

The basic science of myofascial release:

morphologic change in connective tissue

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Introduction

It is imperative, as manual therapists, to seek and understand a comprehensive and cohesive model of what happens to the body's tissues following trauma, and how we facilitate health in our patients. This greater understanding can potentially lead to increased potency of treatment as well as encouraging a multidisciplinary approach. The conscientious bodyworker needs to ask, 'what am I trying to accomplish with my treatment, and what is happening beneath my hands to create these desired changes in tissue health and structural alignment?' The facilitation of the body's self-correcting mechanisms, directing the tissues and systems toward metabolic and morphologic efficiency, and ultimately gaining functional, pain-free movement, should be major goals of treatment.

It is theorized that the alterations in

tissue texture and tension resulting from myofascial release (see Sidebar over page) come from dynamic changes in the connective tissue and neuromuscular systems of the body. These two systems have been shown to be vitally interrelated in function and in their response to therapy (Pischinger 1975). This relationship is cellular, systemic and somatic.

This theoretical and clinical approach asks the individual to reflect on their view of the body; how it is structured, functions and communicates. It involves a conceptual shift from a biological systems infrastructure model to a self-organizing cybernetic biological systems model. Ideally, practitioners of various bodywork approaches are constantly updating their paradigm about bodily function, potentially leading them to a greater unified theory of somatic dysfunction and treatment. According to Foss (1987), health care is entering a second

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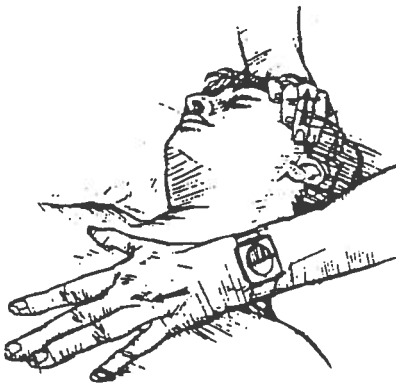
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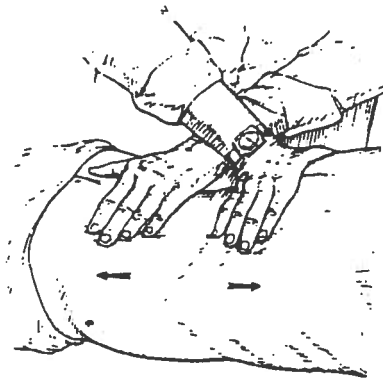
What is myofascial release?

Fascia is tough connective tissue which spreads throughout the body in a three-dimensional web from head to toe. The fascia is ubiquitous, surrounding every muscle, bone, nerve, blood vessel and organ all the way down to the cellular level. Generally, the fascial system provides support, stability and cushioning. It is also a system of locomotion and dynamic flexibility forming muscle.

Tightening of the fascial system is a histologic, physiologic and biomechanic protective mechanism that is a response to trauma. The fascia loses its pliability, becomes restricted, and is a source of tension to the rest of the body. The ground substance



Release of the anterior cervical region.



Cross-hand release to the lumbar region.

solidifies, the collagen becomes dense and fibrous, and the elastin loses its resiliency. Over time this can lead to poor muscular biomechanics, altered structural alignment, and decreased strength, endurance and motor coordination. Subsequently, the patient is in pain and functional capacity is lost.

Myofascial release is a hands-on soft tissue technique that facilitates a stretch into the restricted fascia. A sustained pressure is applied into the restricted tissue barrier; after 90–120 seconds the tissue will undergo histological length changes allowing the first release to be felt. The therapist follows the release into a new tissue barrier and holds. After a few releases the tissue will become softer and more pliable. The restoration of length and health to the myofascial tissue will take the pressure off the pain sensitive structures such as nerves and blood vessels, as well as restoring alignment and mobility to the joints.

medical revolution. In the face of this revolution, this conceptual shift is necessary to advance the quality and efficiency of patient care. This article will discuss the connective tissue response to trauma and myofascial release, supported by a biocybernetic model of morphologic function.

The connective tissue response to trauma encompasses adaptive responses of the morphologic and neuromuscular systems, reflected clinically as dysfunction and pain. These concepts are the very foundation required for understanding the body's response to trauma, and treatment of subsequent dysfunction.

Major developments in biocybernetics

1948. Wiener founded a new interdisciplinary science with his

book, *Cybernetics or the control and transmission of information in the living organism and machines*. This concept was paramount in advancing modern thinking in all areas of science (including biology; biocybernetics), technology and cultural studies. It is the very foundation of system science, in which a unified theory of somatic dysfunction and treatment will be based (Wiener 1948).

1951. Hans Selye's research on stress showed that the body always reacts to various stimuli, trauma and stress, both physiological and psychological, in the same non-specific way. This was termed the *adaptation syndrome*, consisting of a bodily alarm reaction, resistance phase and exhaustion phase (Selye 1956).

1965. Pischinger's environmental theory (Milieu-Theorie) is based on the observation that there are no classic synapses for the parenchymal cells in the neurovegetative periphery. The entire basic autonomic system acts practically as a 'ubiquitous synapse'. He clarified the extent of humoral regulation and showed that there are certain complexes on which humoral regulation depends. According to his theory both the neural and humoral controls have their roots in the active, interstitial connective tissue. Autonomic regulation between the cell and the extracellular environment takes place within this tissue matrix (Dosch 1984).

Cybernetics regards man as a highly developed, self-regulating system always attempting to reach homeostasis and equilibrium. The principle of linear causality, a mechanistic philosophy of cause and effect – on which much of western medicine is based – no longer applies to the treatment of musculoskeletal disorders, especially diseases chronic in nature. For example, fibromyalgia is both a connective tissue and neuromuscular syndrome, having fascial tightening and hypertonus points. This syndrome has proven to

be self-perpetuating and to date has perplexed much of the medical community.

General cybernetic principle in organisms

- A system science perspective recognizes the cybernetic nature of all physical, physiological and psychic processes as being subject to uniform laws.
- These laws apply to both living and inanimate matter which are based on identical principles of control, coordination and regulation.
- These processes also make use of homeostatic feedback mechanisms (circuits) to produce continual reciprocal checks and balance among intermeshed levels of organization.
- Disease symptoms, such as chronic pain in the soft tissues, can be regarded as regulatory disturbances and this is considered to be a biocybernetic problem of persistent malfunction of the information and feedback mechanisms, as in the example of fibromyalgia mentioned above.

Connective tissue

Connective tissue is analogous to fascia, they are one and the same. In much of the osteopathic and physical therapy literature, fascia is considered to be sheaths of primarily collagen that form cavities and muscular septums that cover organs. It is necessary to shift this concept of fascia to the ubiquitous and multifunctional system of connective tissue. The very term connective tissue denotes its primary role; a tissue that interrelates every part of the whole, creating an integrated body. Connective tissue comprises collagen, elastin and ground substance. The collagen gives support, shape and stability, the elastin gives dynamic flexibility, and the ground substance provides cushion and surrounds every

cell determining its functional capacity. The ground substance makes up the bulk of the extracellular matrix and it is towards this environment surrounding the cell that the work of Pischinger is directed.

The cell environment and information exchange

The molecular biology of the extracellular matrix is made of sugar polymers either in free form or bound to proteins and lipids: proteoglycans (PGs), glycosaminoglycans (GAGs) and structural glycoproteins. These form the intercellular substances, and because of their high water binding and ion exchange capacity, serve as conductive material for the exchange of information between cells and the rest of the body.

Bordeu (1767) recognized that the connective tissue has more than a supporting role and space-filling function, and that it has nutritional and regeneration tasks in the service of specific organ functions as well as in the mediation of nerve and vascular functions. C.B. Reichert (1845) recognized that the connective tissue was not only responsible for mechanical binding, but also an organically vital medium and barrier between nerve and nutrition flow. Wittlinger (1978), in reference to Vodder's 'Manual lymph drainage', discusses the function of the ubiquitous loose connective tissue and states: 'This tissue is an organ, and as such has many functions and capabilities. It is the vehicle of the unconscious and undifferentiated bodily functions. It regulates bodily processes and primarily controls the physiochemical and bioelectrical situation. It thus regulates such vital functions as temperature, water, mineral and energy balance, including glycolysis and respiration'. The perfect functioning of the bioelectrical processes is dependent on the presence of synapses. These determine whether

and in which direction stimuli are transmitted further (Dosch 1984). The state of the interstitial connective tissue, being the ubiquitous synapse for autonomic impulses, will determine the quality and quantity of information flow between cell and central nervous system (CNS). This strongly suggests that the connective tissue has direct contact with all parts of the body. The ground regulation system, the terrain where local to global bodily dysfunction occurs, lies within this triad of parenchyma, capillary networks and nerve endings (extracellular matrix).

Ground regulation system and cellular communication

In 1975, Alfred Pischinger published *Matrix and Matrix Regulation. Basis for a Holistic Theory in Medicine*. This work offers the basis for an understanding and explanation of the morphologic and physiologic events occurring with manual therapies such as myofascial release, joint mobilization and various movement therapies. Pischinger founded his observations on the works of Wiener (1962) who propagated developments in cybernetics and thermodynamics, and Von Bertalanffy (1952) who described biological systems as non-linear, but highly integrated and subject to biological vital flow equilibrium. The biological system exchanges energy and material with its surroundings as 'open systems'.

According to Pischinger, open systems are in contrast to the classical Newtonian closed systems. Open systems show that when there is an influx of non-chaotic energy, this energy can spread suddenly through the entire system. The essential points in this phenomenon are the transmission and dissemination of information. The body acts as an open feedback system like a thermostat in a house, in contrast to a light switch that only has an on or off mode. The body

has available many varying states that are receptive to input and has the ability to adjust itself accordingly for homeostasis. Pischinger concerned himself with investigating and describing the communications that the connective tissue uses to spread itself over the entire organism.

Pischinger's system of ground regulation (Fig. 1) is defined as the functional unit of the final vascular pathway, the connective tissue cells and the final vegetative-nervous structure. The entire field of activity and information of this triad is the extracellular fluid, forming a matrix. The lymphatics and lymphatic organs are also connected, constituting the largest system penetrating the organism completely. It regulates the 'cell milieu' determining the extracellular environment, providing nutrition to the cells and eliminating waste, at the same time a part of every inflammatory and defence process. Therefore it is responsible for all basic vital functions of the organism.

According to Pischinger, it is in this extracellular environment that all

the primary regulating processes occur which make life possible. The basic concept:

- It is a medium for the oxygen, water and ion balance (the basic autonomic system) to indirectly produce energy, and all the other conditions essential for the organ cell to live.
- All external stimuli must pass through this basic tissue to reach the organ cell.
- The autonomic fibres have no synaptic connections to the parenchymal cells, they must form mediating chemicals which have to pass through the extracellular fluid to act upon the cell.
- Therefore the cell and its environment are continually interacting with each other, forming a tri-level intermeshed circuit of cellular, neural, humoral control, attempting to maintain homeostatic functional equilibrium.
- If the functions of the interstitial connective tissue are impaired by interference fields (trauma), the

defence system is subject to permanent stress and the defensive capability of the organism is constantly reduced.

- As long as this situation can be compensated, the body remains apparently healthy.
- If the noxious stimuli of the interference field exceed the tolerance of the autonomic system, functional disturbances and objective pathological changes will occur (Kellner 1976).
- As a consequence, the organism will be forced to further compensate, overwork and breakdown. This is seen clinically as physiologic, neuromuscular and mechanical loss of efficiency and function.

Connective tissue response to trauma

The moving body depends on connective tissue for support and biomechanically efficient movement. Connective tissues make a major contribution to the dynamic properties of the body. Movement depends on connective tissue being functional and properly distributed. Tightening of the fascial system due to trauma is a protective mechanism that will arise from either micro-trauma over time or acute injury such as a contusion or tendon strain. The fascial components lose their pliability, become restricted, and are a source of tension for the rest of the body. This is specifically evident at the ground system/cellular level (Ingber 1989) as well as mechanically from collagenous integrity (Klebe 1989, Levin 1990) in which the ground substance solidifies, the collagen develops cross links, is fibrous and dense, and the elastin loses its resiliency.

Stauber (1990) reported disruption in the extracellular matrix following post-traumatic eccentric exercise with resultant inflammatory response and pain (Fig. 2). Stauber (1994) later reported a 44% increase in non-

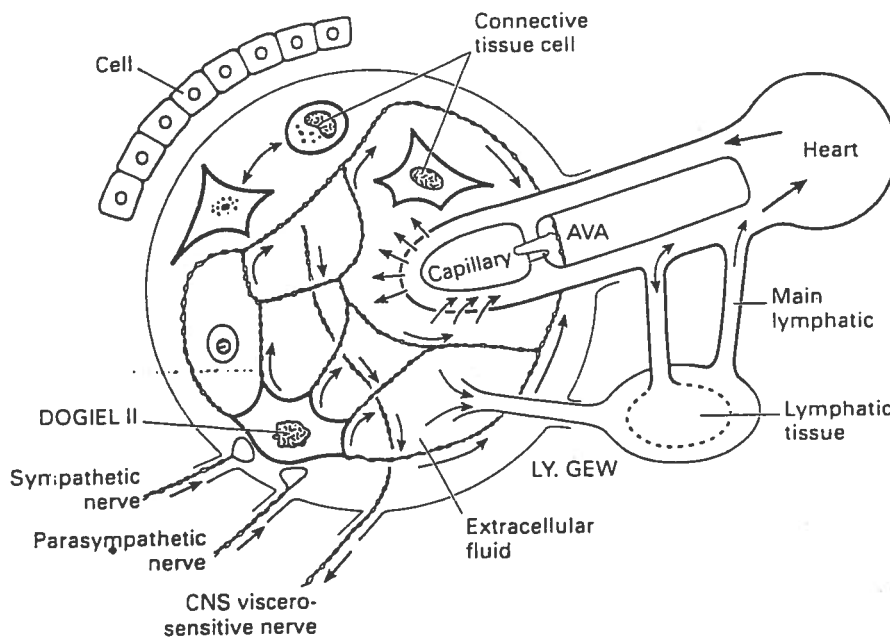


Fig. 1 The ground regulation system (A. Pischinger, University Histological Institute, Vienna).

contractile tissue (expansion of extracellular matrix and fibrosis) after 4 weeks of repeated muscular strain (Fig. 3). Many researchers have identified the loose and dense connective tissue response to trauma (Forrest 1983, Rennard 1984, Hunt 1985) demonstrating the tendency of the connective tissue to solidify and develop adhesions, and become less resilient both physiologically and mechanically with trauma. The effects of these changes, in the long term, are detrimental to the functioning and efficiency of the myofascial tissues. At the cellular level, Heine (1972) states:

'Phylogenetically the extracellular matrix is older than the nerve and hormonal systems. In its formation and breakdown it is appropriately regulated by a very basic cell system in a *compensatory* way: the fibroblast macrophage system. Since the fibroblasts are not able to differentiate between the good and the bad situation, the result in chronic alterations is the development of an extracellular matrix whose structure is not physiologically efficient, which can make an important contribution to the development of chronic diseases.'

Mechanical stress due to connective tissue tightening

Fascial restrictions can create abnormal strain patterns that can crowd, or pull the osseous structures out of proper alignment, resulting in compression of joints producing pain and/or dysfunction (Fig. 4). Neural and vascular structures can also become entrapped in these restrictions, causing neurologic symptoms or ischaemic conditions. Shortening of the muscular component of the myofascial fascicle can limit its functional length – reducing its strength, contractile potential and deceleration capacity. Facilitating positive change in this system would be a clinically relevant event.

Cellular and CNS stress due to connective tissue response

Hans Selye (1956) has clearly demonstrated a specific and

stereotyped reaction of the hormonal system to 'the stress of life'. Due to the bioelectric information capacity of the extracellular matrix, any situation that alters the electrical tone of the matrix can be encoded, and reciprocally spread and processed through the entire organism, a potential byproduct of cellular shock (Fig. 5). Therefore, the solidification of the extracellular matrix with trauma (whiplash for example, see Fig. 6) and inflammation will produce a signal of cellular shock, transmitted via the neurovegetative pathway to the brain stem and higher regulatory centres. In lung biopsies of severely traumatized accident victims, Heine (1980) showed severe disturbance in extracellular matrix

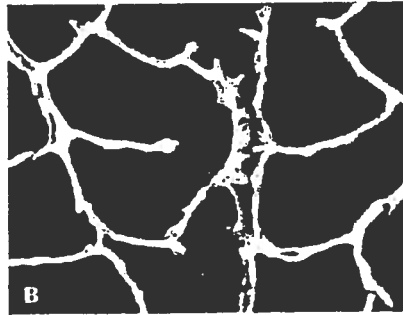
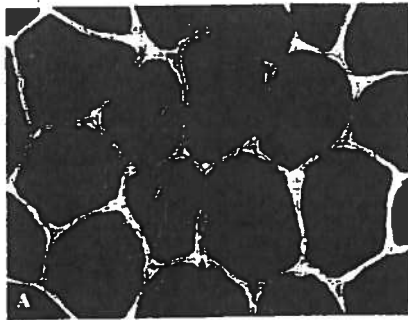


Fig. 2 (A) Normal extracellular matrix and (B) extracellular matrix disruption and thickening with resultant inflammation (Stauber 1990).

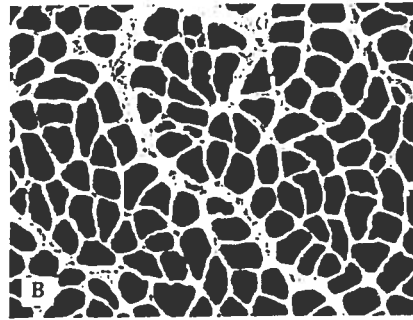
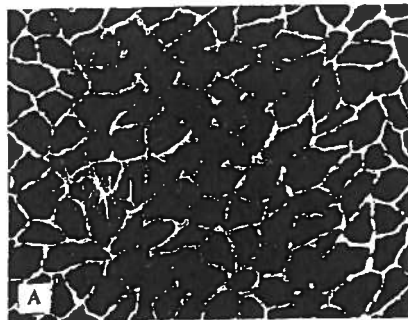


Fig. 3 (A) Normal cellular matrix and (B) extracellular matrix disruption, collagen fibrosis and 44% increase in non-contractile tissue.

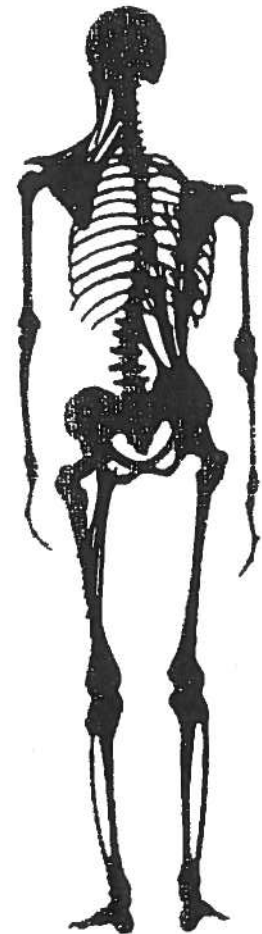


Fig. 4 3-D myofascial restrictions.

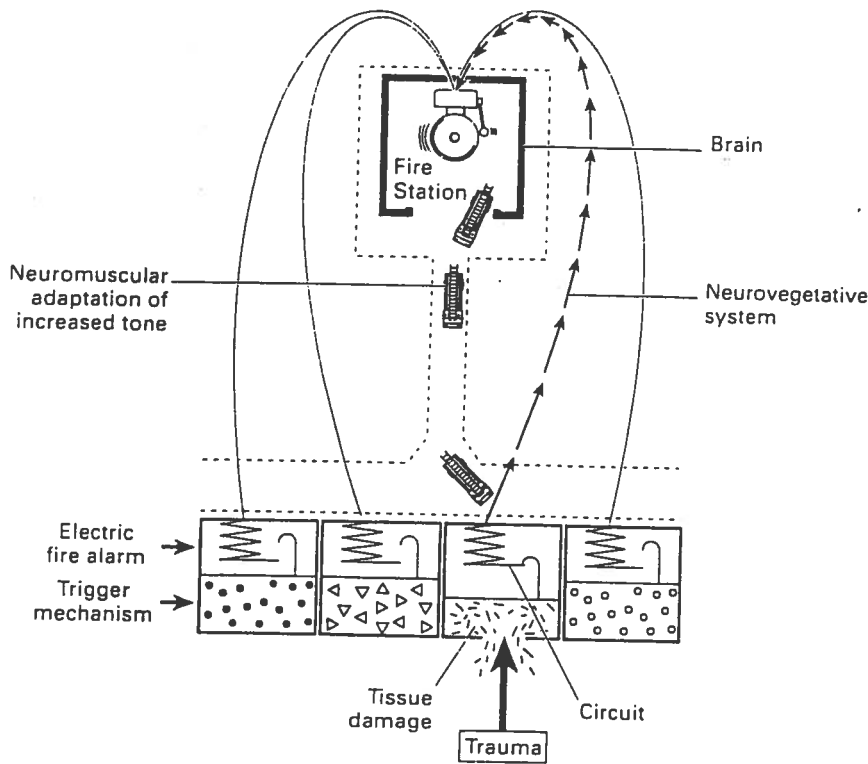


Fig. 5 Neuromuscular whole body response to extracellular matrix damage.

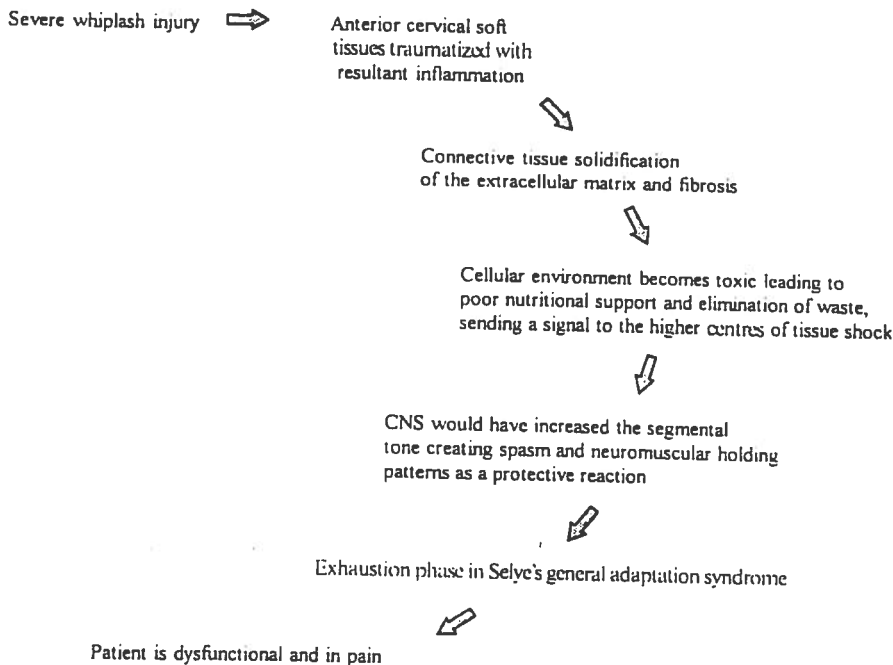


Fig. 6 Series of events resultant from injury as a whole body phenomenon.

and significant increase in collagen in the alveolar septa within 30 minutes, producing shock lung syndrome weeks later.

Problem-solving dysfunction

Many musculoskeletal dysfunctions

have as a major component connective tissue tightening and compensatory neuromuscular activity; for example, the patient with an excessive forward, rounded shoulder from tight pectorals and an infraspinatus trigger point. This results in supraspinatus tendonitis and impingement as well as rotator cuff insufficiency. These are usually reversible if the practitioner addresses the early signs of tissue damage or changes the somatic reaction to the type of stress being adapted to, so encouraging the pathologically modified tissues towards normality, provided repair is still possible (Dosch 1984).

Such therapeutic facilitation as in myofascial release, is seen to be potentiating the inherent self-correcting mechanisms of the human body. According to Dosch, disease is a cybernetic problem, as it is a result of a disturbance of the regulating functions within the interacting structure of the self-regulating dynamic system that is man, and is due to malfunctions in the transmission and processing of information between the individual control circuits within the overall system. He further states that it is the physician's task to act upon these disturbances of faulty control systems in order to restore control and put the disturbed biological functions back into order.

Myofascial release

Connective tissue is colloidal in nature, having elastic, plastic, viscoelastic and piezoelectric properties. Its morphologic state is determined by proportions of energy input and temperature. Deformation is well described by the spring and dashpot model, and stress/strain curves (Zachazewski 1989). The spring and dashpot model (Fig. 7) depicts the viscoelastic functional properties of connective tissue of deformation over time (90-120 seconds). The stress-strain curve

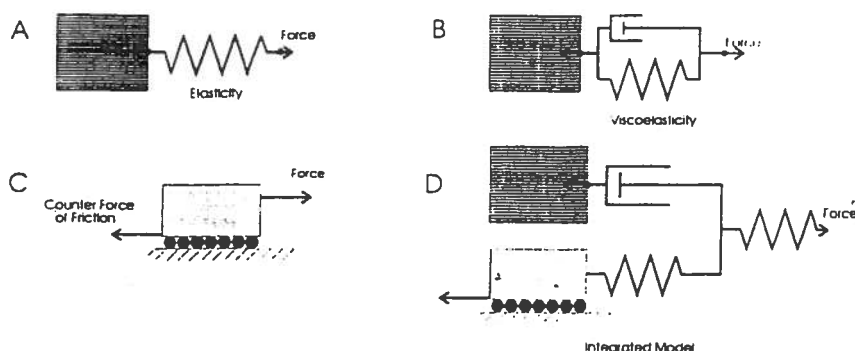


Fig. 7 Functional properties of collagenous tissue: spring and dashpot model. A- D represent morphologic change in viscoelastic connective tissue (permanent length change by the application of a low load, long duration stretch into the tissue as with myofascial release).

(Fig. 8) represents the same viscoelastic properties, but also depicts the failure of the tissue when rate of deformation exceeds the tissue tolerance to the amount of load. The goal of myofascial release is to

elongate and soften the connective tissue, creating permanent three-dimensional length and width.

Most important to this discussion is the change of the ground substance from a sol to a gel. This occurs with a

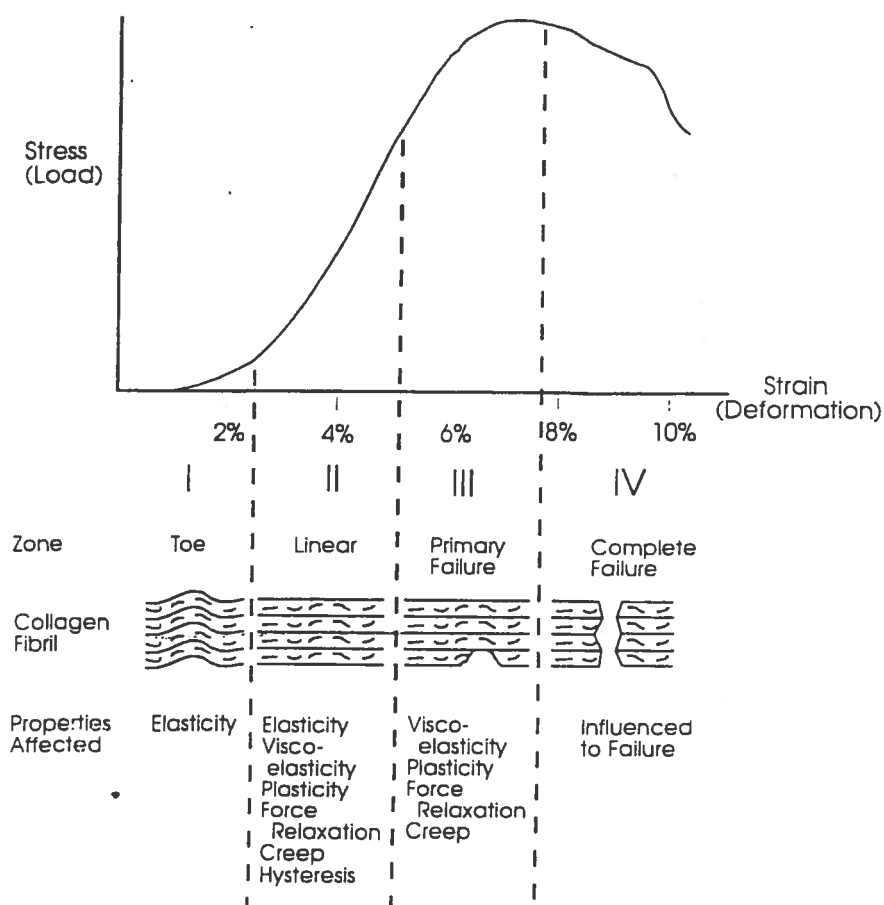


Fig. 8 Stress-strain curve.

state phase re-alignment of crystals exposed to electromagnetic fields. This may occur as a piezoelectric event (changing a mechanical force to electric energy) changing the electrical charge of collagen and proteoglycans within the extracellular matrix effecting the ionic state of the ground substance (Schmitt 1955, Athenstaedt 1974, Linsenmayer 1983). Athenstaedt states that: 'the entire organism is interwoven with chains of piezoelectric dipolar molecules which are capable of oscillation due to their spiral nature. Alterations in the functional capacity of this three-dimensional, ubiquitous network, provides further reason for degeneration in the movement system and that regulatory processes can be affected by varied techniques facilitating change in the polarity potential of the tissue' (myofascial release to acupuncture).

The molecular form of proteoglycans is particularly suitable for binding water, creating the viscoelastic, shock-absorbing and energy-absorbing behaviour of the extracellular matrix. The special suitability of these networks of water molecules and proteoglycans for information conduction and storage between cells is optimal at 37.5°C (normal body temperature). False information stored within the liquid crystals could therefore be cancelled by temperature increase and piezoelectric events, transferring the extracellular matrix back to a homogeneous fluid (Trincher 1981). This process ideally depolarizes the interstitial tissue and resets the ground regulation system to be more efficient in information transmission and eliminate any false signals produced by the crystalline dehydrated matrix.

In light of this information, the introduction of a mechanical force, myofascial release, following the low load, long duration principle of the spring and dashpot model would be sufficient to change the phase state of the ground substance, creating an

extracellular environment of a healthy and efficient fluid gel. Barnes (1990) has described myofascial release as having a three-dimensional quality with a sustained pressure (90–120 seconds) into the colloidal/viscoelastic fascial tissue, having the goal of restoring length, dimension and health to the tissue environment.

It is now possible to recognize the empirical results of myofascial release. There is an underlying simplicity and explanation to what is being performed clinically through basic science which has not, to the author's knowledge, previously been explained in this way. Biocybernetics and a connective tissue/neurovegetative system (Pischinger's ground regulation system) of somatic communication seem to offer possibly the best explanation to date (Fig. 9).

Myofascial release is now widely taught and practised, with impressive claims of benefit in terms of pain reduction and functional improvement. The underlying scientific principles described in this paper may help to demystify this therapeutic approach and so help to explain its well documented results in terms which mainstream

practitioners and therapists find acceptable.

REFERENCES

- Athenstaedt H 1974 Pyroelectric and piezoelectric properties of vertebrates. *Ann New York Acad Sci* 238: 68–110
- Barnes J F 1990 Myofascial Release: The Search for Excellence. Rehabilitation Services Inc., Paoli, PA
- Bertalanffy L V 1975 Perspectives of General Systems Theory. Braziller, New York
- Bordeu L 1767 Recherches sur le tissu muqueux ou l'organ cellulaire. Paris
- Dosch P 1984 Manual of Neural Therapy according to Huneke. Haug, Heidelberg
- Forrest L 1983 Current concepts in soft tissue wound healing. *Br J Surg* 70: 133–146
- Foss L, Rothenberg K 1987 The Second Medical Revolution: From Biomedicine to Infomedicine. New Science Library, Boston
- Hanna T 1979 The Body of Life: Creating New Pathways for Sensory Awareness and Fluid Movement. Healing Arts Press, Rochester, AL
- Hanna T 1988 Somatics: Reawakening the Mind's Control of Movement, Flexibility, and Health. Addison-Wesley Publishing Company
- Heine H 1972 quoted in Pischinger 1991 p.24
- Heine H, Henrich H 1980 Reactive behaviour of myocytes during long-term sympathetic stimulation as compared to spontaneous hypertension. *Fol Angiol* 28: 22–27
- Hunt TK, Banda MJ, Silver IA 1985 Cell interactions in post-traumatic fibrosis. *Clin Symp* 114: 128–149
- Kellner G, Kleine G 1976 Richtlinien zur Synovialzytologie. *Z. f. Rheumatologie* 35: 141–153
- Levin SM 1990 The Myofascial-Skeletal Truss: A System Science Analysis. In Barnes JF (ed) Myofascial Release. Rehabilitation Services Inc., Paoli, PA ch4
- Linsenmeyer TF 1983 Collagen. In Hey ED (ed) Cell Biology of Extracellular Matrix, 2nd edn. Plenum Press, New York, pp 5–38
- Paylov IP see Dosch 1984 p. 71
- Pischinger A (German ed. 1975. English ed. 1991) Matrix and Matrix Regulation: Basis for a Holistic Theory in Medicine. Haug International, Brussels
- Rennard SI, Bitterman PB, Crystal RG 1984 Current concepts of the pathogenesis of fibrosis: lessons from pulmonary fibrosis. Myofibroblasts and the biology of connective tissue. Alan R Liss, New York, pp 359–357.
- Selye H 1956 The Stress of Life. McGraw-Hill, New York
- Schmitt FO, Gross J, Highberger J H 1955 Tropocollagen and the properties of fibrous collagen. *Exp Cell Res (Suppl. 3)* 326–334
- Stuaber WT, Clarkson PM, Fritz VM, Evans WJ 1990 Extracellular matrix disruption and pain after eccentric muscle action. *J Appl Physiol* 69: 868–874
- Trincher K 1981 Die Gesetze der biologischen Thermodynamik. Urban u. Schwarzenberg, Vienna
- Upledger J E 1983 Cranial Sacral Therapy. Eastland Press, Seattle, WA
- Wiener N 1963 Kybernetik oder Regelung und Nachrichtenübertragung im Lebewesen und der Maschine, Econ Verlag, Dusseldorf
- Witinger H, English G (eds) 1992 Textbook of Dr Vodder's Manual Lymph Drainage: Vol 1: Basic Course. Haug International, Brussels
- Zachazewski J E 1989 Physical Therapy. J.B. Lippincott Co., Philadelphia, PA, pp 698–732