Structure and function reexamined

To the Editor:

Life is complicated and gets more so all the time, but there is simplicity to be found in basic laws that govern our lives. We live and die by these laws. Our bodies are sustained by adequate intake of food, water, and air—a basic law. We are bound to earth by gravity, a law investigated and pronounced by Galileo in 1604. But gravity also contributes to the aging process, and, under some circumstances, we can die violently because of its effects. Another natural law first described by James Clark Maxwell in 1865 states that all substances are surrounded by an electromagnetic field. All electrical appliances create an artificial electromagnetic field, and exposure to too much of this can have adverse effects on health. These effects are more insidious than those of the force of gravity. It is common knowledge in metaphysics that some gifted individuals can see this energy field surrounding our bodies, which is called an aura.

One of the most important laws of nature, of which relatively few people are aware and which many of our own profession ignore, is the relationship between structure and function in the human body. When structure deviates from normal, no matter what the cause, it eventually causes abnormalities, a tremendous contribution to healthcare. We not only live and die by these laws, but our quality of life lies squarely in its hands.

Recently, another important law has been investigated called tensegrity. It involves many of the complex mysteries of life. One of those mysteries is the multistep process of the formation of molecules into substances, and with chemical changes, transformation of substances into cellular forms, cells into tissues, tissues into organ systems, and organic systems into complex forms that can grow, reproduce, develop individual characteristics, and perform complex functions.

We are learning more about the architecture of this complex phenomenon and what drives it: how the human body works through its nervous system, chemical modulators, deoxyribonucleic acid, and genes and the identification of genomes. Both organic and inorganic substances have geometric patterns of spirals, pentagons, and triangular forms and contain many of the same building blocks (eg, carbon, hydrogen, oxygen, sodium, phosphorus). The main difference between organic and inorganic substances is in how atoms are arranged in three-dimensional space, termed self-assembly. Donald E. Ingber, MD, PhD, concluded after research that both organic and inorganic substances self-assemble through a common form of architecture known as tensegrity. This system stabilizes itself mechanically because of the manner in which tensional and compressive forces are distributed and balanced within the structure.

In living structures, cells are continually replaced, so structure is maintained by architectural forces of which there are two categories. One category contains geodesic domes and a framework of rigid struts that can bear both tension and compression. The struts are connected in triangles, pentagons, or hexagons arranged to maintain stability. In the second category, the struts are prestressed. The compression-bearing struts stretch the tension-bearing struts, and vice versa, which distributes forces and stabilizes the mechanism. Both structures have one important feature in that tension is constantly transmitted across all structural members, which also produces stability. In humans, the bones are compression struts; muscles, tendons, ligaments, and fascias are the tension struts.

At the microscopic level, cells contain a cytoskeleton of three polymers: microfilaments, intermediate filaments, and microtubules. These maintain cell conformation, which can be altered by contact with adjacent structures. Thus, cells are governed primarily by tensegrity and not by the colloidal solutions they contain.

Tensegrity is even involved in nerve fiber formation and repair. The cytoskeleton of cells can be altered by changing the forces operating across the cell surface. This change has been shown to affect the biochemical reactions within the cell, especially those of protein, which forms the cellular framework. This is strong evidence of the importance of adequate protein intake in the diet.

A new science is emerging to study the human proteome, the collective body of protein made by cells and tissues. This is proving to be more complicated than the study of genes. Although genes contain the chemical organizers and blueprints of our tissues, proteins provide the building blocks. Deoxyribonucleic acid is built from adenine, cytosine, guanine, and thymine, while proteins are made from twenty different amino acids, providing an infinite variety of combinations.

When the shape of cells is altered, it changes the way cells operate in reproduction, differentiation, and function. This is structure and function at the cellular level.

The next step in self-assembly is the formation of tissues, which behave mechanically and respond in a manner called linear stiffening. In response to increasing tensions, tissues create increased resistance and rearrange themselves in the direction of stress. This fully explains the orientation of fibers in fascia in the lines of stress we see osteopathically.

The geodesic structure referred to earlier occurs everywhere in nature, indicating a basic physical law, tensegrity. Even in irregular structures, such as protein, which are long chains of amino acids, tension is produced by the attractive force of hydrogen bonds, while the protein coil resists compression. All tensegrity structures exhibit characteristic resonant frequencies of vibration that tune all interconnected elements into one. This is consistent with the osteopathic concept of all body parts being an integral part of the whole.

Tensegrity explains why trees on steep mountain slopes are able to grow straight up, unless deformed by strong prevailing winds. It is even speculated that the conformity of the universe is maintained by the compressive forces of gravity and the tensional forces of the centrifugal orbits of planetary bodies. Tensegrity explains why we, in our mobile forms, with the help of our com-
plex nervous system, can maintain erect posture, until our mechanism is damaged by disease, injury, bad postural habits, occupational stresses, etc.

Ellen Shumann, MD, reported that astronauts experience low back pain when traveling into space, and scientists had no explanation for it.6 It seems logical to me that when you remove the compression from a lumbar spine that is constantly compressed by the force of gravity, the tissues will expand, eliciting pain. Tensegrity would confirm this explanation.

Dr Still said, “The osteopaths are the champions of natural law.”7 He had an uncanny understanding of the functions of the human body, before tomography, laboratories, reference books, and the technology that so many of today’s physicians depend on to make a diagnosis. Dr Still believed that the body reveals many clues leading to an accurate diagnosis when examined by a careful palpating hand. He knew anatomy thoroughly and understood how the body functions, which enabled him to develop manipulative procedures to restore function integrity. These manipulative procedures, coupled with good nutrition, are capable of overcoming many health problems and maintaining good health. As modern technology digs deeper into the secrets of life, new findings only strengthen the philosophy of Dr Still and his basic law of nature: that structure and function are inexorably related.

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References