Questioning our Assumptions about Fascia:

Science from the Second International Fascia Research Congress – *and how it applies to SI*

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As directors of the Ida P. Rolf Research Foundation, we are deeply committed to advancing research that helps us understand Structural Integration. One of our favorite projects is the International Fascia Research Congress, which brings together cutting-edge fascia scientists and practitioners to collaborate and inform future research and clinical practices. For this article, we reviewed all the science presented at the most recent 2009 Congress in Amsterdam—all four days worth of presentations—to bring you the latest theories and concepts that should be influencing your work with clients.

Hard science about fascia is still in its infancy. Until recently, connective tissues have been long-ignored by the medical and research communities, who opted to study the sexier skeletal, muscle, and organ systems. Perhaps one of the reasons for this is that these systems seemed easier to parse and compartmentalize. We're used to thinking about a femur or a stomach and the qualities related to these structures.

Connective tissue doesn't lend itself to reductionism. Although it's true that anatomists have named fascial structures where the matrix becomes particularly thick, as in tendons or ligaments (which don't exist, by the way, but we'll get to that), these tissues are continuous with different fascia types, which all meld into each other.

And here is the rub: connective tissue's incompatibility with anatomical separation seems to be at the heart of its incredible ability to simultaneously provide support, containment, and freedom of movement. Perhaps more than any other system in the body, the fascial matrix must be addressed as a complex whole.

Ligaments Don't Exist

In Jaap van der Wal's discussion of connective tissue anatomy, he highlighted misconceptions that have proliferated in the literature. Yup, the anatomy texts are fiction; true ligaments are almost nonexistent; in most cases, ligaments are "made" with dissection. Additionally, tendons don't insert into bone; there are no discrete tendon attachments as pictured in anatomical drawings. Rather, tendons insert into a connective tissue apparatus, which transmits force across joints. And what about the nerves and proprioception? We must be able to distinguish between muscle and joint receptors, right? No, sorry, receptor sites continue across both tissues; essentially they're all just mechanoreceptors (van der Wal, 2009).

This research supports SI's approach to the body—working with connective tissues as a system that crosses all boundaries. Furthermore, connective tissue simultaneously performs the seemingly opposing functions of separation and connection. This system both creates an envelope, which permits glide between structures, and binds joints together, controlling tension in three dimensions, transmitting force across joints, and making proprioception possible.

Considerations for SI:

Manual therapy may be able to significantly affect proprioception and locomotion via: 1) creating better glide between the enveloping septa; 2) addressing mechanoreceptors (golgi tendon organs) at the transition of muscle tissue to the septa; and 3) working with muscle and connective tissue as functional units.

Several times during the congress, researchers described their efforts to study the "fascial architecture," which seems a fitting nomenclature for the way SI practitioners think about the body. Whether we view the body as a stack of blocks or as a tensegrity structure, our thoughts are never far from the architectural concerns of: stability and support; force transmission; the relationship between form and function; and of course, comfort and ease of use. Researchers are uncovering how the architecture of the fascia contributes to these qualities in our bodies. We'll look at each.

Stability and Support

Although we tend to consider tension as something we need to get rid of, it usually has a productive side (without stress, this article wouldn't exist). Research (Hodges, 2009) shows that fascial tension plays an important part in low back stability. Fascia needs to bear load, and the carrying of load needs to vary between muscles and back fascia for healthy function of the low back. Hodges asserts that therapists have to retrain muscles as well as fascia, directly, as well as through strengthening of certain muscles such as transversus abdominis.

When researchers disrupted crural fascia, they observed a reduction in the acceleration/deceleration and velocity of distal joints, as well as the progressive loss of medio-lateral stability (Nichols, 2009). They concluded that crural fascia makes a strong link between muscles of the thigh and the calcaneus, contributing to propulsion, stability, and motor coordination. Again, connective tissue lends two disparate qualities to the body—the crural fascia enhances propulsion by increasing retraction and ankle plantarflexion, while also limiting movement of the lower limb, providing stability.

Considerations for SI:

This discussion brings to mind a couple of points: First of all, it reminds us that tension is as important as openness and there are cases where even unbalanced tension may be the best structural compensation for a body. Especially when working with low back instability, release tissues around the low back gradually while providing movement education, over many sessions, to see if a client is able to integrate the work. Releasing too much of this area too quickly can destabilize a low back that may be compensating at a relatively high level, considering other factors. This is especially the case with spondylolisthesis and some disk issues.

Secondly, as movement educators, are we doing enough to retrain muscles and connective tissues as a functional unit? Hodges argues that retraining muscles that are weakened or atrophied as a result of maladaptive behavior may facilitate earlier recovery in patients with low back pain. If you're interested in further reading, consider works by Structural Integration practitioners Kevin Frank, Mary Bond, and Ann and Christopher Frederick, among others. This also raises the question that in addition to movement training, which works with coordination and perception to affect movement patterns, should Structural Integration also include some elements of strength training?

Richard Nichols, PhD presented "Systems for Force Distribution in Motor Coordination: Fascia and force feedback." Fascia contributes to propulsion, stability, and motor coordination with a balance between golgi tendon organ feedback and fascia feedback. During locomotion—with forces moving from proximal to distal—movement in the upright posture is key. Alterations in fascial integrity may lead to decreased stability and difficulty with ambulation and balance (due to decreased restraint of lower extremity structures). This, of course, is what Dr. Rolf said all along.

Force Transmission

Fascia's role in stability is echoed in research that studies how forces are transmitted through the structure. Researchers observed that in most muscles, single muscle fibers do not span the entire length between tendons (Purslow, 2009). So how are forces transmitted through these structures? Connective tissue (the endomysium) keeps fibers tightly in register within the fascicle, which makes it possible to transmit forces between muscle fibers by shear forces. Although it may seem obvious to an SI practitioner that fascia organizes and connects muscle fibers, this has not been (and still isn't) common knowledge among most research and clinical professions.

It's nice to have confirmation for our approach. But this investigation also found something you probably didn't suspect—fascial organization extended from the surface of muscle to the interior of the muscle cell. And Dr. Ingber at the 2007 congress showed quite elegantly how those connections within the cell extend to the nucleus, with tension of the intracellular fibers directly affecting gene transcription (Ingber, 2007). The fascial matrix reaches even farther than we thought.

Classically, the myotendinous junction was considered the exclusive channel for force transmission. However, scientists have found that the connections between muscle fibers and the extracellular matrix along the full periphery of muscle fibers are capable of transmitting muscle force (Yucesoy, 2009). This epimuscular myofascial force transmission has major effects on muscular mechanics, including: 1) forces exerted at origin and insertion of a muscle are almost always unequal; 2) muscle length-force characteristics are not unique properties of individual muscles; and 3) sarcomeres, the contractile units in muscle fibers, vary in length and respond differently to loads.

Interestingly, some sarcomeres are shortening while others are lengthening. It's the summation of all the individual sarcomere activity that determines whether a muscle contracts or lengthens. If you want to change muscle, you need to understand and change the sarcomeres. This research shows that sarcomeres are not uniform in the muscle—distal and proximal sarcomeres respond differently to loads. The direction in which you apply forces makes a big difference in how the muscle responds at the sarcomere level. Mathematical modeling suggests that parallel or cross fiber work has markedly different effects on the sarcomere structure within the muscle—which also varies, depending on whether the sarcomere is located proximally, in the middle portion, or distally in the muscle. The state of the muscles surrounding the target tissue is also an important factor.

Considerations for SI:

So, when we work with our clients, we need to be conscious not only of the immediate tissue we are contacting, but also of the immediate surrounding tissue. Both in client positioning and movement work, we may find it helpful to elicit movement not in the target tissue but in the tissue just adjacent to it. Working at this sarcomere level means you're trying to change the way the muscle works. Modeling of myofascial forces can result in targeted therapy (a bigger bang for the buck), requiring less force to create change and reducing stress on both the client and the practitioner.

The Relationship between Form and Function

A study looking at the effects of stretch on areolar, or "loose," connective tissue (Langevin, 2009), found there was significant remodeling of the fibroblast cells, which make up fascia, in response to only twenty minutes of tension. Structural alteration of fibroblasts in connective tissue in response to stretch may be an important and overlooked parameter when considering various pathologies. This may be especially important when there is a chronic condition that induces tension in the loose connective tissue (scars, fibrosis, inflammation, etc.).

In a study looking at the role of fascia in cancer surgery recovery (Fourie, 2009), the repair process was modulated by elongating tissues for ten minutes, twice a day, after injury. This resulted in a reduced amount of new collagen (less scaring and adhesions) seven days post-injury. Because fascia plays a significant role in proprioception and the quality of movement, this has important implications for rehabilitation.

Although fascia can create tensions in tissue causing dysfunctional movement, fascia by design contributes to fluidity of movement. A study of calf muscles found that as muscle contracts, its tendons actually lengthen a bit, storing energy that is released when the muscle relaxes, making gait more efficient (Kawakami, 2009). Does this happen elsewhere? Probably. If so, the interplay between fascia and muscle is important in energy transfer between tissues. Fascia softens the beginning and the end of the muscle movement. It also stores kinetic energy of movement, much as a hybrid car uses regenerative braking to store energy in its batteries.

Considerations for SI:

Form affects function—working directly with scar tissue and fibrosis may allow practitioners to address inflammation and pain in surrounding areas. In addition to manual manipulation, prolonged stretch has been shown to remodel fibroblasts. Could stretching be a relevant area to bring to our trainings? Is there a Structural Integration yoga on the horizon?

What about ten-minute SI sessions? There may be a place for shorter, more frequent SI sessions as part of post-op rehabilitation. Until then, consider teaching clients techniques they or family members can do that put a gentle static stretch into tissue that's recovering from injury.

Fluid movement results from the coordination of muscles and fascia. This work highlights the necessity to address muscles and surrounding fascial structures as a unit that is influenced by mutual interaction of its components. Therefore, muscle rehabilitation needs to consider fascia, and on the other hand, fascial complaints have to be addressed in the context of muscles and surrounding structures.

Comfort and Ease of Use

As mentioned earlier, tendons don't attach into bone. In fact, 15-80% of connective tissue fibers extend past the designated tendon insertion (Stecco, 2009). Researchers identified three layers of crural fascial. Collagen fibers within each layer were parallel, while fibers of different layers formed 78-degree angles with other layers (this pattern was also found in thoracolumbar fascia). This angle identified in humans is identical to the angle found in bovine neck muscle (Purslow, 2009). Due to the different orientations of the collagen fibers within these layers, the fascia has strong resistance to traction, even when exercised in different directions. Intra-fascial nerves were often oriented perpendicularly to collagen fibers, suggesting that fascial stretch may stimulate nerves and contribute to certain pain conditions.

Fascia's role in pain is a very promising area in working with low back pain. The superficial layers of the thoracolumbar fascia are highly innervated. A study (Tesarz, 2009) found over 90% of nociceptive fibers in the superficial fascia and subcutaneous layer, few fibers in the inner layer, and none in the middle layer. Nociceptors (pain sensors) are also likely to be found in these tissues.

Considerations for SI:

Again, Structural Integration requires us to be able to switch our focus between seemingly opposing views. Dr. Rolf cautioned against dealing with pain specifically and counseled a larger, more holistic approach to working with the body. Although research is supporting her teachings to address the body as a system, we must also be able to consider how our touch may be able to break chronic pain cycles, allowing the client options in movement and perception. If the majority of pain fibers are found in the superficial layers of the thoracolumbar fascia, this may mean revisiting this layer throughout a series of work for clients suffering with low back pain. Again, Dr. Rolf probably had the right idea ending sessions with a sacral lift and back work. Just remember that unsupported back work may not be a good idea for unstable low backs. Consider movement training that engages the transversus abdominus, as well as back work supported by a ball or in a side-lying position to access the thoracolumbar fascia.

Additionally, working with nerves is a fairly new area for Structural Integrators but most find it lends itself pretty seamlessly to our work. Like other structures, nerves are ensheathed in fascia to allow for glide during movement. Like other structures, nerves can be impeded by adhesions (tethered) causing pain and dysfunction.

Conclusion

Myofascial therapists know we can create change—we see it everyday when clients experience increased range of motion, reduced pain, and/or smoother, more coordinated movement. But until recently, we didn't have a lot of places to look to understand the mechanisms for these changes. Fascia has been ignored for a long time, so there's a lot of catching up to do in the research lab. But the latest findings strongly suggest that myofascial therapy is effective because it:

- Improves the glide between the enveloping septa;
- Affects mechanoreceptors; and
- Works with the body as a system, addressing structures as functional units.

Fascia brings together seemingly diametric functions of separation and connection, support and transmission, limiting movement as well as making it more fluid. Working with these tissues demands that we exhibit a similar sophistication. We must be able to sense with our hands and bodies on both a micro- and macro-level. We must be able to identify and address adhesions, scar tissue, and fibroses, which can create tensions through surrounding tissues, leading to dysfunction. But at the same time, it is essential that we track how force transmits through larger areas and, ultimately, the entire system.

Empirical studies are confirming what we suspected—bodywork remains an art, as well as a science. In a study involving tendon transfer surgery for patients with cerebral palsy, researchers found the locations of fascia connections varied significantly among subjects (Kreulen, 2009). Every person who walks in your office is as different as his or her fingerprint. Anatomy books, your teachers, and even your own experience can only give you a general sense of where you need to work. Research can inform you of new things to try and new patterns to notice, but the most important skill you have is your touch and your openness to sensing what's there. Only the sensitivity of our hands will tell us what to do and what to do next.

Luckily, the fascias, once considered inert, replaceable packing material, are turning out to be one pretty smart interconnected cookie. Acupuncture research by Helene Langevin, MD showed that although inserting needles created measureable changes in the fascia, the change was not appreciably different if the needles were placed in traditional points or nearby (Langevin, 2006), introducing the question: "Is the connective tissue a body-wide signaling network?" If so, are we just facilitating healing that the body is trying to do anyway? Or are we able to guide or re-direct this process, or do something entirely different? Any of these sounds feasible to us, but we have been wrong before. It remains to the scientists to tease out these mechanisms—we notice it, the scientists establish what we know. Since fascia connections extend to the nucleus and influence gene transcriptions, what else is possible?

We don't know, but we hope you'll join us at the next Fascia Research Congress to find out.

The Third International Fascia Research Congress, entitled "What Do We Notice, What Do We Know?" continues the goal of bringing clinicians and scientists together for a dynamic exchange of ideas. Scheduled for March 28-30, 2012 in Vancouver, BC. Pre- and post-congress workshops and program details are at www.fasciacongress.org/2012.

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What the Therapist Should Know About Observing

Thomas W. Findley presented his research using mathematical modeling of fascial deformation to evaluate the feasibility of altering different fascia types with manual therapy techniques. Based on his three-dimensional model, he concluded that fascial manipulation may be appropriate in medium- or low-density fascia (for superficial nasal fascia, the amount of force supplied by therapist is well within the range to produce deformation), and less effective in dense tissues such as fascia lata or plantar fascia (forces needed to produce deformation were calculated to be too great to result from manipulation). Overall, the mathematical calculations and graphical representation of tissue response correlated well with reports from manual therapists of the feeling of tissue changing after application of force (Findley, 2009). He then went on to ask: "When a clinician notices positive changes in a client, what is really happening?"

Several choices come to mind:

- Nothing happened. Clinician fools him/herself and client eventually leaves unhappy.
- Nothing happened. Clinician and client fool themselves and continue ineffective treatment.
- No direct therapeutic response; general healing (placebo) response triggered.
- Direct response occurs, but not what the clinician thinks happened.
- Direct response occurs, but not to the fullest extent possible.
- Direct response occurs, exactly as noticed.

Separating these possible causes requires special training in clinical research, but all practitioners should understand that some mixture of all six will usually exist.

Influencing the body's natural healing response

Any practitioner (medical or SI practitioner) does not provide the full treatment benefit to their clients unless they trigger the natural healing response (simplistically labeled by some as the *placebo response*). The power of the natural healing response has been well studied and can be amplified by the following factors:

- Practitioner believes in the treatment
- Client believes in the treatment
- The treatment is technically complex
- The treatment has some direct physiological effects

Dr. Findley explains, "As an experienced practitioner, I usually know what type of work I'm going to do just from watching the client walk into my treatment room. The classical stand and walk is rarely necessary. However, when I started to work immediately, one patient asked, "Aren't you going to do your standing analysis?" Since then, I have always included a brief standing postural analysis. I believe I get better results when the client feels looked at, noticed, and examined in a formal sense."

"So practitioners are encouraged to record their observations," he adds. "It's important that we track *What We Notice* and bring these ideas to the next fascia congress for interaction with scientists and other practitioners in our continuing quest to discern *What We Know.*"

What's in a name?

In their excellent article, "Communicating About Fascia: History, pitfalls, and recommendations," Peter Huijing and Helene Langevin point out the ambiguities and misunderstandings that stem from the different meanings of "fascia." The tendency to use the terms "fascia" and "connective tissue" interchangeably is actually incorrect. It can be confusing because we're talking about a matrix of material that wraps around every muscle cell and creates envelopes, which compartmentalize and wrap around other structures. There are different fascial layers, which, are interconnected. The more we learn, the more we appreciate fascias' different densities, compositions, and unique properties.

Huijing and Langevin argue that it's actually incorrect to lump all these tissues together as "fascia." They distinguish between a dozen types of fascia: dense connective tissue, areolar (loose) connective tissue, superficial fascia, deep fascia, intermuscular septa, interosseal membranes, periost, neurovascular tracts, epimysium, intra- and extramuscular aponeuroses, perimysium, and endomysium. You can read the full article online at http://www.ijtmb.org/index.php/ijtmb/article/view/63/80.

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