Collagen and cytoskeleton

Collagen modulates cell shape and cytoskeleton of embryonic corneal and fibroma fibroblasts: Distribution of actin, α-actinin, and myosin

http://www.sciencedirect.com/science/article/pii/0012160682901555

Possible Involvement of Cytoskeleton in Collagen-stimulated Activation of Phospholipases in Human Platelets*

http://www.jbc.org/content/264/10/5400.full.pdf

Involvement of the cytoskeleton in regulation of collagen synthesis and secretion.

http://www.ncbi.nlm.nih.gov/pubmed/11322343

Eukaryotic cells contain three major types of cytoskeletal filaments

Fascia and cytoskeleton

The Fascia Research Congress from the 100 year perspective of Andrew Taylor Still
Thomas W Findley MD PhD
Mona Shalwala MS-IV

Fascia assists gliding and fluid flow and is highly innervated. Fascia is intimately involved with respiration and with nourishment of all cells of the body,

All living cells also express some inherent contractility by generating tension within their internal cytoskeleton. (Chen & Ingber, 1999) Fascia plays a dynamic role in transmitting mechanical tension

Fascia is also capable of transmitting electrical signals throughout the body. One of the main components of fascia is collagen. Collagen has been shown to have semiconductive, piezoelectric and photoconductive properties in vitro. Electronic currents can flow over much greater distances than ionically derived potentials. These electronic currents within connective tissue can be altered by external influences, and cause a physiologic response in neighboring structures. (Langevin, 2006) However, exploration of the change in bone structures in response to stress (wolffs law) suggests that fluid flow within tissue is more important than piezoelectric effects

Fascia "…is almost a network of nerves, cells and tubes, running to and from it; it is crossed and filled with, no doubt, millions of nerve centers and fibers.."

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Massage Today

June, 2009, Vol. 09, Issue 06

Research in Water and Fascia

Micro-tornadoes, hydrogenated diamonds & nanocrystals

By Leon Chaitow, ND, DO

Several years ago, I wrote a series of articles for Massage Today on the topic of the then-recent and exciting research into fascia.1 As the Second International Fascia Research Congress approaches (Oct. 27 - Oct. 30, 2009) at the Vrije Universiteit or "Free University" of Amsterdam (http://www.fasciacongress.org/2009), it seems appropriate to return to some of the fascinating advances touched on in my earlier articles along with a few new exciting pieces of research - all of which reflect directly on the work of manual therapists.

Some of the key fascia-related topics covered in those earlier articles were:

The presence of contractile smooth muscle cells (SMCs/myofibroblasts) that are embedded in most connective tissues. For example, SMCs have been located widely in connective tissues including cartilage, ligaments, spinal discs and lumbodorsal fascia.2,3

The extracellular matrix (ECM) plays a key role in the transmission of forces generated by the organism (e.g. muscle contraction) or externally applied (e.g. gravity, or by means of manually applied therapy).

Cell-matrix adhesion sites appear to host a "mechanosensory switch" as they transmit forces from the ECM to the cytoskeleton, and vice versa, triggering internal signals following mechanical stimulation, such as occurs in manual therapy.4

There appear to be forms of communication within the fascial matrix, for example caused by tugging in the mucopolysaccharides, created by twisting acupuncture needles.5

In a 2005 study, German researchers, Schleip, et al,6 noted their discoveries on fascia: "The ability of fascia to contract is further demonstrated by the widespread existence of pathological fascial contractures. Probably, the most well-known example is Dupuytren disease (palmar fibromatosis), which is known to be mediated by the proliferation and contractile activity of myofibroblasts. Lesser known is the existence of similar contractures in other fascial tissues which are also driven by contractile myofibroblasts, e.g. plantar fibromatosis, Peyronies disease (induratio penis plastica), club foot, or - much more commonly - in the frozen shoulder with its documented connective tissue contractures. Given the widespread existence of such strong pathological chronic contractures, it seems likely that minor degrees of fascial contractures might exist among normal, healthy people and have some influence on biomechanical behavior."

Anyone using myofascial release approaches, or acupuncture, should be able to appreciate the potential therapeutic implications of these discoveries.

Amazing Crystalline Properties

And recently, even more evidence has emerged of the mysteries of fascia. For example, the behavior of water that interacts with protein in the human body is becoming clearer. In an article "Water is 'Designer Fluid' that Helps Proteins Change Shape, Scientists Say," Dr. Martin Gruebele, University of Illinois, explains: "Water in our bodies has different physical properties from ordinary bulk water, because of the presence of proteins and other biomolecules. Proteins change the properties of water to perform particular tasks in different parts of our cells. Water can be viewed as a 'designer fluid' in living cells." To read the full article go to: http://news.biocompare.com/newsstory.asp?id=239323.

Other research shows that interfascial water plays a key part in what is termed "protein folding," the process necessary for cells to form their characteristic shapes - and that nanocrystals are a part of this process - and that these are influenced by light. According to Sommer, et al7: "In the course of a systematic exploration of interfacial water layers on solids we discovered microtornadoes, found a complementary explanation to the surface conductivity on hydrogenated diamond, and arrived at a practical method to repair elastin degeneration, using light."

The leading researcher in this field, Dr. Gerald Pollack, University of Washington professor of bioengineering, has shown that water can at times demonstrate a tendency to behave in a crystalline manner. He has discussed interfacial water in living cells known as vicinal water. Interfacial water exhibits structural organizations that differ from what is termed "bulk" water. This "vicinal" water seems to be influenced by structural properties that make up the cell. An example of this, and in relation to the water in a temperomandibular joint, Pollack states8: "The combined data from three different methods lead to the conclusion that all or almost all of the water in the intact disc is bound water and does not have properties consistent with free or bulk water."

For fascinating insight into water research, download the free video of Dr. Pollack's recent address at the University of Washington: http://www.uwtv.org/programs/displayevent.aspx?rID=22222.

Fascia, Water and Manual Therapy

Several years ago, Klingler, et al9 showed that the water content of fascia partially determines its stiffness, and that stretching, or compression, of fascia (as occurs during almost all manual therapies), causes water to be extruded (like a sponge) - making the tissues more pliable and supple. After a while, the water is taken up again and stiffness returns, but in the meantime structures have been mobilised and stretched more effectively and comfortably, than if they were still densely packed with water.

Klingler, et al measured wet and dry fresh human fascia, and found that during an isometric stretch, water is extruded, refilling during a subsequent rest period. As water extrudes during stretching, temporary relaxation occurs in the longitudinal arrangement of the collagen fibers. If the strain is moderate, and there are no micro-injuries, water soaks back into the tissue until it swells, becoming stiffer than before.

All this suggests that much manual therapy and the tissue responses experienced, may relate to sponge-like squeezing and refilling effects in the semi-liquid ground substance, with its water-binding glycosaminoglycans and proteoglycans. Muscle energy technique, like contractions and stretches, almost certainly have similar effects on the water content of connective tissue, as do myofascial release methods, and the multiple force-loading elements of massage.

The speed with which research is uncovering the secrets of fascia is mind-boggling, and I hope to see you in Amsterdam to discover even more!

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Mechanotransduction The living cell is a mechanical structure with a force balance between compression bearing microtubules and tension bearing bundles of actomyosin filaments. The cells are anchored to the extracellular matrix by clusters of integrin receptors which connect extracellular proteins to intracellular actin associated molecules. These receptors also serve to sense physical forces outside the cell and transmit that information through mechanical connections throughout the cell to the nucleus as well as multiple locations in the cell. This cytoskeleton provides both mechanical structure and direction to biochemical reactions within the cell. The cell can thus convert external mechanical signals into internal biochemical reactions.

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Can the Body Use Fascia as a Method of Communication?

By Warren Hammer, MS, DC, DABCO

Typically, we think of communication in the mammalian system as occurring by way of the nervous system. Oschman1 quotes Sherrington's2 statement about the single-celled paramecium that swims around gracefully, avoids predators, finds food, mates and has sex all without a single synapse: "Of nerve there is no trace. But the cell framework, the cytoskeleton might serve."

Oschman1 mentions that while we have been constantly studying the nervous system of the brain, communication occurs by way of connective tissue glial cells and neuronal processes. Research is revealing the relationship between the connective tissue and the nervous system.

Pischinger,3 who writes about the extracelluar matrix, states that the fascial system is the largest system in the body and is the only system that touches every other system. The fascia may be viewed as a single organ, a unified whole, the environment in which all body systems function.1,4 Guimberteau5 writes that the exchange of substances across the intercellular ground substance connects the fascia to cellular nutrition and metabolism.

Langevin6 hypothesizes that the connective tissue forms an anatomical network throughout the body and functions as a body-wide mechanosensitive signaling network. The signals work by way of electrical, cellular and tissue remodeling. Signaling also occurs through changes in movement and posture, and signaling would be altered in pathological conditions such as local decreased mobility due to injury or pain.

Langevin also mentions the connective tissue relation to internal tissues such as lungs and intestines, thereby influencing organ systems. She states that to prove this hypothesis, it must be shown how a specific stimulus is created by alteration of the connective tissue and that the signal would propagate over some distance through the tissue. It must be shown that electrical signals can be generated by mechanical forces.

It has already been shown that some proteins including collagen can display semi-conductive, piezoelectric and photoconductive properties in vitro. Oschman1 states that every movement made by the body generates electric fields due to the compression or stretching of bones, tendons, muscles, etc., and that these electric fields spread through the surrounding tissues, providing signals that inform the cells of the nature of the movement, loads, or other activities occurring elsewhere in the body.

Regarding a cellular influence, Langevin6 mentions how the mechanical activation of fibroblasts responds (spreading, lamellipodia formation) within minutes of tissue lengthening resulting in possible cell-to-cell signaling. In another study by Langevin,7 soft-tissue fibroblasts were shown to form an extensively interconnected cellular network, suggesting they may have important and so-far-unsuspected integrative functions at the level of the whole body.

Finally Langevin's6 third idea of signaling might come from remodeling of tissue (mechanical load) causing changes in collagen fiber density and orientation, with resultant changes in tissue viscoelastic properties (changes in tissue stiffness).

Maquart, et al.,8 state that in addition to the soluble factors such as hormones, cytokines or growth factors, cells also receive signals from the surrounding extracellular matrix (ECM) macromolecules. "The activity of connective tissue cells is modulated by a number of factors present in their environment (soft-tissue methods?). Moreover, they may degrade the ECM proteins and liberate peptides, which may by themselves constitute new signals for the surrounding cells. Therefore, an actual regulation loop exists in connective tissue, constituted by peptides generated by ECM degradation and connective tissue cells."

The increasing new information about the effects of mechanical load on our patients, which includes all of the many soft-tissue techniques we use daily in our practices, is slowly explaining why we achieve such great results every day.

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