is like a flock of birds flying together without a predetermined logic and maintaining their individuality at the same time.

Keywords: fascia; osteopathic; manual therapy; fibroblast; fascial continuum

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1 Introduction

From a macro-anatomic perspective, the fascial tissue is equally distributed throughout the entire body, creating various layers at different depths and forming a three-dimensional metabolic and mechanical matrix.[1,2]

Usually, we can distinguish four fascial planes: the superficial fascia, the axial/appendicular fascia, the meningeal fascia and the visceral fascia. The superficial or pannicular fascia is absent in the orifices such as the eye sockets, nasal and oral passages and aboral apertures; it is composed of irregularly organized connective tissue, with

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varying thickness depending on location in the body and presence of fat.[3] The axial fascia, investing fascia or deep fascia is peripherally fused with the previous layer, and extends in depth through the body, surrounding the contractile areas, the vessels and the nerves. This classification includes the epimysium, the periosteum, the tissue that covers the tendons and ligaments, as well as joint capsules.[3] The axial layer is formed by packets of irregularly organized collagen fibrils, and runs along the front and back of the spine, like two parallel rails.[3] Each muscle related to the spinal column and the upper and lower limbs is covered by the pannicular fascia, whilst below there is axial fascia.[3] The meningeal fascia surrounds the central nervous system, ending with the epineurium, which covers the peripheral nerves.[3,4] The visceral fascia extends from the cranial base to the pelvic cavity, covering all the organs and guiding the neurovascular and lymphatic packets towards the organs; the density of this fascia varies depending on its location in the body.[3]

From a microsurgical point of view, by using *in vivo* endoscopic images representing magnifications of anatomical areas, the fascial system can be understood not as an ensemble of layers, but as many inseparable connective units, or a fascial continuum, not permitting the identification of different layers.[5] In studying the organization of connective from the skin to the bone, we can see that the collagen fibrils form a network without separate layers; the same structures can be found from the top to the bottom of the fascia, and the so-called layers are distinguishable only by the density of their fibrils.[5] The same connective structures compose blood and lymphatic vessels, bones, muscles and tendons, as well as nerves. It is the organization of the network of structures that determine the function.[5] The connective fibrils form a repetition of polyhedral units called microvacuoles; these volumes are created between the fibrillar intersections, and are always different in their shapes.[5] The microvacuoles may contain cells (fibroblasts largely constitute the microvacuoles), creating the structure (viscera, muscles, nerves and vessels), thus determining functions; this organization can be observed in the whole body, from the epidermis to the cell nuclei.[5]

The microvacuoles have a diameter ranging from a few microns up to 200 nm, with their size probably depending on the cells that they incorporate and/or on the body area where they are found.[5] The fibrils vary in size between 5 nm and 70 nm in diameter, reaching a length of 10–100 nm.[5] These fibrils are comprised of about 70% collagen types I, III and IV, and about 20% elastin, with around 4% lipids.[5] The microvacuoles are rich in water, due to the hydrophilic properties of the lipids and in particular of proteoglycans (approximately 72%).[5] The core of these molecules is a protein with one or more covalent bonds with polysaccharides (glycosaminoglycans, GAG); the negative charge of GAGs attracts water molecules, facilitating their passage through the membrane of the microvacuoles, and ensuring hydration.[5] This hydration maintains constant pressure within the volumes, allowing them to adapt to the changing internal and external pressures of cells and systems, such as movement or spontaneous variations in blood pressure.[5]

The fibroblasts are the foundation of the fascial continuum.[2] The fibroblasts adapt according to the metabolic and mechanical stimuli present; they allow real-time communication among distant areas of the whole body.[2] Thanks to the fibroblasts, connective fibrils communicate from a mechanical and metabolic point of view.[2] Between two fibroblasts there are gap junctions, made up of two cells known as connexons, which create continuity. They consist of six identical (homomeric) or different (heteromeric) proteins, called connexins.[2] These junctional structures facilitate the conveyance of mechanical information, as well as of small molecules and electrical activity. Communication is possible with distant cells, but not necessarily with those close to one another. Recent research has revealed the existence of nanotube tunnels that differ from the connexons because they allow the continuation of the membrane even when it is far from the original cell or has an irregular direction, and can reach many centimeters in length.[2] These nanotubes are characterized by a contractile structure composed of F-actin and VA myosin. This characteristic is thought to facilitate a rapid transmission of metabolic and electrical information, as the communication between cells takes place just in a few minutes; these connections do not appear to be permanent, but transient.[2]

Other cellular structures recently discovered in the fascial continuum, in particular in the fascia lata of the lower limb, are telocytes. These can be found side by side with fibroblasts and are also able to communicate with distant cell bodies through their prolongations (telopodes), probably, to allow better propagation of the metabolic information.[6]

The fascial continuum can be plausibly considered to be a memory organ, because it not only registers the functions of the structures it surrounds and connects, but also memorizes any function or information arriving and departing from the same structures. The connective tissues remember the morphological variations they have undergone, and this probably influences the behavior expressed by the tissues.[2] Spider web is very reminiscent of the perfect and chaotic organization of the fascial system that can catch the water (Figure 1).