Interpreting Anatomy Illustrations

2016 Fascia Research Summer School Report and Insights

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ABSTRACT *Rolfing® faculty member Fernando Bertolucci reflects on his experience at the Fascia Research Summer School (FRSS) held in Leipzig, Germany. Bertolucci specifically focuses on the construction of anatomy images and the difference between fascia-oriented dissection images and organ-oriented dissection images.*

This article is based on my experience at the Fascia Research Summer School (FRSS) held in Leipzig, Germany, in September 2016, where I had the honor to participate as a grant recipient. I thank the Dr. Ida Rolf Institute® (DIRI) and the University of Leipzig for making such an opportunity available. Below are some pieces of information I found interesting and useful to the Rolfing Structural Integration (SI) context, along with some insights I had.

Jaap van der Wal, MD, PhD, is a medical doctor, and before his retirement in 2012, he was an associate professor in anatomy and embryology at the University of Maastricht, Holland. I want to highlight van der Wal's point of view that he presented for his FRSS presentation of fascial anatomy, very much in line with the Rolfing perspective of wholism. He has a helpful understanding of the role of fascia in motion, and his insights can inform us about our practice as Rolfers®. The human starting point is embryological development where our bodies have no *'parts'* and anatomy (meaning literally to 'cut up') is about cutting, separating, locating, and naming *parts*. This anatomical point of view may be helpful to show more or less identifiable *parts* during dissection, as is the case of an organ such as the liver, for instance. But when one aims their attention to the tissues *in between* those parts (fascia), such a method becomes inappropriate.

Fascia is continuous throughout the body and one of its main features is putting

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parts *in relation* to one another and, in so being, having no clear boundaries. In this article I will present van der Wal's 'dynament' concept (van der Wal 2009). In short, this has to do with the relationship between musculoskeletal motor function and fascia, that integrated function of the body's movable units, and how these relationships allow forces to travel among body parts. Separating parts, as is done to produce anatomy images for study, distorts the behavior of the system and hampers the understanding of its function. The scientific method usually separates parts to study them, but how can one learn a system whose functions depend on its *continuity*?

Anatomical View

Let us start with the unfoldings of the 'anatomical' view present in anatomy illustrations. Van der Wal shows that many anatomy illustrations in commonly used books are faulty representations of the fascial anatomy and its organization (or *architecture*, as discussed below). This may occur because, when dissecting, the anatomist already has an idea of what is supposed to be found and can often 'make up' anatomical structures with the scalpel (sharp dissection) based on such expectations. The scalpel could work as a pencil to draw the frame of mind of the anatomist. Considering the omnipresence of the connective tissue, each and every separation by an anatomist will be artificial and already disruptive to the original continuity. To study what is 'in there', commonly the anatomist disregards fascia, as it may be in their way to study a specific *part.* An anatomist may disregard the wrappings of structures, like one that throws away the wrapping of a present, eager only to know the contents. But the container, as Rolfers knew from long ago, is as essential as the contents and constitutes the environment that such contents inhabit.

Nonetheless, one can perform a *fascia-oriented* dissection to study connective-tissue organization, as opposed to *organ-oriented* dissection. In the 1980s, van der Wal (2020) made fascia-oriented dissections of the forearm and, based on his findings, developed a phenomenological and philosophical view of fascia. This view of fascia integrates and resonates with the Rolfing SI point of view. Below are some examples and reflections about such a view.

1. Ligaments and Tendons: One Continuous System

One example of anatomical 'interpretations' deals with the structures that are responsible for joint stability. The classic concept describes: (a) a *passive* system of ligaments and (b) an *active* system of tendinous structures linked to muscles. With this frame of mind, it is possible that the anatomist 'foresees' such structures and separates them with his scalpel accordingly. Such separation may have artificially 'created' structures that were originally part of a continuous system.

In his fascia-sparing studies of the forearm, van der Wal did not find any *separation*, proximally, between the tendinous and ligamentous structures. They seemed to be all part of the same connective-tissue complex to which the muscles converge, in a complex but continuous system. Just like the rotator cuffs described in the shoulder, he describes this same type of structure embracing the epicondyles and inserting into the bone, including, in an uninterrupted way, structures formerly described as joint capsule, ligaments, and tendons. In other words, what is described in the anatomy books as collateral elbow ligaments may be all part of the dense connective tissues that connect the muscle fibers to the bones.

Likewise, the same could be true for the annular ligament that is part of the supinator muscle. Sharp dissection can 'make' an annular ligament. Previous anatomists' knowledge may steer their mind to use the scalpel to 'find' the so-called annular ligament. Van der Wal's *fascia sparing dissections* showed no boundaries between such structures.

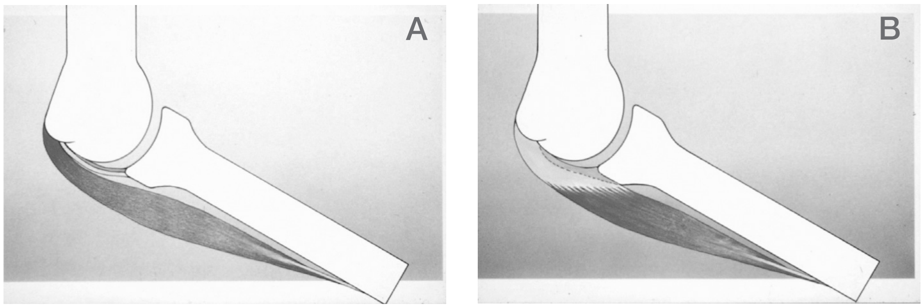

Figure 1: Many anatomy book illustrations depict muscle (darker grey) and capsular ligaments (lighter grey) as being discrete structures that lie in parallel with one another (A). Van der Wal and other anatomists have shown that muscle (dark grey), tendon, and capsular ligaments (lighter grey) all make part of the same system and lie in series with one another. This would allow tension to be present all along the range of motion of a joint, and hence continuously feeding the central nervous system with proprioceptive information (B).

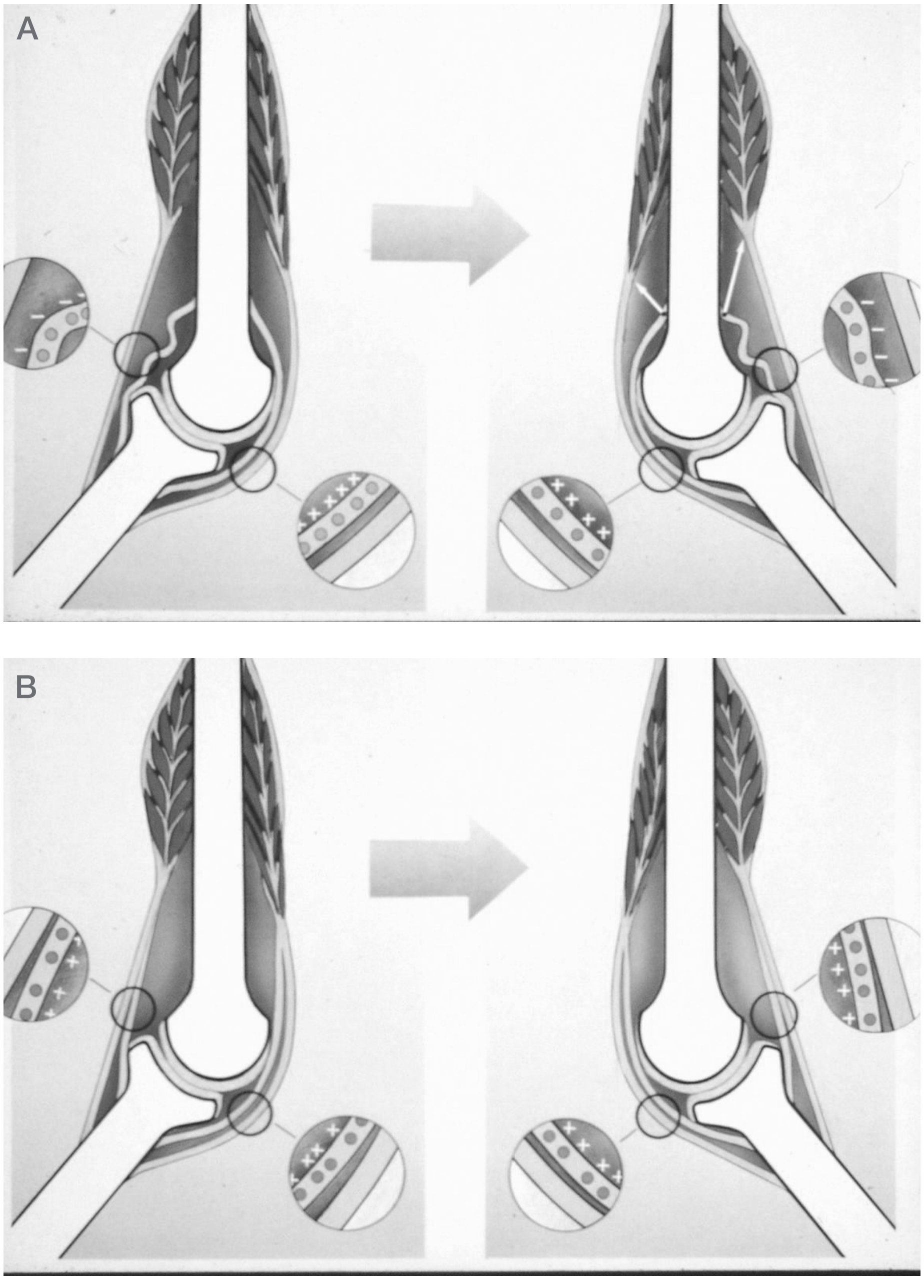

Figure 2: The traditional the concept of ligaments is that they are passive structures lying in parallel with tendons. They would be slack (---) and tense (+++) depending on the position of a joint, i.e., the system would turn on and off (A). If ligaments and tendons are part of the same system, there will be a certain degree of tension throughout the range of movement of a joint. The mechanoreceptors would then be able to convey proprioceptive information continuously (+++) (B).

2. Ligaments and Tendons: In-Parallel or In-Series Structures?

The classic anatomical separation between ligaments and tendons also considers these structures as functionally distinct: to achieve joint stability, 'passive' ligaments lay *in parallel* with 'active' tendons (see Figure 1). Van der Wal showed that in this continuous system of connective tissue linking the muscles to the bones, what has been described as 'ligaments', is laid down in fact, *in series* with the 'tendons' in one single, continuous structure.

The biomechanical view to describe ligaments in parallel is that they are slack when their bones are brought together and then become taut when their associated bones move apart from each other. For example, ligaments undergo tensile stresses [and hence become able to convey proprioceptive afferents to the central nervous system (CNS)] only in certain joint positions (see Figure 2). It follows from this logic that the proprioceptive source would be turned on and off depending on joint position, which would not seem to be an ingenious choice by nature. But, if ligaments and tendons were all part of the same continuous structure, there would also be a *continuous* tension in the system, signaling proprioceptive afferents to the CNS along the whole range of motion (ROM). The latter would possibly be associated with a richer dynamic control of joint stability, as opposed to a system that turns on and off.

This concept is useful for us Rolfing SI practitioners, to imagine *continuous* tension within the whole connective-tissue structure along the ROM of a joint. Then we can include this as a possible element for working with appropriate proprioceptive afferents and hence contributing to good movement quality. Our intervention would help ameliorate the *distribution* of such tension, which may work in two cooperative ways: first with better proprioceptive information and better effectors (joints, muscles etc.) and second, refined performance (i.e., when the structure is moving in a higher degree of tensile integration, as discussed below).

3. Pennate Muscle Architecture: Intramuscular Tendons and Intermuscular Septa

An aspect often neglected in anatomy book illustrations is the *type of muscle-fiber arrangement*. In many current anatomy books, the drawings of the

Figure 3: Oblique vanes of a feather. Photo by Jasmin Sessler on Unsplash.

forearm muscles show muscle fibers oriented longitudinally to the muscle belly and also continuing longitudinally to the tendon and then to the bone. A closer look will show that the muscle fibers of these muscles have an *oblique* arrangement respective to the tendinous structures, which proximally is the antebrachial fascia itself. Van der Wal's studies showed that in the proximal third of the forearm, the muscle fibers are inserted in the *inner* surface of the antebrachial fascia, which is considered an *aponeurotic* fascia for this reason. (Aponeurosis is a flat tendon.) Such aponeurotic fascia wraps the condyles and inserts into the epicondyle of the humerus. On the other end, distally, the muscle fibers of the forearm insert into dense tendons that are present within the muscle bellies (the so-called intramuscular tendons and/or intermuscular septa). The organization of muscle fibers, inserting obliquely in their tendons, resembles a feather (see Figure 3), and so they are described as *pennate* muscles (*pena* Latin for feather).

The intramuscular tendons converge as they run distally, giving rise to the tendons in the proximal third of the forearm. Such oblique pennate arrangements of muscle fibers are often not represented in anatomy illustrations, giving the false impression of many tendons attach to the – small – epicondyle area. Rather, the deep antebrachial fascia receives the insertions from the various muscles, just like a rotator cuff. Van der Wal coined these structures lateral and medial force transmission systems, and they stabilize the elbow in a similar way that the rotator cuff does in the shoulder.

In fact, such continuity between tendinous and ligamentous structures has been described for the shoulder's rotator cuff by Jobe and Coen (2004). One can say, then, that the antebrachial fascia has muscle attachments in its proximal third, i.e., it *links or connects* structures in this region. Palpation of this area has a fleshy feeling of the muscles, and if one strums transversally, it is possible to notice the myofascial compartments moving in relation to one another.

4. Same Name and Diverse Functions: Antebrachial Fascia

In contrast with the proximal third, in the distal third of the forearm, dense antebrachial fascia *encases* the tendons (of the same muscles it proximally gave rise to) and permits their gliding underneath. Note that here the antebrachial fascia has a different role than the proximal third. It creates room or *disconnects* structures instead of having the connecting role just described in its proximal third. Palpating this area, one can notice the rope-like tendons moving in relation to each other in the areolar planes of connective tissue contiguous with the dense plane of the antebrachial fascia. So, the same structure, the antebrachial fascia, has different functions depending on the region concerned: proximally, it serves as an attachment site for muscle fibers on its inner surface and *connects* structures, and distally, it creates room (or acts to *disconnect* structures) for the tendons to glide freely.

This observation of the antebrachial fascia relationships is interesting to people doing Rolfing SI and related manual approaches. Suppose we consider manual fascia-oriented manipulation affecting areolar tissue and encouraging gliding of neighboring structures. In that case, we can deduce one key area that should be worked is the middle third of the forearm. In other words, Rolfers' fascial interventions can affect the connection/disconnection qualities of the relationships with neighboring structures, and the middle third of the forearm is the area where the transition occurs between these two opposite functions. Dense tissue and adhesions would be more likely to happen where the two polar fascia roles of connection/disconnection interchange.

It is noteworthy to mention that the distal third of the antebrachial fascia, besides disconnecting structures to allow tendons to glide, also works connecting structures in another fashion. Near the wrist, this fascial structure is reinforced and constitutes the so-called retinacula. Such structures have, in this sense, a linking role, as they maintain the tendons near the bone during wrist movements. This is another example of how anatomists can 'make structures' with their scalpels as the retinacula are often depicted as discrete structures in anatomy books, and yet, they are reinforcements of the antebrachial fascia and continuous with it. Considering the above features together, one can imagine how the study of fascia is a challenge, and the classic *cutting* anatomical methods have limitations.

5. Integrating Fascia Anatomy and Fascia Architecture

As we've covered, anatomists dissect and separate structures, they locate structures and give them names. But the connective tissue is continuous all over the organism, lying within and in between structures, and this is what makes anatomy study particularly difficult. Each and every anatomist's 'cut' is artificial and may 'create' a structure that *in vivo* is not separate from the rest, a fact that may hamper the understanding of the body structures' real relationships and functions. To address this issue, van der Wal talks about the notion of *fascia architecture*, instead of fascia anatomy (2009). The latter would describe *where* structures are while the former describes *how* the structures are functionally related.

In the anatomy lab it is common to hear things such as "I will 'clean' this area up, so we can better see what is within." But *cleaning up* means taking off the fascia, especially the areolar tissue, and the original structural relationships that existed among neighbor structures are now severed and cannot be appreciated anymore. This has been happening more and more in the recent years, authors and illustrators want to give as 'clear' an idea as possible to the readers of the anatomy structures. In doing so, many such

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illustrations carry their *interpretations* of what supposedly is to be seen. Nice and 'clean' illustrations may be useful to show some aspects of anatomy, but they are biased by our previous knowledge and expectations, and that should be noted. As the importance of the connecting/disconnecting role of the connective tissue has been valued only recently, the anatomy books that show such features are recent or yet to be published.

It is worth mentioning that being at the FRSS exposed the participants to the work developed by the anatomy team at Leipzig University, where they had specially prepared cadavers that were pliable and the tissue looked fresh. These were a great resource in studying the relationships among parts established by the connective tissue. By the end of the FRSS week, we were also presented with an exhibition of wonderful photos to be part of a published fascia atlas. Such endeavors will give us a progressively better understanding of the role of fascia in integrating body parts.

One can have an idea of how cutting-anatomy procedures interfere with the integrative role of fascia. In one paper, the group around Peter A. Huijing, PhD, performed a 'progressive dissection' from the skin to the deeper tissues while monitoring the forces acting in the muscles underneath (Huijing, Maas, and Baan 2003). Interestingly, just cutting the *skin* already changes the forces in the tendons lying deep in the rat paw!

6. Endo and Exoskeletons: Means to Distribute Forces?

Mammals have bony endoskeletons, which are moved by the muscles that lie outside them. The classic biomechanical view is that we move segments through moving their bones, which are pulled by the tendons attached to them (muscle-tendon-bone path of force transmission). But we know now that the fascia system is also linked to the muscles and integrates their function through the *myofascial force transmission* path. Dense aponeurotic fascia constitutes a whole system where the muscles are also connected, then in turn, to the osseous skeleton through the intermuscular septa. We can then envision a whole 'fibrous skeleton' with spaces occupied by muscles (and organs). Van der Wal suggested the idea of a 'connective-tissue skeleton', a concept also described by Bienfait as a 'fibrous skeleton' (Bienfait 1987). In this view, our bodies could be considered a structure composed of a softer fibrous skeleton and a more rigid osseous skeleton.

Such a 'fibrous or connective-tissue skeleton' encompasses structures in various depths: more superficial (near the skin) structures, such as the antebrachial fascia or the thoracolumbar fascia, as well as deeper ones (such as intermuscular septa). Consider the existence of muscle attachments in the *inner* surface of aponeurotic dense fascia, as described above in the forearm, as well as myofascial expansions (such as the lacertus fibrosus), richly described by Stecco (2015). One may conceive that the aponeurotic dense fascia can somehow also have an *exoskeleton* capacity, as it also encompasses more superficial dense fascial structures (although such structures are considered deep fascia, as opposed to superficial fascia). One such example would be the gluteus maximus, which has two portions, a deeper one that inserts to the great trochanter (muscle-bone path) and a more superficial one, attaching to the posterior portion of the iliotibial

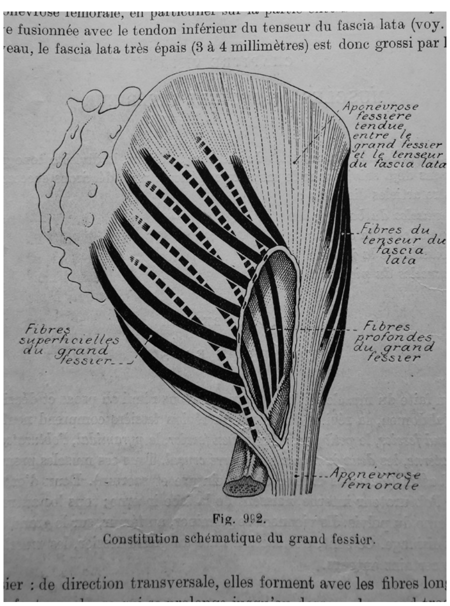

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Figure 4: The gluteus maximus muscle can be subdivided into two layers: a deep one, inserting to the greater trochanter and a superficial one, inserting to the iliotibial tract; both move the hip, the former via the osseous skeleton and the latter via the deep fascia, which could be considered a kind of 'exoskeleton'. The distribution of forces within the system would make it more resistant to possible mechanical overload, the main cause of musculoskeletal disorders (Testut 1909).

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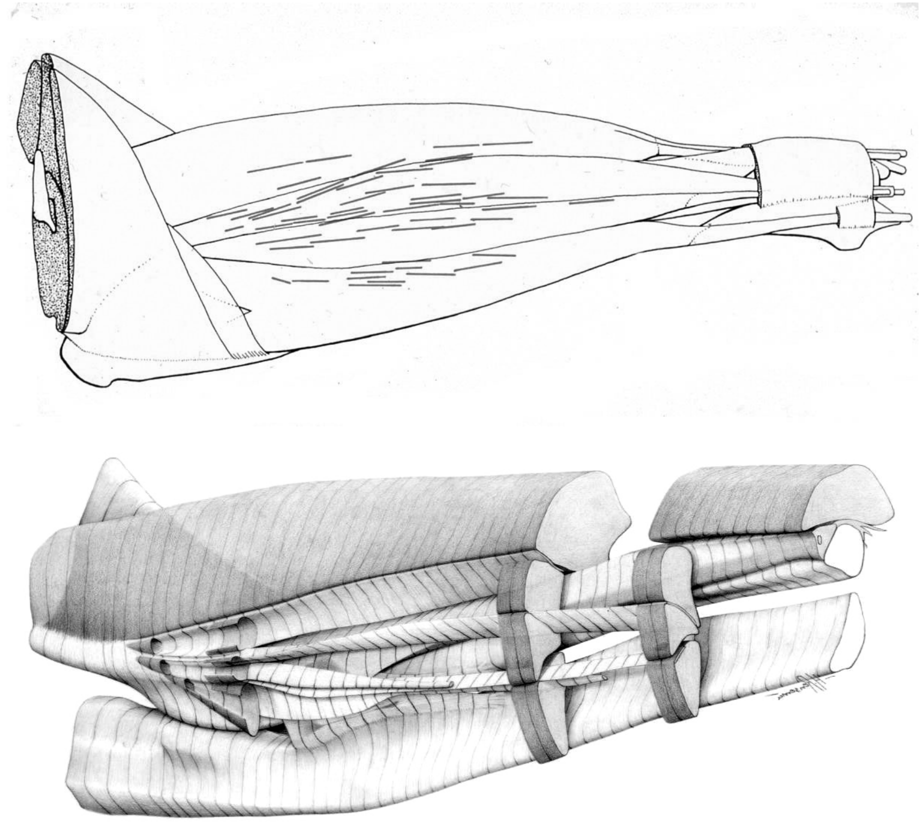

Figure 5: The muscular zones dense in muscle spindles (short grey lines in the upper image) are the stress- and force-conveying zones of the myofascial structures. They concentrate mainly in the interfaces between tissues with various mechanical properties (e.g., muscle and dense connective tissue structures) where tissue deformation occurs. In the upper image, the distribution of muscles spindles are found around the areas where dense structures are, like intermuscular septa, light grey in the lower image.

tract (muscle-fascia path, see Figure 4). In other words, movement of body parts could arise from forces acting both: (a) in an inner osseous endoskeleton, through muscle-tendon-bone attachments, and (b) in a fibrous skeleton, through muscle-fascia attachments and fascia-fascia expansions. Multiple force-transmission paths would be an important feature to the force *distribution* within the fascial system.

Most musculoskeletal pain syndromes are related to *mechanical overload* of moving tissues, often resulting from force *concentrated* in certain areas (for instance, the entheses). Hence, the more the forces are *distributed*, the less the likelihood of tissue overload to arise. One can then visualize Rolfing interventions and related manual approaches that can affect/optimize myofascial force transmission within these two co-acting skeletons contributing to higher movement quality and amelioration of symptoms related to tissue overload, damage, and inflammation.

7. Mechanoreception and Proprioception

Standard classification of mechano–receptors divides them into joint receptors for somatesthesia, kinesthesia, and muscle receptors for muscle motor control. Joint receptors are present in capsules and ligaments; muscle receptors are present in muscles and tendons.

Again, anatomical classification seems to impart a broader understanding of how the whole works. The classification of proprioceptors as either 'muscle receptors' or 'joint receptors' seems to be artificially based on the anatomical distinction between ligaments and muscles as passive and active structures, respectively, as discussed above. Considering the *continuity* of connective-tissue structures that seem to include ligaments, capsules, tendons, and fascia, van der Wal reported to us during the FRSS the distribution of receptors in the forearm of rats, specifically the distribution of proprioceptive receptors, follows a functional logic rather than an anatomical one.

He detected that the distribution of mechanoreceptors was not homogenous within myofascial structures, but rather they were present mainly in the regions where there is a *deformation* of tissue when subjected to mechanical stresses (see Figure 5). Dense connective tissue, which deforms very little under stress, showed no mechanoreceptors. In the *transition* between dense connective structures, muscle fibers, and areolar connective tissue, all deformable interfaces, those receptors were present. What's more, the distinction between joint and muscle receptors seemed not to make sense. The features of the receptors found were described as being both joint *and* muscle receptors. In other words, the distribution of proprioceptive receptors seemed to follow the *functional architecture* of the connective tissue and not its location (e.g., ligaments/muscles), as they are commonly described.

The presence of both receptors where tissues of different mechanical properties meet, i.e., in areas that undergo *deformation* when under stress, showed how the deformation is the condition that makes them able to convey information about mechanical stresses to the CNS. Different kinds of receptors are located where mechanical stresses can be sensed/measured in a continuous in-series chain of structures that encompasses bone-fascia-muscle-fascia-bone, defying the historical classification of proprioceptors.

8. Dynamic Ligaments: Dynaments

In so being, one can conceive joint stabilization function as being accomplished by continuous soft-tissue structures linking bone-to-bone, the constitution of which depends on their *functional* demands. The amount and type of tissue (muscle and fascia) between bones will correspond to the relative movement of these segments as they link together. This collection of associated tissues will vary from more fibrous or less fibrous, to more muscular or less muscular. This is the 'dynament'

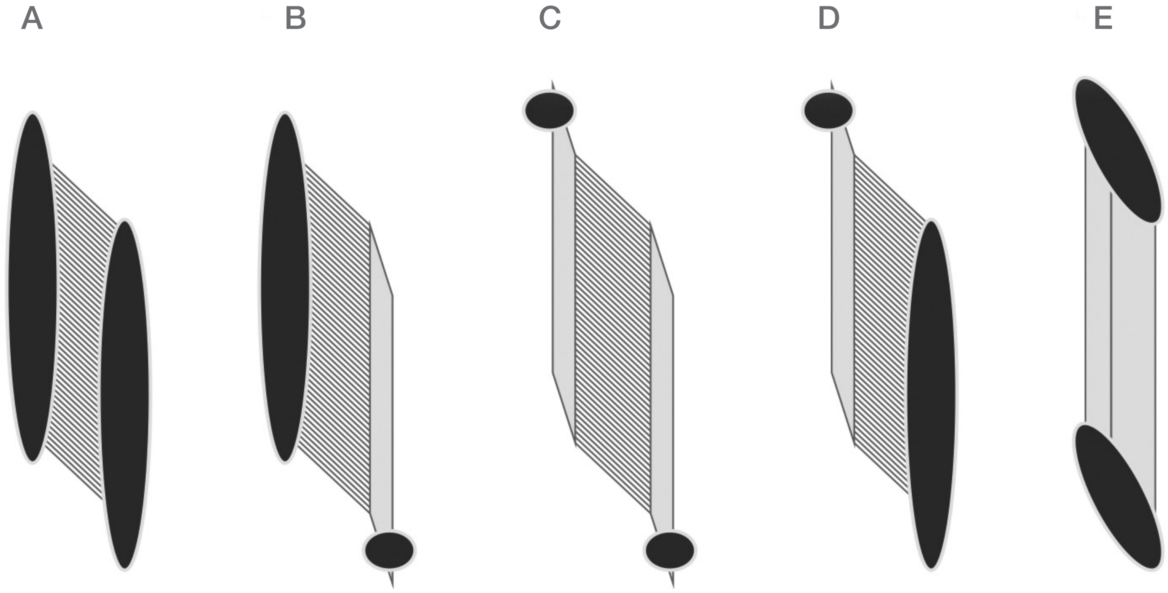

Figure 6: The dynament concept. [Note: superior aspects of shapes are proximal and inferior aspects of shapes are distal.] (A) Long oval black shapes are bones. This is a 'pure' muscle where the angled stripes are the muscle bellies within their connective-tissue scaffolding. (B) Proximal bone continuous with muscle tissue, distally inserting into regular dense connective-tissue structures – a tendon. (C) Muscle fascicles span between two regular dense connective-tissue structures. (D) Proximal regular dense connective-tissue structure, where muscle tissue spans to the skeletal element (periosteum). (E) No musle tissue intermediating, only regular dense connective tissue – a 'pure' ligament (van der Wal 2009). There would be no distinction between 'muscle', 'tendon', 'ligament', being that all of them are part of a functional continuum aimed at dynamically linking bones.

model put forth by van der Wal back in the 1980s, that brings in a renewed principle of functional units underlying motor control. According to this vision, what has been described as ligaments, tendons, and muscles can all be unified as dynamic ligaments, or *dynaments* constituted by in-series organization of soft tissue (fascia and muscle fibers) between bones (see Figure 6). One dynament may show no muscle fibers and be considered a pure 'ligament' like the cruciate ligaments of the knee and interosseous membranes. On the other side of the spectrum, a dynament can have almost exclusively muscle fibers like the deltoid, and all the possibilities of more or less fibrous tissue (tendons, aponeuroses) interposed in between. So, the functional units of motor action can be considered the dynament units, where the CNS is orchestrating their function in a task-oriented manner.

Walshe (1946) cited the physiologist John Huglings Jackson (1835-1911), who had already said, back in the 1890s, to paraphrase, that the CNS knows nothing about muscles but about *movements* of muscles. Van der Wal recalls and reviews this notion with the lens of connective-tissue architecture and distribution of proprioceptors. There is not a 'map' of muscles in the CNS, rather it is sensitive to changes in mechanical information conveyed by proprioception. Changes in relationships of body parts during posture and movement will deform the connective-tissue structures involved, which will change the proprioceptive afferents entering the CNS. Such information processed and integrated with the organism's action plan will eventually produce muscle activity accordingly; by its turn, it will give continuous feedback to the proprioceptive afferents. This is a loop where proprioceptive information will reenter the CNS and give rise to the appropriate motor control efferents to accomplish the plan in a real-time, continuous servomechanism. The CNS continuously compares actions, plans, and execution while making the appropriate adjustments.

9. Manual Therapy and Proprioception

Now you can see, actual anatomy is much more than those clean structures shown in anatomy drawings. There is continuity of the whole connective-tissue system. As Rolfers, we work with the possibility that fascia-oriented manual input can change the amount or balance between connection/disconnection among moving structures. It is possible to take our intervention further to visualize that it would be possible to change the quality of proprioceptive information entering the CNS with the therapeutic touch acting on these dynament units. If connective-tissue structures have plasticity, then manual therapists can influence the amount and the location of connection/disconnection of parts. This could change the mechanical environment where proprioceptors are embedded, possibly bringing them towards their *optimal range* of proprioceptive function. Tension receptors are known to work best under a certain degree of tensile stress. Too much or too little tension would hamper mechanoreceptors' functions. By changing the relationship between connection/disconnection of parts towards a more homogeneous distribution of basal tension, fascia-oriented manipulation input could optimize the quality of the neural afferents from mechanoreceptors to the CNS. By lowering the strain in areas already subjected to a habitually high degree of tension and, at the same time, redirecting forces to areas previously under lower tension, appropriate hands-on work could help the *distribution* of tensile stress in the connective-tissue web. This effect would correspond to better mechanoreceptive afferent signaling, which, by its turn, could potentially reflect in higher movement quality.

10. Studying Organisms' Integrity: Tensegrity?

Rather than the body being a collection of parts, connective tissue establishes *relationships* among parts. It follows that if one wants to understand the systemic functions of an organism, i.e., the relationship of its parts, one should somehow integrate the study of anatomy with the study of the *integrity*. In this context, van der Wal mentioned the concept of *tensegrity* as a possible means to understand better how the whole human works. The tensegrity principle was found in many presentations at the FRSS and was also the subject of a workshop presented by Danièle-Claude Martin.

Tensegrity systems are built by compression-bearing elements 'floating' in a pre-tensioned web of tension-bearing elements. The tension within such systems is evenly distributed so that it *integrates* all parts of the system. If one part moves, the whole system immediately changes and adapts to that movement. In a tensegrity system, all parts are interconnected. If the distribution of tension within the web is uneven, then the interconnectedness of its parts will diminish (we could recall here Ida Rolf, PhD, using the illustration of tents). Some of its parts will be under too much tension and others under too little tension, hampering the assembly of the system and its function. The same idea could be applied to human bodies, which should maintain tensegrity during movement. That is to say, the system should be able to adapt and maintain an appropriate distribution of tension while changing body configurations to maintain the internal connectedness that characterizes tensegrity.

For instance, flexing the torso by simply bending the thorax in the direction of the pelvis, loosening tension in the belly (as in a 'slouched' posture), we lose the tensional integration and hence its role in maintaining the support of the trunk. This situation would probably be associated with poor overall force distribution and likely to lead to tissue overload – potential tissue damage. This would likely lead to inflammation and pain. But if, in flexing the torso, an appropriate degree of tension is also present in the belly (the concave side), tensegrity would be maintained, rendering better trunk support and a more homogenous force distribution in the system, a better movement pattern.

11. Neural and Non-Neural Connectivity within Live Tensegrity Structures

So, the distribution of tension is a key aspect in tensegrity structures, and it is a condition to maintain the integration of its interconnected parts. What's more, such integration may be conceived as having two main control sources. One, and the more obvious, is *neural*, as discussed above. The quality of proprioception can be reflected in the integration of the person's movement, an effect mediated by the CNS. Two, more recent research shows that there may be an additional integrative control mechanism that does not involve the CNS directly and resides in the structure itself. This second integrative control is *non-neural*, and is a distinctive feature of tensegrity structures. These structures behave in a fashion in which morphology, physical forces, and displacements act as non-neural channels of information generation and communication, the so-called *morphological communication* (Rieffel et al. 2010). This mechanism is based on the tensile forces within the continuous pre-tensioned web of the tensegrity structure. Under tensegrity, local structure configuration changes affect the tensile forces within the whole structure in a purely mechanical action. Such communication takes place at the speed of sound, faster than neural mechanisms.

Think of the variations and discontinuities in the distribution of tensile forces in the connective-tissue web, what would hamper its *structural* connectivity as well as its *neural* connectivity (through the lack of morphological and neural communication respectively)? Both mechanisms may interrupt whole-body tensegrity and high-quality movement. So, the original continuity and communicability of the connective-tissue web may exhibit, depending on the arrangement of its parts, higher or lower degrees of tensile integrity, or tensegrity. As manual therapists, we may help the distribution of tensile stresses in our clients' systems by changing, among additional variables, the mechanical loading along with myofascial structures and consequently the net baseline tension in the connective tissue web.

In short, a better distribution of tension may have the effect of enhancing movement quality: (a) via neural control, by improving the mechanosensitive input and hence offer the CNS better conditions to control movement; (b) via

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ameliorating the degree of morphological communication among its parts. The latter is an effect that may enhance non-neural mechanisms of motor control, related to tensegrity. Interestingly, pandiculation (yawning and morning stretching) seems to be a natural and inherited way to achieve such effects. Through creating tensegrity in various positions, pandiculation updates maximum bodily dimensions, these actions seem to autoregulate myofascial connection/disconnection balance, refreshing the baseline tension distribution. This, in turn, stimulates morphological and neural communication, and maintains the quality of movement. Pandiculation could then be conceived as a sort of myofascial hygiene (Bertolucci 2011).

12. Alternative Methodologies to Study Fascia?

The above descriptions show the difficulty of studying fascia. Anatomists do a fair amount of cutting to show us specific structures, yet we know fascia has an integrative function, easily disrupted by the current analytic methods.

An additional example of this difficulty was presented at the FRSS by Freddy Sichting, PhD, describing the so-called heel-pad paradox, which refers to differences in stiffness of the heel pad measured *in vitro* compared to *in vivo* (Pain and Challis 2001). *In vitro* stiffness appears to be much greater than *in vivo* but a conclusive explanation is still missing. Nonetheless, the studies that led to such a paradox were based on current deterministic and reductionist scientific methods calculating the mean values of variables to establish what is ‘normal’. It is possible that such methods are not appropriate due to the complexity and individuality of fascia development, remodeling, and behavior. In his presentation, Sichting relayed an analogy: “Connective tissue is a poem of which we are still trying to understand the letters” and he questioned whether we should question and possibly revise the methods used so far. As an alternative, he mentions the possibility of studying each individual and trying to learn from each one. Interestingly such a view matches Rolf’s distinction between normal and median: she would say that ‘normal’ refers to the full potential of each individual, and mean (what in academia is typically related to 'normal') is average for the whole population, which is less than what nature could achieve.

Conclusion

Modern science has evolved trying to isolate, as much as possible, the various aspects of a phenomenon and study one part at a time. Such a method is well suited for many fields, but not so much for researching fascia, as connective tissue has a role of integrating the functions of all systems and hence exhibits an extremely complex behavior. This makes fascia very difficult to isolate its roles. Does fascia deserve alternative methodologies so we can have a comprehensive understanding of its many functions? More recent methodologies aimed to study *complex systems* are being put forward. They deal with connectivity and emergent properties (Turnbull et al. 2018) which may also be useful in the fascia research field.

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