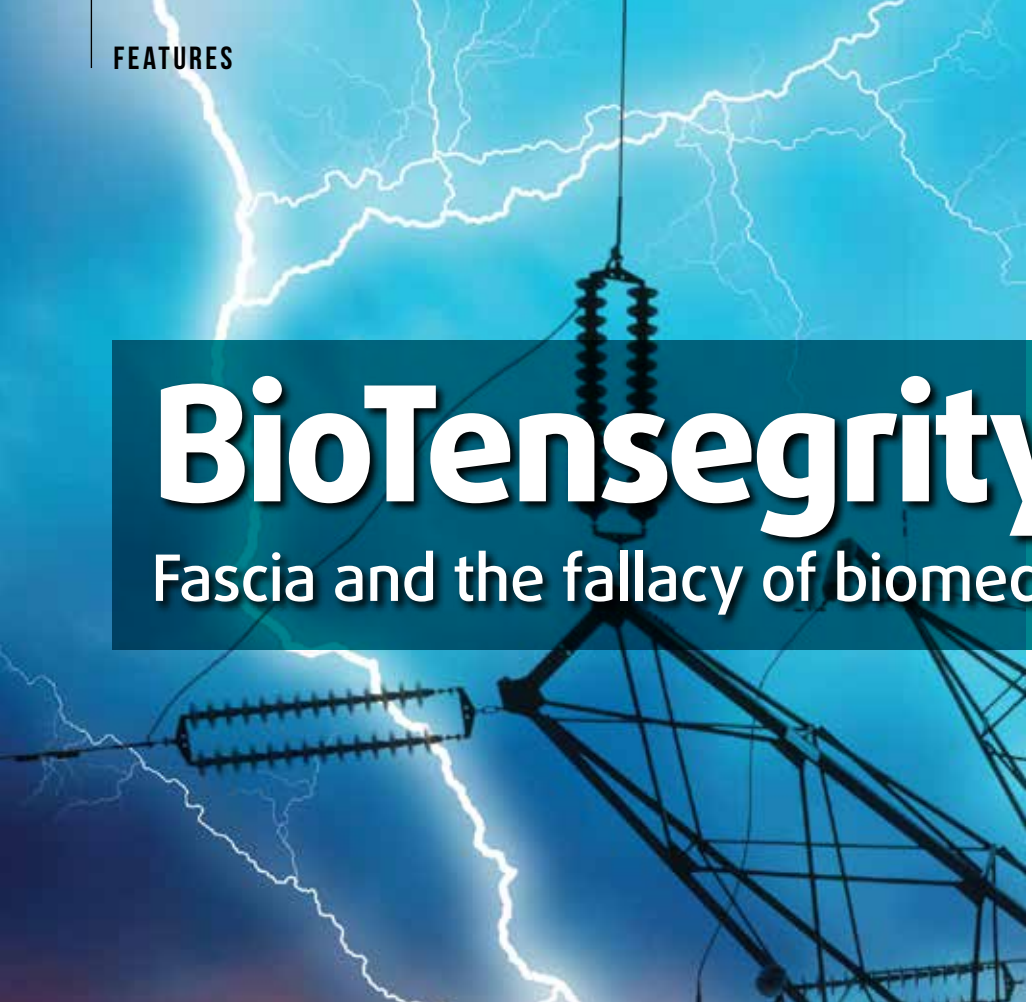

BioTensegrity

Fascia and the fallacy of biomechanics (Part 2)

"Discovery consists of seeing what everybody has seen, and thinking what nobody has thought" (Albert Szent-Gyorgyi). This is true of Dr. Stephen M. Levin M.D an orthopedic and spine surgeon. Dr. Levin former Clinical Associate Professor at Michigan State University and Howard University, originated the concept of Biotensegrity 40 years ago.

Fig 1: BioTensegrity beautifully reflected in this amazing image. Special thanks to RJ Muna Pictures (www.rjmuna.com).

Introduction

In the first article of this three-part series I provided a basic explanation of BioTensegrity.

While a growing number of professionals are beginning to understand what Tensegrity is, a wider population of bodywork and movement therapists need to know what it is not. Bodywork and movement therapists also want to understand how they can integrate BioTensegrity into their specific model of movement and bodywork within their clinical practice. Understanding BioTensegrity has wide reaching implications for massage therapists of all stripes and for medical specialists including surgeons. The father of biomechanics was born 28 January 1608 and following his death in 1679 (penniless and destitute), Giovanni Alfonso Borelli left behind a legacy that would prevail to the present day. BioTensegrity claims more than a tincture of skepticism when it comes to the classic descriptions of animal movement and human biomechanics as promoted by Borelli.

I believe that BioTensegrity is one of the most important developments in medical science, bodywork and movement therapy in the modern era.

Outrageous theories

In 1916, geologist Alfred Wagener had the audacity to suggest that the continents floated around on the surface of the earth. Wagener stated that West Africa and the East Coast of South America had at one time fitted together like a jigsaw puzzle and that they had somehow drifted apart from each other due to platonic movement. Wagener was ridiculed for having had the boldness to bring forward a new radical scientific hypothesis, but by the late 1950s his outrageous theory was being thought in schools as accepted, accurate science and all thanks to his courage. The promotion of a new concept or model in science takes courage, daring, nerve and a thick skin.

New concepts and paradigms are rarely accepted straight away. Change takes time. It invariably takes years to break down the barriers associated with changing an accepted and well-established fact, and rightly so. A new paradigm suggests that our current model of reality could be wrong. A new theory needs to be challenged and tested, rebutted and ridiculed. If the new model or hypothesis cannot stand up to scrutiny and provide undisputable answers and better explanations, it does not deserve recognition. While still in the stages of organic evolution, BioTensegrity has already passed much rigorous scrutiny with flying colors. In contrast, the old biomechanical model of levers, joints and laws developed from observation made in the sixteenth century by pantheons of great scientific minds, scientists and mathematicians of antiquity including Galileo Galilei (1564-1642), René Descartes

John Sharkey MSc, Clinical Anatomist, University of Chester/National Training Centre, continues his three-part series looking at understanding BioTensegrity.

(1596-1650) and Isaac Newton (1642-1727) have come up short in providing adequate explanations of living mechanics.

Our miraculous construct

Considering the body exclusively as tissues and bones does not do justice to the wondrously complex and miraculous construct that makes us human beings. We are not simply defined by the fact that we utilise bipedal locomotion. Diving beneath the flesh we discover we have thoughts, emotions, consciousness; we have feelings and we respond. The study of anatomy has led to a reductionist view of what is ultimately a global or holistic organism. Historically, anatomical study concentrated on specialties, a focus on specific processes or applications. Anatomists viewed their role as the scientific discipline that investigates the structure of the body including the form of structures, microscopic organisation and the process by which they develop. BioTensegrity promotes a language of "Whole" (a global view) while recognising that a language of "parts" can be helpful, even necessary, at times. When discussing BioTensegrity, classical anatomy provides a foundation upon which we can discuss the part and then place it in the context of the whole.

The language of BioTensegrity is the language of soft matter physics. It is tension and compression with continuity. The premise of BioTensegrity is non-linear continuous matter that is self-generated, self-organising, self-stressing, hierarchical, load distributing and low energy consuming. There are no shear moments, no bending moments, no levers and no joints.

Let me explain what tensegrity is not ...

Our bodies are self constructed on the basis of continuous tension and floating compression. Continuous compression, such as is seen with block on block buildings, would not be a good architectural model for any living structure. When we look at the tissues deep to skin in a cadaveric specimen we can be forgiven for mistaking the non-living form as reflecting evidence of stratification or layers (Fig 2. Courtesy of Stecco, C. 2012).

Fig 2: (With kind permission from Stecco, C. 2012 personal correspondence). Analogous to a sea of molten lava the body has no stratification until, similar to cooled and rolled lava, the lack of motion and life presents a misguided image. We cut the skin from the sub-cutis or the superficial fatty fascia from the fascia profundus and we sadly declare, "look at these layers".

Figures 3 and 4 are examples of what tensegrity structures are NOT. Or put slightly differently, they are not tensegrity structures.

Fig 3: The sailing ship is the most widely used misrepresentation of a tensegrity structure.

Fig 4: This bamboo structure needs the wall and not the other way around. (Photo supplied by Serge Gracovetsky private correspondence)

Figure 3, the sailing ship, is the most widely misused example for a tensegrity structure. While it does provide examples of tension and compression it is not a continuous structure and the mast needs the ship for support and not the other way around. Figure 4 is similar where the structure needs the wall and not the other way around. Of course the wall itself is a continuous compression structure.

Let me explain what a tensegrity structure is ...

The model of BioTensegrity is an extension of Fuller's term "tensegrity", a syntactic of "tension" and "integrity". A tensegrity structure has both a discontinuous compression member and a continuous tensional member (Levin. 1982). It is imperative that they are continuous with each other. For convenience, in humans the skeletal system would represent the discontinuous member and the softer tissues (fascia, ligaments, tendons etc.) represent the continuous member. Keep in mind that all living tissues are soft matter. Hard matter mechanics cannot work for soft matter so I suggest we need a paradigm shift in that respect.

The joint space

Most readers will be familiar with x-rays of the knee joint (Fig 5). Even while standing, the space between the femur and tibia is obvious. This space teasingly hints at the special architecture of the human form. During running, cartilage tissues absorb the crushing forces of three to six times our bodyweight compressing and crashing down on our joints, right? Wrong.

Not even a technologically savvy organisation like NASA has invented a material that could do such a job. Textbooks inform us that cartilage absorbs crushing forces repeatedly, over hours of impact (six times our body weight crushing down on our joints) such as when running a marathon. Thankfully your knee joints are frictionless. This tells us the cartilage is not compressed and therefore has no need to absorb the impact. That is, not in a healthy joint supported by healthy tissue. Of course, massage therapists know that good tissues go bad, at which time compressive forces damage the cartilage and bone.

Imagine you are standing upright. By magic your skin and soft tissues (muscles, fascia, viscera and all) disappear. What would happen to your skeletal system? Of course it would

crash to the floor. But what if we disappeared all your bones, leaving only the soft tissues? Again, we would gather in a soft heap on the floor. This begs the question, "who is holding you up". In such a scenario it is easy to conclude that it is the relationship between the soft and harder tissues working in continuity that provide humans with what we call "lift". It is this lift that protects the integrity of the joint space.

Fig 5: Note the joint space between the articulating bones. (Photo Sharkey, J. 2009)

The Trojan work of my colleague Dr JC Guimberteau (Guimberteau. 2010) has, in pioneering fashion, demonstrated in vivo a histological continuum without any clear separation between skin and hypodermis, the vessels, the aponeuroses and the muscles (Fig 6). Such images from Guimberteau have forever changed our view of the living tissues reflecting a fractal, chaotic (but very organised), shape-shifting architecture of these three-dimensional vacuoles. The work of Dr Guimberteau reflects BioTensegrity in motion under your hands and fingers.

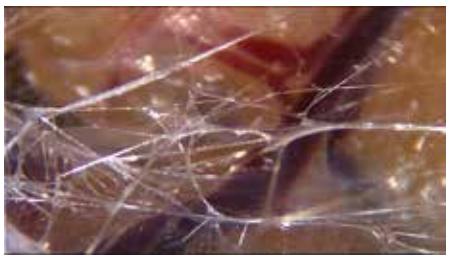

Fig 6: The true image of the connective tissue beneath our skin. A moist, fractal, shape- shifting, hydraulic tubular fluid network. Merging, emerging responding to forces. With kind permission of Dr J.C.Guimberteau and Endovivo Productions

Visible everywhere are structures that ensure a gliding movement between the aponeuroses, the fat structures and the dermis. This also has implications on our view of "stretching" as tissues glide and morph to facilitate movement and perceived elongation. The word gliding is important here specifically as tissues in the human body glide relative to each other but they do not slide relative to each other. In my view the use of the word sliding reflects a common misunderstanding in anatomy. Sliding would result in friction but tensegrity structures (when working as designed) are frictionless as seen in the joints of the body (Fig 5). This is a reason why I say cartilage tissue is not a shock absorber. (www.intensiondesigns.com/s_of_tensegrity.html).

In BioTensegrity there is no internal surface on which to move along unless of course the body breaks down and we experience the pain and discomfort of bone on bone or organ or organ. The space witnessed at joints is a result of the bones floating in the tensional connective tissues. Bones are not meant to touch and when they do (and they sometimes do) this is a reflection of something having gone wrong. In effect, the system is not performing, as it should.

Tensegrity structures are triangulated allowing force transmission in multiple dimensions. When discussing BioTensegrity structures we must take into account our neurofascial network; understanding that the model of BioTensegrity has major implications for our appreciation of the therapeutic mechanisms behind manual soft tissue techniques used in massage such as Positional Release and Strain Counter-Strain, Soft-Tissue Release and others. In fact in her recent best selling book "Yoga Fascia Anatomy and Movement " Joanne Avison makes the point "The implications of understanding tensional forces in this context are exceptionally valuable for yoga teaching". The same can be said for all movement and bodywork models including but not limited to Feldenkrais, Alexander technique, Neuromuscular Therapy, Massage, Osteopathy, Tai Chi and others.

Four Bar (Multibar) Linkage

The joints in our bodies are not made of overlapping bones with pins at either end to secure their positions accurately in an effort to eliminate transversal shifting forces (See Fig 6). As mentioned, our joints have no pins and allow for a space between the boney articulating surfaces. Our vertebral bodies do not slide off each other when we bend forwards or sideways even with a twist. When we bend forwards or lay on our side our vertebral column becomes a beam. The vertebrae should slide off each other in such circumstances, not what the doctor ordered.

Fig 5: (Kindly provided by Joanne Avison)

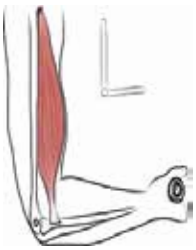

Fig 6: The elbow, like any other joint, would require a hole in the humerus and ulna for bones to overlap and facilitate a pin through the hole and screwed securely in place

We maintain the joint space and its integrity through the omnidirectionality of our living tissues, continuous from finger to toe, from side to side, front to back and top to bottom. The body having originated from one cell has developed, grown and rotated back on itself creating the familiar helical basis of all living structures. The Möbius strip or Möbius band is evident everywhere in the human body from the anatomy of joints to that of the continuous myofascial tissues (I include the hardest of the soft tissues the bone, internal organs and everything else). This moves us from a linear mechanics, hinge like joints and "one muscle works at a time" mentality to a more global, continuously tensioned contractile fabric that facilitates closed chain kinematic linkages. A three bar linkage system would be too rigid and would not allow movement. A four or multi-bar closed chain system provides a cohesive explanation of living movement. It helps to explain, though stored and returned energy in fascia, bone and tendons, how the kangaroo's tendon does not combust into flames on each hop (Fig 7) and why the northern wheatear, a tiny insect-eating Arctic bird, can travel an

enormous 9,000 mile return journey every year without cooking itself to death during the migration. It also moves us to a new vision of bones as primary movers.

Figure 7: BioTensegrity explains how kangaroos can hop without burning their tendons

The multi-bar (four bars or more) system is a self contained, enclosed system where only one motor is required to drive a motion, similar to a pantograph. BioTensegrity is a force transmission energy efficient system. Coming to grips with BioTensegrity helps to explain why a person may be hurting in one body part (the messenger) while the true source of the pain is at a remove. Excessive compression or tension can express itself at the weakest point within the BioTensegrity resulting in a need to identify and treat the true source of insult and not just kill the messenger. As an example, one of my life's goals is to work with surgeons to integrate BioTensegrity principles into their surgical techniques. This requires a fascial sparing approach during surgery as well as a global consideration of the body as a whole.

The burning question

This brings me to the burning question key to massage and all manual therapies. How do we translate forces employed in massage into the BioTensegrity specific resonance that will ensure therapeutic responses at cellular and tissue level? This cannot be achieved by accident nor stumbled across by chance.

It requires expert palpation and soft tissue manipulation skills ensuring continuous, volumetric, non-invasive Guided Stress Transfer (GST). It involves using contact with your client's skin as the interface. It also requires patience and stillness. Slow intuitive motion is the order of the day. According to BioTensegrity Interest Group (BIG) member Leonid Blyum, "Any physical contact between two bodies is, in the first place, being a stress transfer from one to another. That's the bottom-line physics, a hard fact and a tangible reality. Missing such a step in one's reasoning is a major disservice both to the practitioner and to the client".

Stress transfer can occur in many ways. In martial arts a roundhouse kick could provide a stress transfer resulting in a bruise or a break. In massage and manual medicine the stress transfer is seeking to be specific (i.e. guided) utilising appropriate vectors such as force, intensity, direction, duration, sequencing, velocity and depth. The surface contact area is also crucial to ensure the appropriate level of strain. Whatever the effects, muscular, metabolic, neural, fascial, lymphatic, are all dependent on the appropriate level and delivery of the stress guided transfer. In exercise physiology this is called specificity. In bodywork therapy it is known as Specific Adaptation to Imposed Demands (SAID). The application of force on a targeted tissue translates into a change in spatial and textural properties of the matter that it impacts.

In the third and final article in this series I will delve deeper into the important difference between force and strain. I will translate the differences into practical recommendations for massage therapists and movement practitioners.

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