The Elasto-Collagenous Complex

By John F. Barnes, PT

Structural Integrity

The following is information about the evolutionary, biochemical, anatomical and functional aspects of connective tissue. Its purpose is to evaluate the elasto-collagenous aspect of our physical structure and how we as therapists can better understand its impact upon our patients' function and health.

It has been estimated that if we could somehow remove every structure of the body except the fascia, the body would retain its shape. Every muscle, bone, nerve, organ and vessel of the body is covered with fascia like a continuous saran wrapping.

Superficial fascia is a second "skin" just under the skin. This body stocking infuses into a deeper layer (deep fascia) covering each muscle. These layers are identified as follows. The "epimysium" is the second "skin" of the muscle. Each muscle bundle is surrounded by "perimysium" and each individual fiber is surrounded by "endomysium." The muscle belly converges into the tendon which attaches to the fascia covering the bone, the pain-sensitive, "periosteum."

With this image in mind, the following information from the texts *Physiology of Exercise and Journal of Applied Physiology,* states: "The importance of the fascial tissues has been shown by a recent experiment in which a small slit in the epimysium of the fascia resulted in 15% loss in muscle strength."[1]

"The data clearly indicates that the presence of fascia is important in the development of muscular tension and pressure. As shown with surgical fascial release, there is approximately a 15% reduction in the forces produced and a 50% decrease in the intracompartmental pressure developed during muscle contraction."[2]

The following information is paraphrased from "Molecules That Keep You in Shape" by John Scott, professor of chemical morphology at the University of Manchester in the *New Scientist,* July 24, 1986 pg. 49-53.

Connective Tissue and Our Body's Structural Integrity

- "It is easy to overlook the advantage of having a definite shape. A nervous system that could communicate speedily and precisely with any part of a complicated organism, for instance, would operate with difficulty if the organism could not maintain the relative positions of the various parts of itself. Although our shape is characteristic, it changes, grossly and subtly, throughout our life. These are all reflections on our connective tissues. Connective tissues give us strength to resist mechanical stresses, and a recognizable shape which persists in the face of these forces. John Arcadi, from the University of California at Los Angeles, put it well: "If by some magic solution one could dissolve all the connective tissues of the body, all that would remain would be a mass of slimy epithelium, quivering muscle, and frustrated nerve cells."
- In the first stages of evolution of multi-celled organisms, two or more cells stayed together, to share the labour of living. The structure that helped them to stay in contact allowed communication between them, and was strong enough to resist buffering by the environment. As the cells evolved, the connecting tissue also evolved to respond to more difficult tasks. The remarkable finding, from 30 years of investigations, is that the framework of connective tissue in which evolution took place has remained more or less constant in general design and composition over hundreds of millions of years.[3]

Fascia, the immediate environment of every cell of the body, can have a profound influence on cellular health.

Fascial restrictions can impede proper cellular metabolism, respiration, nutrition, elimination, fluid and lymphatic flow. Fascia, home of the phagocyte, can

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influence the immune system. In other words, fascial restrictions can create the environment for pain, dysfunction, disease and necrosis!

The Function and Molecular Structure of Connective Tissue

• Connective tissues must abe able to resist both pulling (tensile) and compressive stresses. To this end they contain two different elements, fibres and interfibrillar jelly. The fibres resist tensile stresses, thus determining the maximum size of the tissues. The jelly-like filling between the fibres resist compressive forces.

• Tendons, which are specialized for pulling, contain mainly fibers. Cartilage, which often acts as a shock absorber at the end of bony structures, contains much water-rich gel. Later in evolution, living organisms found ways of replacing the watery jelly with insoluble inorganic material, such as calcium phosphate, to give much harder and less deformable structures — that is, the skeleton evolved.[3]

Proteogylcans - A Complex Gel

• Proteogylcan is the name given to the polymers which form the gel between collagen fibrils. Proteoglycans molecules (PGs) are some of the most complicated molecules known to biochemists, but their basic structure can be represented by the simple bottle-brush diagram. The shank of the brush is the polypeptide and the bristles are the glycans. Each takes its name from the glycan chain it carries.

• The simple bottle-brush diagram satisfactorily summarizes current knowledge. One glycan, hyaluronan, is the odd one out, in that it does not link up to polypeptide. It is, therefore, not a proteoglycan, but it is chemically so similar to the other PGs, and is found so closely associated with them, that it is regarded as "honorary PG." In evolutionary terms, it may be the oldest of all the connective tissue components.

Hyaluronan may be the "keystone in the arch," stabilizing the jelly against the leakage of PGs that might otherwise occur under the persistent pounding that connective tissues, and cartilage in particular receive.

• The jelly itself is in contact with the outside world via the lymph, blood and so on.

It is important that as long as the forces are not too great, the gel of the matrix is designed to absorb the shock and disperse it throughout the body. If fascial restrictions are present when a person is traumatized, the forces cannot be dispersed properly and areas of the body are then subjected to forces beyond their tolerance and injury occurs.

This could be a car accident or a fall where maybe the forces were not enormous but the person just didn't have enough "give" and was severely injured.

This also begins to explain all the reoccurring sports and performance injuries that persist despite appropriate therapy and strengthening and flexibility programs. So an athlete with these very common fascial restrictions will not efficiently absorb the shocks of peak performance. The body then absorbs too much pressure in too small of an area and during performance the body keeps "breaking down."

This same scenario takes place over time from the micro-trauma, step after step of having a long and short leg from structural leg length discrepancy caused by a torsioned pelvis, which is extremely common. Each step can produce microtrauma sending imbalanced forces throughout the body, the body must compensate through muscular spasm and fascial restrictions ultimately producing symptoms.

Molecular Structure

• The molecule that makes up the major part of the fibrous material in the body-collagen is a remarkable example of evolutionary economy. Its molecular structure leads with elegant inevitability to the production of fibrils that resist pulling forces efficiently.

• One recently characterized collagen, type IV, does not form linear fibrils, but rather ramified, fishnet structures. These fishnets are thought to be the scaffolding of sheets of tissue called basement membranes, which act as a kind of bag surrounding groups of cells. The importance of basement membranes in preserving the internal environment is currently of great interest to biologists. Their involvement in life-threatening processes such as the invasion of healthy tissues by tumors is the focus of much attention.

• The plymers that give the jelly its characteristic properties are called proteoglycans. These extraordi-

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nary diverse molecules are hybrids of polypeptides (fragment proteins) and polysaccharides.

- Thus even in the watery jelly of soft connective tissues such as skin there is structure, and this structure is centered around the binding site of the collagen fibril.

The proteoglycan jelly that surrounds the collagen fibrils protects them from attack. In several forms of arthritis it seems that the breakdown of this gel is the first stage in the erosion of cartilage, which is followed by severe damage to the joint.

- The study of collagen and its jelly may one day enable us, as in Aldous Huxley's *Brave New World,* to maintain our youthful appearance right up until the point of death![3]

Collagen as Protein

- Collagen, from the Greek for "glue-producer," is a protein, consisting of three polypeptide chains (the a-chains) twisted around each other in a triple helix.
- The a-chains are about 1,000 amino acids long, which is on the large side for a polypeptide, but they have a simple structure. Hydroxyproline is characteristic of collgagen. It is found in very few other proteins. Glycine and proline or hydroxyprolien contribute vitally to the formation of the triple helix. Glycine is the smallest amino acid, takes up the least room, thus allowing the polypeptide chains to be packed tightly in the triple helix. Both Linus Pauling and Francis Crick, of DNA double helix fame, had a hand in working out the triple helix of collagen, which in its present form was proposed by N. Ramachandran, from Madras.
- This accounts for the property of collagen molecules to line up spontaneously in a quarter-stagger array, which grows to form the fibril.
- The quarter-staggered overlap ensures that there are no weak points across the fibril, which could give way under tension. The presence of every collagen molecule of three polypeptide chains, intimately interwined, gives a big margin of safety against overload and slippage. Collagen fibres are thus almost inextensible. In situations where elasticity is requited, in skin or arteries for example, an excess length of collagen fibres is laid down in a parallel with fibrils of another protein, elastin, which as its name implies, is intrinsically rubber-like. This combination can absorb tensile stresses. The collagen acts as the ultimate arbiter of maximum distortion, beyond which rupture occurs.[3]

As mentioned earlier, the ancient Greeks discussed collagen as the "glue producer," and this is the feeling one perceives during Myofascial Release. As the release occurs, it feels like glue stretching. The therapist follows this sensation with sensitive hands as it twists and turns, barrier through barrier until an increased range of motion is accomplished.

In addition to increases in range of motion, the enormous pressure of the fascial restrictions are eliminated from pain-sensitive structures, alleviating symptoms and restoring the quantity and quality of motion and our bodies' ability to absorb shock.

The effectiveness of releasing the fascia can be understood by viewing the fascia as a handle or lever which seems to profoundly influence the golgi tendon organs, the spindle cells of its muscular component, the position of the osseous structures, the lymphatic and circulatory systems, all the organs of the body and the central, peripheral, and autonomic nervous systems. Myofascial Release has enabled physical therapists to impact upon these important systems with consistent clinical results.

REFERENCES

1) deVries, Herbert A., *Physiologyof Exercise.* University of Southern California, William C. Brown, Fourth Ed., 1986.

2) *Journal of Applied Physiology,* August, 1981, Vol. 5, pgs. 317-320, "Role of Fascia in Maintenance of Muscle Tension and Pressure," Division of Orthopaedics & Rehab., Univ. of Calif.

3) Scott, John, "Molecules That Keep You in Shape". *New Scientist,* July 24, 1986, pgs. 49-53.

4) Kyoto, J., *Tensile Strength of Fascia,* Prefector Medical U., 69:484-488, 1961.

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ABOUT THE AUTHOR:

John F. Barnes, PT, graduated from the University of Pennsylvania as a Physical Therapist in 1960; he holds physical therapy licenses in Pennsylvania, Arizona, New Jersey, Delaware, Colorado, and Hawaii. John is on the Counsel of Advisors of the American Back Society; is an Editorial Advisor of the Journal of Bodywork and Movement Therapies; and is a member of the American Physical Therapy Association.

John lectures internationally presenting the "John F. Barnes Myofascial Release Approach" seminar series and "Advances in Spinal Diagnosis and Treatment for the 21st Century," for the American Back Society.

He wrote the definitive book "Myofascial Release: the Search for Excellence" in 1990. He has also been a columnist for the Physical Therapy Forum's, "Therapeutic Insight" column; he has contributed to Physical Therapy Today writing articles for his "Mind & Body" column; and has written several articles for the Advance for Physical Therapists publication. John also wrote a second book, "Healing Ancient Wounds: the Renegades Wisdom," which was published in 2000.

John F. Barnes, PT, was named one of the most influential persons in the therapeutic professions in the last century, in the national Massage Magazine's featured article "Stars of the Century." John was also the featured speaker presenting his "Myofascial Release Approach" at the American Back Society's meeting whose theme that year was, the most important advances in healthcare in the last century!

MYOFASCIAL RELEASE FOR:		
Back Pain	Whiplash	Migraines
Jaw Pain (TMJ)	Fibromyalgia	Chronic Fatigue
Disc Problems	Myofascial Pain	Syndrome
Headaches	Syndrome	Carpal Tunnel
Sports Injuries	Infants/Children	Adhesions
	Neurological	Neck Pain
	Dysfunction	Scoliosis
	Chronic Pain	Sciatica

WOMEN'S HEALTH PROBLEMS:		
Pelvic Floor Pain	Mastectomy Pain	Problematic Breast
and Dysfunction	Painful Intercourse	Implant/Reduction
Urinary Incontinence	Urinary Urgency	Scars
Infertility Problems	Vulvodynia	Menstrual Problems
	Endometriosis	Urinary Frequency
	Painful Scars	Coccydnia (Tail Bone)
	Interstitial Cystitis	Adhesions
	Lymphedema	Episiotomy Scars