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COMMENTARY

The Bodywide Fascial Network as a Sensory Organ for Haptic Perception

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There can be no doubt that the article by Turvey and Fonseca (2014) suggests an important reorientation in the field of motor control research. Up to now, most models in this field separate the passive tissue properties of the skeleton and other collagenous connective tissues from the active dynamics of the muscular system, which itself is understood as being primarily controlled by the voluntary nervous system. According to this common perspective, neural coordination is seen as the key factor in and the main origin of our motor behavior: the neural system generates impulses to the motor units in the skeletal muscle fibers, and they in turn respond by pulling the origin and insertion of the muscles towards each other thereby exerting forces on the skeleton.

In contrast to this widespread assumption, Turvey and Fonseca (2014) place high importance on the fibrous collagenous connective tissues in the body; these are seen as providing a tensional network throughout the whole body, the biomechanical properties of which provide the framework for muscular force transmission as well as for the haptic sensory system.

Neural Signaling Dynamics: Merely a Downstream Effect of Altered Fascial Tissue Properties?

Turvey and Fonseca (2014) extensively discuss the rare case of a male patient who suffered a loss of proprioception due to an isolated inflammatory neuropathy. Some members of our group had the opportunity to examine the myofascial tissue characteristics of this patient via manual palpation at rest as well as in sitting and standing. Two of our group's experienced manual therapists examined the skin and underlying connective tissues of his shoulders, upper arms, and lower back and compared it with their therapeutic experience with healthy men of the same age group as well as with various connective tissue pathologies such as ankylosing spondylitis, Dupuytren's contracture, or Marfan's syndrome. The subjective experience of both examiners was that tissue stiffness as well as tissue elasticity were well within the normal range for healthy individuals. Unfortunately no easy to use technology existed at that time to objectively assess the tissue properties.

This finding, if valid and reliable, may suggest that the lack of proprioceptive perception in this unique person may be more than an adaptation of neural tissues in response to a change in fascial tissue properties. Modern sonographic elastography (Bercoff, Tanter, & Fink, 2004) or myometry (Aird, Samuel, & Stokes, 2012) could now be applied to more reliably examine whether the connective tissues of this man indeed show some very unusual properties that may serve as potential origin of the unusual and extreme defect in haptic perception in this person. However, if our impression gleaned via skillful touch was correct, then the causal correlation between neural perception and connective tissue architecture may work—at least sometimes—in a two-directional manner. Alterations in neural dynamics may lead to modifications in motor behavior, which then influences connective tissue morphology. In addition, alterations in tissue architecture may lead to changes in neural processing which then induces modifications in motor behavior.

It could be of interest to closely monitor the rapidly developing exploration of distribution differences of different fascial mechanoreceptors in different topographical regions. Tesarz, Hoheisel, Wiedenhöfer, and Mense (2012) showed that in the human lumbar area, an increased density of proprioceptive as well as nociceptive nerves was found in more superficial fascial layers rather than in deeper layers of the lumbar fasciae. In addition Stecco et al. (2007) reported a high density of proprioceptive nerve endings in retinacular fascial tissues (e.g., the retinaculae of the ankle and wrist region), whereas a lower density was found in fascial tissues specializing in muscular force transmission such as the lacertus fibrosus.

Very recently a scarcity of free nerve endings has also been found in the superficial fascia of fibromyalgia patients, except for a particular increase in such nerve endings located on the arteriole-venule shunts within this layer (Albrecht et al., 2013). If the hypothesis of Turvey and Fonseca is correct (i.e., that many perceptual alterations are primarily driven by changes in mechanical connective tissue properties), then it could be of interest to also look at these recent findings of altered distribution patterns in neural afferents and to examine if and how they correlate with changes in fascial tissue properties.

Recent Advances in the Field of Connective Tissue Related Terminologies

Turvey and Fonseca (2014) emphasize the impact of a systematic labeling of fascial structures. Based on the fact that fascia-related terminologies show the same degree of

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diversity and lack of clear distinction as the tissue itself, Schleip, Jäger, and Klingler (2012) reviewed three of the most commonly used terminologies in respect to different historical backgrounds as well as their respective strengths when applying each terminology to a particular practical context. Briefly, the terminology proposed by the British edition of Gray's Anatomy (Schleip et al., 2012) works best when communicating with medical professionals whose semantic understanding is primarily rooted in conventional British and American terminology. Most importantly it encompasses the subcutaneous loose connective tissue layer—here called Fascia superficialis—as part of the fascial network of the human body.

In contrast, the terminology proposed by the Federative International Committee on Anatomical Terminology (1998) excludes these loose connective tissues from their proposed definition of fascia, which they suggest to limit to only dense multidirectional dissectible connective tissues. Congruently the thin intramuscular endomysium, with its relatively high quantity of type III and IV collagen fibers, is excluded from the fascial network in contrast to the epimysium. While being a cumbersome terminology for describing myofascial force transmission on a macroscopic scale, this nomenclature is most helpful for histological tissue examinations on a microscopic level.

This is different in the more comprehensive fascia terminology which was first prosed as a basis for the first Fascia Research Congress (www.fasciacongress.org), and was subsequently further developed for the following two congresses. This terminology was inspired by the quest to recognize and better understand tensegrity-like dynamics in the mammalian body. It includes all fibrous collagenous tissues that can be understood as being part of a bodywide tensional force transmission system. The term fascia here includes joint capsules, aponeuroses and ligaments as well as looser fibrous connective tissues such as the various layers of intramuscular connective tissues, which resist tensional forces. This terminology is quite suitable for describing the interconnectedness of various connective tissue layers, such as the continuities between joint capsules, ligaments and tendons as is so well described in the keynote article.

However in regions like the lower back—where for example a mostly unidirectional aponeurotic tissue layer can clearly be separated from more multidirectional epimysial layers—this terminology benefits from additionally specifying fascial tissues according to one of the 12 distinctive descriptions proposed by Langevin and Huijing (2009; shown in Table 1 of Turvey & Fonseca, 2014).

Haptic Perception in Relation to Resonance Frequencies in Rapidly Moving Bodies

We propose a further exploration of haptic perception of the oscillatory dynamics of the fascial net in fast dynamic movements such as running, walking, throwing, and dancing. New sonographic studies have demonstrated how fascial tissues can act as elastic springs (Sakuma, Kanehisa, Yanai, Fukunaga, & Kawakami, 2012). Similarly to the catapult effect observed in the tendons of kangaroos, tendons and aponeuroses of human legs have been shown to be able to store and release kinetic energy. In oscillatory movements such as human running an important function of related muscles may then consist of adapting fascial tensegral tension, such that the inherent resonance frequencies of the limbs are optimally adjusted and utilized. Effective orchestration of rapid locomotion has been an important factor in the survival and evolution of our ancestors. Watching juvenile mammals spending hours at play, it also seems that in the development and training of haptic perception, the fine tuning of such dynamic tissue properties may be an important goal in the linkage between haptic perception and connective tissue properties.

Fertile Ground for Further Therapeutic Investigations

We suggest that the model proposed by Turvey and Fonseca (2014) also provides impetus for the exploration of new therapeutic strategies for dealing with a number of soft tissue pain syndromes such as low back pain, fibromyalgia, myofascial trigger points, or plantar fasciitis. For example, recent studies have revealed a reduced shear strain transmission in the lumbar fasciae of chronic low back pain patients compared with normal controls (Langevin et al., 2011). Similarly a thicker endomysium has been found to characterize the connective tissue of fibromyalgia patients (Liptan, 2010). While both of these tissue changes could possibly be understood as being a result of pain induced changes in movement behavior, it is also possible—and the article by Turvey and Fonseca takes this an intriguing viewpoint—that the changes in sensory dynamics are themselves driven by the alteration in mechanical connective tissue properties. If verified, this understanding could place an increased value to therapeutic modalities such as osteopathy, Rolfing, fascial fitness, and yoga, which aim at restoring normal mechanical properties in respective fascial tissues.

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