



FASCIA RESEARCH

*Basic Science and Implications
for Conventional and
Complementary Health Care*



ELSEVIER

Thomas W. Findley and Robert Schleip, Editors

Fascia is the soft tissue component of the connective tissue system that permeates the human body. It forms a whole-body continuous three-dimensional matrix of structural support. It interpenetrates and surrounds all organs, muscles, bones and nerve fibers, creating a unique environment for body systems functioning. There is a substantial body of research on connective tissue generally focused on specialized genetic and molecular aspects of the extracellular matrix. However, the study of fascia and its function as an organ of support has been largely neglected and overlooked for several decades.

The purpose of this book is to organize relevant information for scientists involved in the research of the body's connective tissue matrix (fascia) as well as professionals involved in the therapeutic manipulation of this body wide structural fabric. It is based on materials presented at the First International Fascia Research Congress: Basic Science and Implications for Conventional and Complementary Healthcare, October 4-5, The Conference Center, Harvard Medical School (www.fascia2007.com). It includes sections on...

- *Microdynamics: From Mechanotransduction to Cellular Dynamics*
- *Myofibroblasts and Fascial Tonus Regulation*
- *Anatomy and Biomechanical Features of Fascia*
- *Fascia and Pain*
- *Clinical Considerations*
- *Muscle and Fascial Dynamics and Surgery*
- *Measurement of Fascial Change in Humans*
- *New Hypotheses, New Directions*

Interest in fascia extends to new scientific findings in the following categories:

- *The presence of contractile cells (myofibroblasts) within the fascial fabric. Clinicians are interested in their role in creating contractile tonus in the fascial fabric, how they form, how they are activated, and their influence on passive muscle tonus.*
- *Biomechanical properties of fascial tissues: creep, relaxation, hysteresis, effect of sustained spinal flexion on lumbar tissues, strain induced hydration changes, myofascial manipulation and fascial viscoelastic deformation.*
- *Mechanotransduction between the cytoskeletal structure within the cell and the extracellular matrix, and its implications for health and disease.*
- *Forms of mechanical signaling within the fascial matrix, such as the tugging in the collagen matrix created by twisting acupuncture needles*
- *How fascia is innervated, and how proprioception and pain are created, detected and modulated by the spinal cord and the rest of the nervous system.*

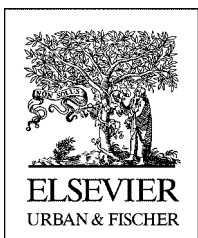


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Thomas W. Findley, Robert Schleip (eds.)

Fascia Research

Basic Science and Implications for Conventional
and Complementary Health Care



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Foreword

Welcome to the first scientific exploration of fascia from an interdisciplinary perspective. This book contains 16 full-text articles from the leading scientists in fascia research. These articles explore a diverse range of topics: the microdynamics and mechanotransduction, myofibroblasts and fascial tonus regulation, fascial anatomy and biomechanics, the sensory innervation of fascia and related pain mechanisms, as well as explorations of clinical aspects, measurement technologies and new hypotheses. They are complemented by abstracts from the First International Fascia Research Congress, held at The Conference Center of Harvard Medical School, Boston, October 4-5 2007. This book pays equal attention to a basic science investigation of fascial anatomy and fascial dynamics, as well as to the exploration of clinical implications for conventional medicine as well as complementary health care. The full text articles reprinted here represent the highest standards of scientific methodology, with thorough review of the entire text by standard journal review procedures, and were selected by the editors from over 1500 papers from the key presenters at this congress. The abstracts were selected by peer review by 3 members of the scientific review committee of the Fascia Research Congress and those accepted are presented as submitted without editorial input from the reviewers. Some are clearly from experienced scientists, and others from less research experienced clinicians, which in some cases are based more on clinical observation than on rigorous scientific experiments. Nonetheless, the review committee members felt that they contained valuable information based on clinical experience, which may – or may not – be validated by more substantial scientific research studies.

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This book will be an invaluable asset for those attending the congress, where the authors of the enclosed full-text articles will be among the major keynote presenters. It will also be most useful for all other scientists and clinicians interested in fascia research. All abstracts are also posted at the congress website: www.fascia2007.com. Please refer to this website for viewing original color illustrations of some of the enclosed illustrations, if their legend refers to specific color markings. The website also contains a glossary of terms used in this book in relation to fascia research.

This book is written for medical scientists interested in fascia, as well as for clinicians who work with this interesting tissue. The latter category includes acupuncturists, physiotherapists, osteopaths, chiropractors, massage therapists, practitioners of structural integration as well as orthopedic and other medical clinicians, and also yoga instructors, sports coaches and other movement therapists. It is designed to give both a thorough overview of the fundamental of fascia research as well as a taste of most recent scientific and clinical explorations and hypotheses.

This book was supported by NIH grant 1 R13 AT004146-01 from National Center for Complementary and Alternative Medicine. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the NCCAM, NIAMS, or the National Institutes of Health. Many people have generously donated their time and expertise to the planning of the fascia research congress and to the production of this book. We want to express our deepest appreciation for the devoted work of Mr David Wronski, project coordinator, and editing assistance of Matthew Foy, without whom this book would not have been possible.

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Introduction

Thomas Findley, Robert Schleip

Fascia is the soft tissue component of the connective tissue system that permeates the human body forming a whole-body continuous three-dimensional matrix of structural support. It interpenetrates and surrounds all organs, muscles, bones and nerve fibers, creating a unique environment for body systems functioning. The scope of our definition and interest in fascia extends to all fibrous connective tissues, including aponeuroses, ligaments, tendons, retinaculae, joint capsules, organ and vessel tunics, the epineurium, the meninges, the periosteum, and all the endomysial and intermuscular fibers of the myofasciae. There is a substantial body of research on connective tissue generally focused on specialized genetic and molecular aspects of extracellular matrix. However, the study of fascia and its function as an organ of support has been largely neglected and overlooked for several decades. Since fascia serves both global, generalized functions and local, specialized functions, it is a substrate that crosses several scientific, medical, and therapeutic disciplines, both in conventional and complementary/alternative modalities.

Thirty years ago the study of physical medicine and rehabilitation included muscle strengthening, anatomy, exercise physiology, and other aspects of therapeutic modalities. What was notably less present in the scientific and medical literature was how to understand and treat disorders of the fascia and connective tissues. Since then much additional information has been developed. The purpose of this book is to organize relevant information for scientists involved in the research of the body's connective tissue matrix (fascia) as well as professionals involved in the therapeutic manipulation of this bodywide structural fabric. It is based on materials presented at the First International Fascia Research Congress: Basic Science and implications for conventional and complementary health care (www.fascia2007.com). The Fascia Research Congress is the first international conference dedicated to fascia in all its forms and functions. The principal thematic topics are: mechanical force transmission through fascia and fascial anatomy; matrix and fibroblast biology; force adaptation and response to loading; fascial innervation, nociception and proprioception; fascial research in special populations; a panel discussion of controversies in fibroblast research; and a panel for scientist-clinician interaction and formulation of future research directions. Bringing together the most recent solid research on the properties of the fascial fabric with those who observe its workings daily in the clinic will inform and energize both

groups toward further comprehensive developments and applications in this growing field. It is hoped that this endeavor will also serve to advance understanding of structure and function so as lead to answering ongoing questions with scientific rigor.

In the general population of industrialized countries, about two thirds are unable to work because of back pain at least once in their life and musculoskeletal pain accounts for 17% of primary care office visits in the US (Lynch 2005). In 1997 in the United States there were 192 million visits to chiropractors, 114 million to massage therapists and 5 million to acupuncturists (Eisenberg 1998). Ni (Ni 2002) found that in 1999, 15 million adults used chiropractic therapy, 12.5 million used massage and 3 million acupuncture. These numbers were confirmed again in the US national health survey of 2002 (Barnes 2004) (Tindle 2005); percentage use is 25% higher among persons with arthritis (Quandt 2005). The tendency for this kind of ailment is rising in concordance with the increased percentage of jobs which require extended static positioning of the worker in a fixed, usually seated, position. Fascia is an important factor in generation of the described ailments, and a more thorough understanding of its function will allow better prevention measures and healing therapies to be developed, benefiting the American economy.

Hypotheses which accord myofascia a central role in the mechanisms of therapies have been advanced for some time in the fields of acupuncture, massage, structural integration, chiropractic and osteopathy. Practitioners in these disciplines, especially those which do not have the longevity of osteopathy or chiropractic, are generally unaware of the scientific basis for evaluating such hypotheses. Many practitioners are unaware of the sophistication of current laboratory research equipment and methods. Laboratory researchers, in turn, may be unaware of the clinical phenomena which suggest avenues of exploration.

Among the different kind of tissues that are involved in musculoskeletal dynamics, fascia has received comparatively little scientific attention. Fascia, or dense fibrous connective tissue, nevertheless potentially plays a major and still poorly understood role in joint stability, in general movement coordination, as well as in back pain and many other pathologies. One reason why fascia has not received adequate scientific attention in the past decades is that this tissue is so pervasive and interconnected that it easily frustrates the common ambition of researchers to divide it into a discrete number of subunits which can be classified and separately described. In anatomic displays the fascia is generally removed, so the viewer can see the organs nerves and vessels but fails to appreciate the

little formal statistical training, yet also contain more advanced statistical guidelines for the more experienced researcher, and are widely used for teaching research to medical residents.

Chapter 3

Microdynamics: from mechanotransduction to cellular dynamics

→ **3.1.1:** The first paper by *Chen* and *Ingber* describes design principles for the musculoskeletal system which result in special improvements in performance. They first explain engineering principles of tension and compression, with emphasis on effects of architecture and prestress. Pre-stressing in biological systems serves to obtain stability with minimum mass, providing rapid mechanical responsiveness to added stress, and reducing loads on individual structures thus reducing structural fatigue. There is a hierarchical organization of a few types of material in the musculoskeletal system which allows a broad spectrum of mechanical properties exhibited by bones, muscles, cartilage ligaments and tendons (and other forms of fascia). The remodeling of bone in response to local mechanical stress, known as “Wolffs Law” results in deposition of bone in specific patterns which correspond to engineering lines of tension and compression. This molecular organization results in increased strength for less mass in the bony system. The design principles carry through to the molecular level in other biological tissues, including cartilage tendons and ligaments. In soft tissues composed primarily of collagen and elastin, the prestress is generated from active contraction of the myofibroblasts. Mechanical engineering at the cellular level begins with the observation that all living cells are contractile; in muscle cells there is a highly organized contractile system and in other cells the contractile elements are organized into a loose network. Cells have a structural framework which allows forces to be transmitted within the cell. The cytoplasm itself can locally alter its stiffness by changes in cytoskeletal polymerization. Living cells react to a mechanical stimulus on the cell surface by immediate changes in the cytoplasm and nucleus.

The basic design principles of the musculoskeletal system result in maximal use of tensile materials from the molecular to the whole body scale. How the different elements are connected in a three dimensional network is more important than material properties of the individual components. Stability is achieved through prestress and geometric organization such as triangulation. Hierarchical organization of components structured on

smaller and smaller scales results in overall structural efficiency. Finally, dynamic remodeling results in ability to modify stiffness and flexibility in response to loading patterns experienced over time. The design principles in living systems can be described by the architectural system known as “tensegrity.” In this system, isolated compression elements are connected by continuous structure providing tension. In contrast, most man-made structures rely on continuous stacks of bricks or similar compression objects. Even when prestress is incorporated, as in prestressed concrete, the stiffness in such man made objects remains constant regardless of the imposed stresses. In contrast, stiffness increases when stress loads are increased in living tissues and also in man made 3D tensegrity structures. The tensegrity model suggests ways in which living tissues can sense and respond to mechanical stresses.

→ **3.1.2:** In the second paper *Langevin* and *Sherman* suggest a model for low back pain which incorporates connective tissue plasticity with pain psychology, postural control and neuroplasticity. They start by describing what is known in persons with low back pain about tissue structure abnormalities, psychological factors, changes in movement patterns and increased peripheral pain sensitivity and brain cortical activation patterns. They suggest that connective tissue remodeling in persons with chronic low back pain may result from either increased stress (“overuse injury”) or consistent absence of stress leading to atrophy and fibrosis. The loose connective tissues surrounding and within the muscle fibers play important roles in the response of muscle tissue to mechanical stress as well as in the sensory input from these tissues. They propose that connective tissue fibrosis occurs in the low back due to decreased activity, muscle spasm co-contraction or microtrauma, and neurally mediated inflammation. This model can be used to evaluate interventions which involve application of external forces (e.g. massage, manipulation and acupuncture), movement education such as tai chi and yoga, and general increase in activity level and conditioning. They rightly point out that “the development, testing and implementation of effective treatment strategies are highly dependent on understanding the pathophysiological mechanisms of the condition being treated.” After reviewing the basic science presented here, the clinician scientist may be eager to skip to chapter 9 on measurement and new hypotheses. However, perseverance in reviewing the full-text articles and abstracts will be rewarded by yet more ideas for evaluation.

→ **3.1.3:** The third paper by *Grinnel* describes the ability of fibroblasts to reorganize collagen matrix in cell culture to a dense mass one tenth the original size; these mechan-

ical forces are large enough to cause scarring and deformation in many body organs after injury. Applying a mechanical load to the fibroblasts results in generation of actin stress fibers within the cell and development of these cells into myofibroblasts while absence of a mechanical load for as little as 24 hours cause the same cells to become quiescent through the extracellular signal regulated kinase pathway. Microscopic examination of the collagen matrix shows vast difference in structure and organization of the fibroblasts depending on whether tension on the cells was released immediately or after four hours during culture. Since the collagen matrix contracts to the same degree in both cases, little attention has been paid to the structural differences and different cellular mechanisms which may signal contraction in the two models. Grinnel emphasizes that “cells use different signaling mechanisms for contraction according to whether they are mechanically loaded or unloaded at the time when contraction is initiated.”

→ **3.2:** Paper abstracts explore the effects of tissue stretch on collagen fibers in skin (→ **3.2.4 Hoffman**), nuclear shape and smooth muscle actin redistribution (→ **3.2.2 Storch**) and Procollagen-1 and TGF- β 1 (→ **3.2.1 Bouffard**). Micromanipulation of individual fibroblasts by *Evanko* (→ **3.2.3**) showed both changes in cellular shape and in hyaluran amount and organization. Finally, *Corey* (→ **3.2.5**) explored the innervation of deep fascia by large numbers of sensory fibers, suggesting a mechanism for both generation of musculoskeletal pain as well as more distant effects of tissue stretch.

→ **3.3:** Poster abstracts suggest that tissue stiffness increase due to isometric stretch (“strain hardening”) is not dependent on cellular viability (therefore not due to cellular contraction) but does correlate with enhanced tissue matrix hydration (→ **3.3.3 Schleip**). Tissue studies in humans with particular clinical conditions were performed in women with stress urinary incontinence (→ **3.3.5 Wen**), Pelvic organ prolapse (→ **3.3.1 Man**), Low back pain (→ **3.3.2 Schleip**), and sulcus vocalis or scarring of the vocal cords (→ **3.3.4 Tsunoda**). These studies suggest altered collagen and elastin metabolism, regions of fascia with increased tissue repair activity, reduced numbers of contractile cells, and regeneration of fascia from transplanted stem cell population in these different clinical conditions.

Chapter 4

Myofibroblasts and fascial tonus regulation

Myofibroblasts are connective tissue cells which contain dense stress fiber bundles that are mostly composed of

alpha smooth muscle actin. First discovered by *Majno* and *Gabbiani* in the early 1970’s, they have been shown to play a major role in wound healing and to be also involved in many other normal as well as pathological contractile tissue processes. Most of these cells develop out of normal fibroblasts stimulated by the influence of mechanical tension as well as specific cytokines. Their smooth muscle-like contractility enables these cells to maintain a contractile force over long duration times with little energetic costs. An increased presence of myofibroblasts is a driving factor behind chronic fascial contractures, such as in Morbus Dupuytren, in plantar fibromatosis, in excessive scar formation, or in frozen shoulder. Recently, the presence of myofibroblasts (or myofibroblast-like contractile cells) has also been demonstrated for normal dense connective tissues, such as joint ligaments, menisci, tendons, organ capsules, and others.

The full-text articles in this section (→ **4.1**) start with a review of the biology of myofibroblasts by *Gabbiani*, co-discoverer of this cell type and prominent keynote presenter at this first fascia research congress (→ **4.1.1**). His brief review emphasizes the heterogeneity of this cell type and proposes 4 different phenotypes of this versatile cell. Since publication of this classic paper in 1992 many important advances have been made in understanding this new cell type. This is represented by two excellent articles by *Hinz* (*Gabbiani*’s successor at the EPFL research laboratory in Lausanne, Switzerland) and *Gabbiani* (→ **4.1.2** and → **4.1.3**). They represent present day understanding concerning myofibroblasts, particularly the transition from normal fibroblasts to myofibroblasts, as well as the role of force transmission between this cell and the extracellular matrix via specially developed adhesion complexes at their cell membrane. Finally, most recent findings of the Fascia Research Project at Ulm University in Germany are reported regarding the presence of myofibroblasts in normal fascia. These include the unexpected finding of an increased density of these cells in the human lumbar fascia and culminate in a force calculation for fascial contraction in vivo based on mechanographic tests with rat fascia in vitro (→ **4.1.4**). The following abstracts of further congress lectures related to this subject cover further details. *Tomasek* links to the chapter on mechanotransduction (→ **chapter 3**) with new findings concerning the expression of different smooth muscle actins in response to mechanical stimulation (→ **4.2.1**). *Spector* emphasizes the contractile behavior of musculoskeletal connective tissue cells and the important roles he proposes for it in regenerative medicine (→ **4.3.1**). This is followed by *Naylor*’s description of past and current attempts in finding pharmacolo-

gical agonists and antagonists for fascial contractility (→ 4.3.2). His approach is taken into further detail by the in vitro contraction tests reported by the German fascia research group, including their successful stimulation of active fascial contractions with thromboxane and of fascial relaxation with the gaseous smooth muscle relaxant nitric oxide (→ 4.3.3). In conclusion *Remvig* gives an overview on current knowledge of general hypermobility and tissue stiffness (→ 4.3.4). The following poster abstracts explore the subject of tissue stiffness regulation in further detail (→ 4.4). Notably a relation of fascial stiffness and the enigmatic feature of resting muscle tone (passive muscle stiffness) is addressed by *Masi* (→ 4.4.2) and by *Klingler* (→ 4.4.3). *Remvig* (→ 4.4.4) looked at myofibroblast density in tendon and fascia biopsies from persons with hypermobility and controls. *LeMoon* (→ 4.4.1) suggests connective tissue contractility is the central mediating factor in myofascial pain.

Chapter 5 Anatomy and biomechanics

Three full-text articles emphasize the important role of fascia in musculoskeletal force regulation. The first one is by *Huijing*, recipient of the prestigious Muybridge award 2007 in the field of biomechanics for his recent insights into the role of epimuscular force transmission between antagonistic and synergistic muscles in normal muscle as well as in patients with spastic paresis. This article reviews available literature on myo-tendinous and myo-fascial force transmission in general (→ 5.1.1). *Solomonow* then examines the role of ligaments musculoskeletal disorders such as in work-related low back pain (→ 5.1.2). He stresses the important sensory function of these fascial structures as well as their viscoelastic properties of creep and relaxation in response to extensive loading. Last but not least the article by *Olson et al.* (→ 5.1.3) explores the ‘flexion-relaxation phenomenon’ in which trunk flexion from the standing position results in a myoelectric silent period of the lumbar posterior muscles, which is commonly attributed to a taking over of spinal stabilization by the passive stretch resistance of posterior lumbar connective tissues. Interestingly, this phenomenon is radically altered when the trunk flexion is performed from a supine body position rather than from the classically used standing position. It is concluded that lumbar kinematics or fixed sensory motor programs by themselves are not sufficient to explain the flexion relaxation phenomenon. Bodyworkers especially in structural integration (Rolfing) are accustomed to observing clinical differences in muscle and fascial motion between supine and stand-

ing body positions, and this paper begins to establish scientific parameters of these observations.

The abstracts from the plenary session on fascia anatomy and biomechanics consist of two important contributions, both of which point at the important biomechanical function of the lumbodorsal fascia. The first one by *Vleeming* (originator of the force/form closure concept about joint stability) cites evidence for the ability of the lumbar fascia to transmit tension between leg and trunk muscles, such as from the latissimus dorsi on one side and the gluteus maximus on the other side (→ 5.2.1). The second abstract of this group is written by *Gracovetsky*, who is mostly known for his ‘spinal engine’ model concerning the role of spinal rotation in human gait (→ 5.2.2). It asks the provocative question “Is the lumbodorsal fascia necessary?” and then proceeds to provide two positive answers: First, the essential role of visco-elastic behavior of collagen for the stability of the spinal system; and secondly, the role of fascia in providing necessary constraints for muscular movements.

These important contributions from keynote presenters at this first congress are then complemented by additional abstracts. This includes three anatomical examinations of particular fascial sheets in the human body: the deep fascia of the limbs (→ 5.3.1 *Stecco*), the fascia lata (→ 5.3.2 *Fourie*), and the superficial fascia (→ 5.3.3 *Headley*); and is then followed by a mathematician’s proposed model of the relation between mechanical forces and deformation of human fascia in manual therapy (→ 5.3.4 *Chaudhry*). The chapter is then completed by 7 poster presentations (→ 5.4). The first examines the use of the term fascia in the literature (→ 5.4.1 *Mirkin*), and is then followed by two examinations of particular fasciae – pectoral fascia (→ 5.4.2 *Stecco*) abdominal fascia – as well as by different explorations concerning therapeutic fascia manipulation. *Burns* (→ 5.4.4) has developed a simulator for training fascial palpation. *Remvig* (→ 5.4.5) explores the literature for scientific evidence of myofascial release, and *de Witt* (→ 5.4.6) describes a technique for assessment and treatment of lines of fascial motion in athletes.

Chapter 6 Fascia and pain

→ 6.1.1: *Simons* and *Mense* review muscle tone as it relates to clinical muscle pain. Muscle tone depends on the physical properties of the soft tissues – viscoelastic properties of the muscular and associated tissues, and anatomic limitations in motion- as well as degree of electrical activation of the contractile elements of the muscle,

both voluntary and involuntary (muscle spasm). They define viscoelastic tone as measured by resonant frequency of the muscle, and elastic stiffness as measured by slow movements. In both cases there may or may not be electrical activity of the muscle detected by electromyography (EMG), but this determination is critical to know just what is being measured. They cover clinical usage and measurement of muscle tone as well as definitions of mechanical properties of muscles. Muscle is thixotropic, that is when first moved it resists motion but after the initial motion the viscosity decreases up to ten fold. Similarly they cover clinical usage and measurement of contracture and muscle spasms, as well as several clinical conditions such as tension headache, torticollis and night cramps. The reader will gain insight into both clinical practice and definition of terms and measurement which are essential to research in this area.

→ **6.1.2:** *Khalsa* provides a review of the system used to perceive musculoskeletal pain. Both peripheral and central neurons in this system can adapt from milliseconds to weeks after noxious stimuli. Sensory stimuli is sent from muscles over nerves which conduct at a wide range of velocities, from over 100 meter/second to under 2 meter/second; half of such nerves are in the slowest category. Muscle nociceptors vary in mechanical thresholds, and can be sensitized by a number of local chemicals. The response at the cellular level to local mechanical trauma in a muscle is described in detail. Different mechanisms may be involved for compression than for stretch.

→ **6.1.3:** An experimental study in rats by *Sauer, Bove* et al. shows that primary nociceptors innervating nerves and their surrounding connective tissue release neuropeptides involved in inflammation, but this does not happen when the nerve is isolated from its neighboring connective tissue matrix; in contrast, capsaicin (hot pepper) stimulates both isolated nerve axons and axons with intact connective tissue sheaths.

→ **6.2.1:** *Shah* reports latest insights concerning the nature of myofascial trigger points. Using the newly refined method of microdialysis (using ultrafine needle biopsies) he found that active trigger points in the upper trapezius exhibit a unique biochemical milieu of substances associated with pain and inflammation, such as substance P, bradikinin, and others.

→ **6.2.2:** The previous examination of *Sauer, Bove* et al. of the influence of perineurial connective tissue elements and related nerve endings in the creation of pain sensations (→ **6.1.3**) is updated in an abstract by *Bove*, which proposes different mechanisms for distally perceived pain as opposed to pain which is perceived as arising from the nerve trunk.

→ **6.3:** Further abstracts include the reported increase in estimated weight of their gun belts by police officers with chronic low back pain as opposed to matched healthy control subjects from the same group (→ **6.3.1 Moga, Barker** (→ **6.3.2**), recent recipient of the Young Investigator's Award of the journal *Spine* for her related work on the lumbar fascia, explores the influence of lumbar fascia tension on segmental sagittal spinal motion stability, using loading tests and rapid motion photography on 9 unembalmed cadavers. She concludes that tension on the lumbar fasciae simulating moderate contraction of transverse abdominal muscle alters segmental rotation and translation, reducing the instability factor in both flexion and extension. *Stevens-Tuttle* (→ **6.3.3**, from Langevin's group) shows that perimuscular fascia remodeling occurs in a pig whose movements are restricted with a harness, and that similar movement restrictions can be observed in humans with low back pain. This section is completed by two interesting computerized theoretical modeling contributions. Using MSM.Adam software, *Trudeau* and *Rancourt* (→ **6.3.4**) found that the thoracolumbar fascia has the potential to be the posterior structure that contributes the most to the stiffness of the spine in forward flexion. They conclude that this fascia could therefore be subjected to trauma if the spine is displaced in a way that exceeds its mechanical limits. Finally *Zorn* and his German colleagues (→ **6.3.5**) explore the spring-like function of the lumbar fascia in human gait. Their calculations reveal that – in contrast to the traditional gait analysis model – the pendulum action of the arms and the spring-like action of the lumbar fascia can have the potential to facilitate energetic efficiency in human walking.

→ **6.4:** Posters from clinicians explore different aspects related to therapeutic fascia manipulation, including lumbar skin stretch measures in persons with hamstring tightness (→ **6.4.1 Moga**), postural changes after Core Integration (→ **6.4.2 DellaGrotte**), treatment of subacute lumbar compartment with Graston Technique, an instrument assisted soft tissue mobilization (→ **6.4.3 Hammer**), a randomized trial of Functional Fascial Taping for low back pain (→ **6.4.4 Chen**), and identification and myofascial treatment of pelvic obliquity in athletes (→ **6.4.5 LeLean**).

Chapter 7 Clinical considerations

→ **7.1:** Five clinician/educators have prepared some questions on a wide range of topics for the final Fascia

Contributors



Ron Alexander is the founder of Functional Fascial Taping® and refined this technique over several years on the dancers of The Australian Ballet. During this period he was awarded the 'Lady Southey Scholarship for Excellence'. He delivers FFT® workshops internationally and has presented these real time

ultrasound investigations to the Royal College of Surgeons, Edinburgh. → 192, 203, 251



Priscilla Barker is Senior Tutor in Anatomy at the University of Melbourne. She completed her Bachelor of Physiotherapy in 1996 and PhD in Anatomy in 2005. Her research is published in 'Spine', 'Grieve's modern manual therapy' and 'Movement, Stability & Lumbopelvic Pain'. She was awarded the 2005 Spine Young Investigator of the Year. → 185



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sor of Biomedical Engineering Department. His areas of research interests are signal processing applied to biomedical signals, detection, processing and interpretation of surface EMG. → 219, 221

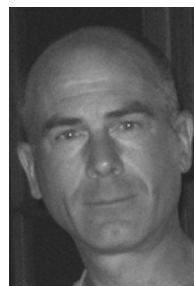


Luiz Fernando Bertolucci, MD: physiatrist, biologist, Rolf Institute faculty (anatomy and myofascial release), has been using Rolwing® in the treatment of musculoskeletal dysfunctions. He is currently developing a particular technique to release fascia, which seems to be based on neural reflexes. → 221

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Julian Baker is the Principal Instructor of The Bowen Technique in the UK and Europe. As Director of The European College of Bowen Studies, he has been responsible for its rapid growth since 1994, travelling extensively to teach, research and has written many articles on The Bowen Technique. → 247



Geoff Bove, DC PhD's research focuses on mechanisms of pain due to nerve injury, and how they relate to the musculoskeletal dysfunction. He is an authority on the mechanisms of pain, particularly those associated with nerve injury and musculoskeletal disorders, and neurobiological mechanisms related to

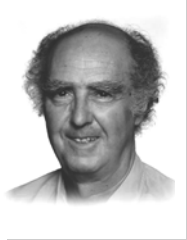
manual therapy. He has published over 30 original articles reviews, and chapters, including publications in Journal of the American Medical Association (JAMA), Journal of Neurophysiology, and The Lancet, and regularly participates as a grant reviewer for NIH. → 174, 183



Janet M. Burns, DO, an assistant professor of Osteopathic Manipulative Medicine (OMM) at Ohio University College of Osteopathic Medicine, is board certified in Neuromusculoskeletal Medicine/OMM, and Family Practice. Her research interests include the neurophysiology of palpation and mechanisms of OMM. → 139



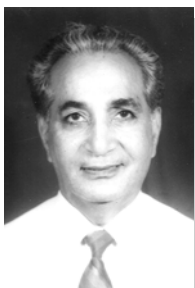
Sarah Corey is from the Department of Neurology, University of Vermont Burlington VT. → 48



Leon Chaitow, DO ND is editor of Journal of Bodywork and Movement Therapies. He is author of almost 70 books relating to osteopathic and manual medicine and is visiting lecturer at schools in Australia, Denmark, Holland, Italy, Ireland, Switzerland, Spain, and the United States. → 196



Patrizia D'Alessio, MD PhD is an Italian researcher with cell biology expertise, and lectures as Ass. Prof. at Paris Universities. She has 3 patents on 4 anti-inflammatory anti-senescence molecules targeting endothelium and received the 2005 French Ministry award for Innovative Research and foundation of the start-up company "AISA Therapeutics". → 244



Hans Chaudhry, PhD is a Research Professor in Biomedical Engineering Department at New Jersey Institute of Technology, Newark, New Jersey, U.S.A. His research publications pertain to Mathematical Modeling in Postural Stability, Human Fascia, Cardiovascular System, Optimal Patterns of Wound Suturing. → 135, 242, 255

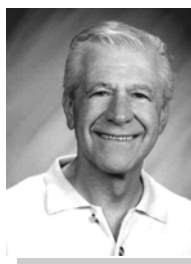
Julie Ann Day completed a Diploma in Physiotherapy in Adelaide, Australia in 1977. Practitioner of Fascial Manipulation since 1999, and authorised teacher, she translated Luigi Stecco's book "Fascial Manipulation for Musculoskeletal Pain" (Piccin 2004). Julie lives and works in Padova, Italy. → 257



Shu-Mei Chen is a qualified physical therapist as well as a lecturer of Physical Therapy in Taiwan. She received the B.Sc. in Physical Therapy and the M.Sc. in Medicine from Kaohsiung Medical University in Taiwan. She is currently studying her PhD program at the School of Exercise and Nutrition Sciences at Deakin University, Australia. → 192



Benita de Witt, B Sc Physio, has 25 years of experience treating athletes and works in private practice in Stellenbosch, South Africa. She has developed the Lyno Method, which focuses on the treatment of chronic injuries; restoring body alignment by means of fascia manipulation. → 141



Josef DellaGrotte PhD CPF LMT is Director of Core Integration Training Institute Inc. → 190



Stephen Evanko received his PhD from the University of New Mexico in 1993 where he studied the biological properties and biochemistry of connective tissues, with principle interest in how tissues remodeled in response to different mechanical stresses. He currently serves as a Staff Scientist at The Benaroya

Research Institute at Virginia Mason in Seattle where he studies the biology of hyaluronic acid and proteoglycans in fibroblasts and smooth muscle cells. Stephen is also a Certified Advanced Rolfer® with a Structural Integration practice in Seattle. → 46



James R. Fox is from the Department of Neurology, University of Vermont, Burlington VT. → 186, 224, 252



Thomas W. Findley MD, PhD trained in physical medicine and rehabilitation at the University of Minnesota. Dr. Findley has extensive training in complementary medicine, beginning with training in acupuncture while a medical student at Georgetown in 1975. He maintains an active clinical practice

as a Certified Advanced Practitioner of Rolfing Structural Integration in addition to his research activities as Associate Director of the Center for Healthcare Knowledge Management, New Jersey VA Healthcare System. He is also Director of Research for the Rolf Institute of Structural Integration. → 2, 135, 222, 242, 254, 255



Richard Allen Freiberg, OMD, DAP, Lac. began studying Acupuncture and Oriental Medicine in 1985 as an apprentice to Dr. Robert C. Sohn, AP, PhD. He received Diploma of Acupuncture and Oriental Medicine from the Atlantic Institute of Oriental Medicine. He did advanced studies as senior graduate-doctor

apprentice, for over six years, with world famous Traditional Chinese Medicine herbal expert Dr. Wu, Boping, OMD, MD, PhD (China). He practices in Acupuncture and Oriental Medicine as a primary care provider diagnosing and treating illness and injury specializing in soft tissue injury and pain syndromes. Received international Doctor of Oriental Medicine degree in 1998 from Medicina Alternativa Institute in Colombo, Sri Lanka from Prof. Dr. Anton Jayasuriya. He has created a synergistic method consisting of two ancient modalities: Gua Sha (frictional rubbing) and Ba Guan (empty cupping), which Dr. Wu named as Ba Gua Fa, and during the past thirteen years has successfully utilized Ba Gua Fa in over 20,000 patient treatment visits. → 208



W. J. Fourie Nat. Dipl. P.T. Thirty years experience as musculoskeletal Physical Therapist. Working in private practice in Johannesburg, Masters Student in the School of Anatomical Sciences at the University of the Witwatersrand and International presenter of courses on the role of Connective Tissue in Movement Dysfunction. → 215



Guilio Gabbiani, MD PhD is Professor of Pathology and Immunology and the University of Geneva, Switzerland. His area of research is smooth muscle and fibroblasts, and he has published more than 300 scientific papers. He is a member of the Editorial Board of the American Journal of

Pathology, Arteriosclerosis Thrombosis and Vascular Biology, Laboratory Investigation, Wound Repair and Regeneration, Differentiation, Cell Motility and the Cytoskeleton, and Experimental Cell Research. → 56, 67



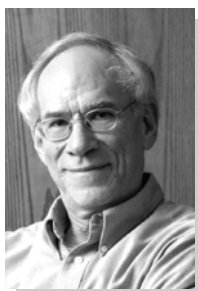
Serge Alain Gracovetsky, PhD, Professor Emeritus, Electrical Engineering, Concordia University, Montreal, Canada, is the author of numerous research articles and recipient of several awards related to his work on the biomechanics around spinal dynamics and gait. He is the originator of the ‘spinal

engine’ model, which emphasizes the important contribution of paraspinal connective tissues to human gait and is one of the first scientific authors exploring the biomechanical function of the thoracolumbar fascia. → 131



Peter Grigg, PhD is Professor and Interim Chair of Physiology, and director of the Biomedical Engineering Program, at the University of Massachusetts Medical School in Worcester MA. He is a neuroscientist with an interest in mechanoreceptors. Studies of the mechanism of mechanoreception led him into

investigations of the way soft tissues respond to mechanical loading, which led to the work described in this abstract. → 47, 236

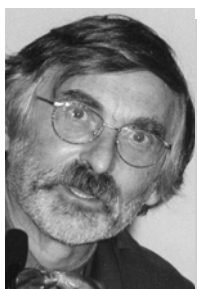


Frederick Grinnell, PhD, is Professor of Cell Biology, University of Texas Southwestern and has been the co-chair of the Gordon Conference on Science and Technology Policy and chair of the Gordon Conference on Wound Repair. → 39



Alan Grodzinsky, PhD, is professor of Electrical, Mechanical and Biological Engineering and Director of the Center for Biomedical Engineering at MIT. His research looks at how connective tissue metabolism, growth, remodelling, pathology and repair is influenced

by mechanical, chemical and electrical stresses. → Mechanotransduction panel chapter 3



J.C. Guimberteau, MD, is cofounder and scientific director of the Aquitaine Hand Institute (I.A.M), member of the French Hand Society (GEM) and of the French Plastic and Reconstructive Society (S.F.C.P.R.E). He was trained in the Hand and Plastic Surgery Department of the Bordeaux

University (Dr. A.J.M. Goumain and Pr. J. Baudet) from 1973 to 1980. During this surgical training, he was one of the pioneers in microsurgery and transplantations. → 237



Warren Hammer, DC lectures at the National Chiropractic College and is a renowned writer and lecturer on treatment of soft tissue injuries. He incorporates into daily practice the constant flow of new scientific information that relates to the clinical improvement of the patient. Of critical importance has been the incorporation of all valid methods and techniques of soft tissue evaluation and treatment. He believes that all joint manipulations of the human body require evaluation of the soft tissue attachments to these joints. → 191, 206



Thomas Hausner, MD, Orthopedic Surgeon and General Surgeon, aged 42 years. He specialises in Hand and reconstructive Microsurgery in one of the largest Austrian hospital for treatment of Trauma (“Lorenz Böhler Trauma Hospital”), which treats about 65000 trauma patients a year. As a General Surgeon he is also

engaged in the treatment of multitraumatised patients, especially with visceral trauma. → 241



Gil Hedley, PhD, founder of Somanautics Workshops, Inc. and Integral Anatomy Productions, LLC, teaches dissection workshops internationally. He also produced The Integral Anatomy Series, documenting on DVD his layer-by-layer, whole body approach to human form and fascial relationships. → 134

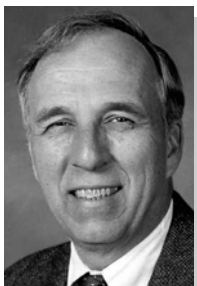


Ed Hemberger, structural Integration Practitioner is a holistic practitioner involved in health and bodywork for over 15 years, specializing in sports massage, neuromuscular and deep tissue. An avid cyclist and athlete himself, since 2001 Ed has been an assistant massage therapist for the Division II Professional

Cycling Team, the Navigators. In 2002 he was selected to be on the winter sports massage team for the U.S. Paralympic ski team in Salt Lake City, Utah. In 2003 Ed toured with Ofoto Lombardi, a Division III cycling team from California. Ed is a certified holistic practitioner through the Velazquez System of Training which is a synthesis of principles and techniques of medical models, somatic techniques, sports psychology, psychotherapy methods, organizational management and spiritual traditions both ancient and contemporary. → 207



Boris Hinz, PhD, did his postdoctoral training with Dr. Gabbiani and is currently with the Cell Contractility research group of the Laboratory of Cell Biophysics, School of Basic Sciences, Swiss Federal Institute of Technology in Lausanne. His research focuses on myofibroblast contraction, differentiation and wound repair. → 60, 67



Allen H. Hoffman, PhD, PE is a Professor of Mechanical Engineering at Worcester Polytechnic Institute. His research focuses on the mechanical behavior of soft tissues. In 1988, he was a co-recipient of the Elizabeth W. Lanir Kappa Delta Award from the American Academy of Orthopaedic Surgeons. → 47

Peter Huijijng, PhD, Human Movement Sciences, Vrije Universiteit, Amsterdam, The Netherlands, has received international honors for his research in mechanisms of extra-muscular myofascial force transmission and how this relates to properties of spastic muscles. → 90, 212



Shabbir Indorewala, born: 1953, Nashik, India. Recipient of RAF Cooper and AOI-E.Merck Awards. Has developed concept of: Endomeatal Tympanoplasty, Anterior Tympanotomy and Dimensional Stability of Free Fascia Grafts. Professor-consultant and MD of Indorewala ENT Hospital, accredited by National Board for ENT PG training. → 216



Donald Ingber, MD PhD is Director, Center for Integration in Medicine and Innovative Technology at Childrens Hospital and is the Judah Folkman Professor of Vascular Biology at Harvard Medical School. He has over 200 publications on cell structure and contractility. → 20



Helen James, MPT, Adv. Cert. Rolfer; the PI, has her graduate degree in Physical Therapy from Stanford University. She is Professor Emeritus, Physical Therapy Dept. California State University, Fresno. Ms. James

owns a private practice in PT/Rolfing at Clovis, Ca. → 256 Her Research Team includes:

Mr Luis Castaneda, a graduate of Univ of Texas at El Paso, and a graduate student in Physical Therapy at California State University, Fresno, and **M.E. Miller**, PhD, PT, GCS; Assoc. Prof. in the Physical Therapist graduate program at California State Univ., Fresno.

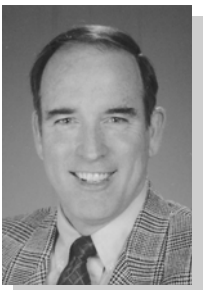


Ricardas Kerpe MD, PhD is a lecturer at the Rehabilitation department, Kaunas University of Medicine, Lithuania. In 2006 accomplished the doctoral dissertation "Foot muscular tone in type 1 diabetes mellitus patients and its correction using functional electrical stimulation". Research interest area: muscles and connective tissue properties. → 220



Partap S. Khalsa, D.C., Ph.D., F.A.C.O. is Program Officer for the National Center for Complementary and Alternative Medicine of the NIH and was recently an Associate Professor of Biomedical Engineering, Orthopaedics, and Neurobiology at the State University of New York(SUNY) at Stony Brook, and

currently serves as the Graduate Program Director for the Department of Biomedical Engineering. Dr Khalsa has an active research laboratory investigating neurophysiological mechanisms of mechanosensory neurons, soft tissue biomechanics, spine biomechanics, and mechanisms of muscle and low back pain. He maintained, for 17 years, a private practice of chiropractic in Massachusetts, is board-certified in chiropractic orthopaedics, and served terms as the President and Vice-President of his local chapter of the Massachusetts Chiropractic Society. → 12, 162, 196



Hollis H. King, DO, PHD, FAAO. Dr. King is the Associate Executive Director of the Osteopathic Research Center and Associate Professor of Osteopathic Manipulative Medicine at the Texas College of Osteopathic Medicine. He is a co-author of the chapter on Osteopathy in the Cranial Field in Foundations

for Osteopathic Medicine, second edition. He has published research on the effects of prenatal OMT on obstetrical outcomes, and has submitted grants to NIH for further research in this and other areas OMT. Dr. King is a Past President and Fellow of the American Academy of Osteopathy. → 264



Miglena Kirilova, Institute of Mechanics, Bulgarian Academy of Sciences. Research Associate at Institute of Mechanics, Bulgarian Academy of Sciences, Sofia, Department Biomechanics of Tissues and Systems. Member of Bulgarian Society of Biomechanics, Union of Bulgarian Mathematicians and the

Executive Body of the Bulgarian Society of Biorheology. Research activity and interests mostly in the biomechanics of soft tissues, cardiovascular biomechanics, tissue engineered vascular grafts, biomaterials. → 138



Werner Klingler, MD works as clinical anesthesiologist and specialist for human physiology at Ulm university, Germany. His research focuses on the pathology of contractile tissue. He is member of scientific organizations and has contributed several publications in high-rank journals. → 50, 51, 76, 81, 82, 86, 188



Aleksandras Krisciunas, M.D.,D.Sc. habil is the Head of the Department of Rehabilitation Kaunas University of Medicine, Lithuania. The main research area is rehabilitation of patients with cardiac and cardiovascular diseases and evaluation of its efficiency. He has participated in developing an effective rehabilitation

system for patients and disabled people, consulting work at rehabilitation centres and boards of medical-social expertise. → 220



Nicky Lambon, MA MCSP DipTP Cert Ed FE PGCE CCIM. Nicky became a physiotherapist in 1980. She has an MA in Law & Medical Ethics and is Principal Lecturer and Programme Manager for physiotherapy at Coventry University. Nicky is also an external examiner at Liverpool, Edinburgh & St George's Universities. → 247



Helene M. Langevin MD is Research Associate Professor and the Department of Neurology, University of Vermont Burlington VT. A licensed acupuncturist for ten years, she and her team are studying tissue displacement and remodelling due to acupuncture needling. → 33, 44, 45, 48, 186, 224, 252, 260



Aaron LeBauer, LMBT is the owner of LeBauer Structural Bodywork in Greensboro, NC. He has a B.A. from Duke University, a certificate in Massage Therapy and Health Education from the National Holistic Institute, and is currently working toward his Doctor of Physical Therapy at Elon University. → 204.



Linda-Joy Lee, a University of British Columbia graduate and fellow of the Canadian Academy of Manipulative Therapy, Linda-Joy Lee is known internationally for her skills in movement and performance analysis to restore optimum function. She has created novel approaches to train thoracic stability, and is

investigating these ideas in a PhD at the University of Queensland. LJ consults at her clinic, Synergy Physiotherapy in North Vancouver BC, and teaches clinicians world-wide how to integrate multiple paradigms, new ideas and science for effective outcomes in clinical practice in a series of courses in affiliation with Diane Lee. → 201



Diane Lee is a University of British Columbia graduate (BSR), a fellow of the Canadian Academy of Manipulative Therapy (FCAMT) and a certified Gunn IMS practitioner. She is well known internationally for her clinical work and case studies in which she integrates scientific research with clinical

expertise into a practical evidence-based model. This model is taught world-wide in a series of courses in affiliation with Linda-Joy Lee. Diane's passion is in helping women restore their form and function after pregnancy and she works as a physiotherapy consultant at Diane Lee & Associates in White Rock, BC. → 201



R.P. Lee received his DO degree from the University of Kansas City of Medicine and Biosciences in 1976, and a residency in Osteopathic Manipulative Medicine at the A.T.Still University College of Osteopathic Medicine in Kirksville, MO. He also trained with the American Academy of Medical

Acupuncture in 1986. In 1991, he moved to his present location in Durango, Colorado to open a private practice in osteopathic manipulative medicine, nutritional counseling, homotoxicology, and medical acupuncture while using a system he developed to read the body for diagnostic and treatment strategies.

He has served on the board of Governors of the American Academy of Osteopathy, chair of the Louisa Burns Osteopathic Research Committee of the AAO and has served on the Board of Directors of the Cranial Academy and the Cranial Academy Foundation. His 2005 book, *Interface: Mechanisms of Spirit in Osteopathy* is about the spiritual basis of osteopathic philosophy and a theoretical physiological model of the primary respiratory mechanism. → 265



Peter Lelean is a remedial masseur and structural integrator with 15 years experience. He has taught advanced therapeutic techniques around Australia and specializes in idiopathic scoliosis. Peter has identified fascial anomalies common to a number of musculoskeletal conditions. → 193

Kim LeMoon is the originator of Fascial Facilitation, a soft tissue therapy for myofascial pain. Clinical success with this method led to an exploration of the relationship between fascial contractility and myofascial pain syndrome. Since 1997, she has maintained a massage therapy practice in New Jersey. → 84



Huub Maas is a research associate in the Department of Physiology, Feinberg School of Medicine at Northwestern University. His research interests are muscular force transmission and the role of mechanical skeletal muscle properties as well as proprioceptive feedback in neural control of locomotion. → 213



Weng Chi Man did her graduate work with Dr. James Ntambi at the University of Wisconsin-Madison and obtained her PhD in biochemistry in 2005. She is currently working with Dr. Bertha Chen in the OB/GYN department at Stanford University for her postdoctoral training. → 49



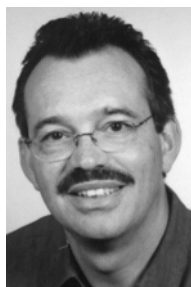
Michelle Marr, MSc BScHons PgCertHE MCSP. Michelle became a physiotherapist in 1995 and is a specialist in neurological rehab. She has worked in the UK, USA and Zambia. Following her Masters in 2005 she became Senior Lecturer at Coventry University and runs a private practice called Therapy Fusion Ltd. → 49, 247



Marilene Martin is in the School for Physiotherapy at São Marcos University - São Paulo, Brazil. → 205



Alfonse Masi, MD, DrPH, is at the University of Illinois College of Medicine at Peoria Il. → 85



Johannes Mayer Dr. med. 1981 – 1987: Family medicine; 1984 – 1987: Manual medicine; 1996 – 2000: Osteopathic medicine; since 2001: teacher in Osteopathic medicine; 2000: member of AAO (American Academy of osteopathy). 2000: Vice president DGOM (German Society of Ost. Med.). 2003: President EROP (European Register for Osteopathic Physicians). 2006: educational committee of WOHO. → 258



Laurie McLaughlin graduated from McMaster University (BHScPT), is a fellow of the Canadian Academy of Manipulative Therapy (FCAMT) and is certified in Contemporary Acupuncture (CMAG). Laurie teaches nationally and internationally on the topics of fascia, breathing and spinal manipulation. She is a senior consultant with LifeMark Health and is currently pursuing a Doctor of Science degree in Physical Therapy at Andrews University. → 201



John M. McPartland first studied medicinal plants with Euell Gibbons in 1969, and began cannabinoid research in 1981 (Mycopathologia 87:149-153). Dr. McPartland earned degrees, residencies, and fellowships at Penn State, University of Illinois, Chicago College of Osteopathy, University of Pittsburgh, and Michigan State University. He has composed and delivered osteopathic curriculum at Michigan State University (as Assistant Professor) and Unitec New Zealand (as Associate Professor). → New Directions panel chapter 10



Siegfried Mense Dr. med., is University Professor at the Department of Anatomy and Cell Biology, Heidelberg University, Germany. His research looks at neurological pathways for pain stimuli and muscle pain. → 144



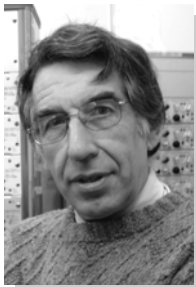
Hanno Millesi Dr. med., is the Medical director of Wiener Privatklinik and full professor at the Department of Plastic Surgery of the Medical Faculty of the University of Vienna. He has received the Millennium Award of the International Society for Reconstructive Microsurgery in 1999 and in 2001 the Paracelsus Ring Award, Villach. → 241



Sue Mirkin is a physiotherapist with a passionate interest in integrative anatomy and bodywork therapies. She is currently engaged in short term contract work while deciding how best to apply talents in clinical, educational and/or research practice. → 136



P. Moga, DO is boarded through the American Osteopathic Board of Family Practice His clinical interests have evolved towards musculoskeletal medicine, including manual-, occupational-, and sports medicine. His research interests focus largely on spine loading, spine injury, and manual medicine outcomes. → 184, 189



I. L. Naylor: PhD is Senior lecturer, School of Pharmacy, University of Bradford, UK. His research interests are study of myofibroblast behaviour in wound repair and healing. → 81



Arya Nielsen is an adjunct faculty and practices East Asian medicine at Beth Israel Medical Center's Continuum Center for Health and Healing in NY. She teaches internationally and has completed a doctorate in Interdisciplinary Studies with focus on integrative clinical science and health care. → 249



James L. Oschman, PhD has published 30 research papers in leading scientific journals, and an equal number in journals of complementary medicine. His work focuses on the connective tissues and myofascial systems and their connections with the cytoskeleton and nuclear matrix, a system he has termed the

living matrix. Jim has written two books on energy medicine, both published by Elsevier, in 2000 and 2003. He lectures and gives workshops internationally on the biomedical significance of the living matrix. → New Directions panel chapter 10



Tim Paine, MA, is Senior Lecturer and Award Leader, Department of Sports & Exercise Sciences, University of Bedfordshire. He formed the Academy of Sports Therapy UK in 1994 and Sports Therapy UK in 2001 offering specialist training

courses in sports therapy . He is now compiling his second book on advanced soft tissue techniques. → 218



Alessandro Pedrelli: graduated as a Physiotherapist in 2003, at the University of Bologna, with a thesis titled: "Modular prosthesis with electric knee (C-LEG): personal experience in walk re-education of transfemoral amputated patients". Since October 2003 he has been working as a professional at his own consulting room in Cesena, Italy. He attend-

ed three courses on Fascial Manipulation as a student (2003, 2005, 2006), and in 2007 as a teaching assistant. In October 2007, will run his first course on Fascial Manipulation as a Teacher. → 250



Helga Pohl, founder of Sensory-Motor Body Therapy and the Centre for Body Therapy, worked as a clinical psychologist at the Max-Planck-Institute and at German universities, and as a psychotherapist in private practice. Her own experiences with chronic back pain lead her to a new path as a body worker. → 245



Denis Rancourt, PhD, is associate professor in Mechanical Engineering at Université de Sherbrooke. He is a member of the PERSEUS research group interested in human performance and safety. His research interests include human motor control and system modelling and design. He holds a PhD degree from MIT in ME. → 187



Lars Remvig, MD and DMSc, rheumatologist, senior consultant at the Clinic for Orthopaedic Medicine, Rigshospitalet, Copenhagen. He is past president of DSMM and past member of FIMM Academy, Science Board and has published articles, reviews and textbooks in manual/musculoskeletal medicine. His main interest now is Hypermobility. → 83, 87, 140



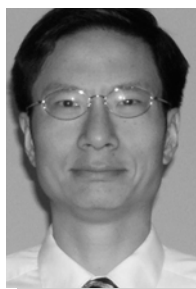
Thomas Sandercock is a Research Associate Professor in the Department of Physiology, Feinberg School of Medicine at Northwestern University. His research interests are the mechanical properties of motor units, muscle, and their interaction to produce whole muscle force and stiffness. → 213



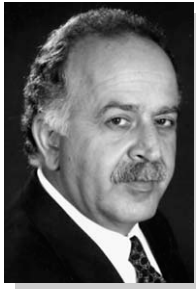
Robert Schleip, PhD, is a certified Rolting and Feldenkrais Teacher, is Research Director of the European Rolting Association and Director of the Fascia Research Project, Ulm University, Germany. He holds a PhD in human biology and an MA in psychology and has been awarded with the Vladimir Janda Award for Musculoskeletal Medicine 2006. → 2, 50, 51, 76, 81, 82, 86, 87, 135, 188



Jay P. Shah is a physiatrist/researcher at the NIH studying the pathophysiology of myofascial pain, chronic pain mechanisms and promising physical medicine treatments. His team is utilizing novel microanalytical techniques to uncover the unique biochemical milieu of myofascial trigger points and acupuncture points. He teaches acupuncture at Harvard Medical School and New York Medical College. Dr. Shah has given many invited lectures and workshops at various national and international meetings. → 214



Charles Shang, MD, is from the Cambridge Health Alliance, Harvard Medical School. → 209



Moshe Solomonow, PhD, MD (Hon) is the Founding Editor of The Journal of Electromyography and Kinesiology, and serves on the Editorial Board of several bioengineering and medical journals. He was a council member of the International Society of Electrophysiological Kinesiology, the

International Society of Functional Electrical Stimulation, and the IEEE-Biomedical Engineering Society. He published over 120 refereed journal papers on motor control, electromyography, muscle, ligament and joint biomechanics, electrical muscle stimulation, prosthetics and orthotic systems for paraplegic locomotion.

Dr. Solomonow organized the EMG Tutorial Workshop in the ISB Congress, the Canadian Society of Biomechanics, The Human Factors and Ergonomics Society, and The Society for Clinical Movement Analysis. He received the Crump Award For Excellence in Bioengineering Research (UCLA), the Distinctive Contribution Award. → 108, 119



M. Spector is Professor of Orthopaedic Surgery (Biomaterials), Harvard Medical School. Senior Lecturer, Mechanical Engineering and Lecture, Health Sciences and Technology, Massachusetts Institute of Technology; Director of Tissue Engineering, Veterans Administration Boston Healthcare System.

Director of Orthopaedic Research, Brigham and Women's Hospital. → 80



Victoria A. Stahl received her B.S. degree in Computer Science from the Georgia Institute of Technology, Atlanta, USA in 2001 and is currently pursuing a PhD in Biomedical Engineering from the Georgia Institute of Technology and Emory University, Atlanta, USA. → 214



Paul Standley, PhD, is a vascular physiologist and professor in the Department of Basic Medical Sciences at the University of Arizona College of Medicine. His research program investigates how vascular smooth muscle and fascial fibroblasts demonstrate regulation of cytokine and growth gene expres-

sion in response to biophysical stimuli. → Mechano-transduction panel chapter 3



Antonio Stecco, MD, Padua University, 2007. Collaborator with the University Paris Descartes to study the anatomy of fascia. Collaborator with the Physical Medicine and Rehabilitation Clinic of Padua University to analyse the myofascial pains and the clinical applications of the Fascial Manipulation method.

→ 132, 137, 257



Carla Stecco, MD, Padua University, 2002. Specialisation in Orthopaedist, 2007. Collaborator with Paris Descartes University to study the anatomy of the fascia with dissections. Membership of Italian Society of Anatomy and Histology. Author of 18 scientific papers and of a book about Fascial Manipulation.

→ 132, 250, 257



Debbie Stevens-Tuttle is from the Department of Neurology, University of Vermont, Burlington VT.

→ 44, 186, 224, 252



Kirsten N. Storch earned her Bachelors of Arts in Environmental Studies at the University of Oregon in 2000 and went on to receive a Masters of Education at Plymouth State University in Plymouth, New Hampshire in 2003. She has worked at the University of Vermont in the Department of Neurology with

Helene Langevin's group since 2004 as a Laboratory Research Technician. She published "Fibroblast spreading induced by connective tissue stretch involves intracellular redistribution of alpha and beta actin" in 2006, "Alpha smooth muscle actin distribution in cytoplasm and nuclear invaginations of connective tissue fibroblasts" in 2007, and is currently completing a follow up paper. → 45



James J. Tomasek is David Ross Boyd Professor in the Department of Cell Biology at the University of Oklahoma Health Sciences Center and is also Dean of the Graduate College at the University of Oklahoma Health Sciences Center. → 78



Matthieu Trudeau is a Master's student in ME at Université de Sherbrooke, Québec, Canada. He has a Bachelor's degree in ME from Dalhousie University, Halifax, Nova Scotia. Trudeau is a member of the PERSEUS research group, which conducts research projects in the field of biomechanics. → 187



Koichi Tsunoda, MD, PhD is Assistant Professor, Faculty of Medicine, University of Tokyo and Chairman, Department of Artificial Organs, National Institute of Sensory Organs, Japan. His Specialties are Laryngology, Phonosurgery, Artificial Organs, Neuroscience. → 52



Petra Valouchová, PT, PhD, specialised in Biomechanics, Master's Degree in Physiotherapy. She has been a physical therapist at Rehabilitation department of University Hospital in Prague and a university teacher of physical therapy and general medicine students at Charles University Medical school. She has

certificates in Vojta's method, Bobath concept, Mobilization and soft tissue techniques. → 217



Andry Vleeming, clinical anatomist, worked for 17 years in the Erasmus University in Rotterdam. His PhD was on the clinical anatomy, biomechanics and radiology of the pelvis. In 1996 he founded the Spine and joint center in Rotterdam the Netherlands. He is visiting professor in clinical anatomy in several

Universities around the world. He is program chairman for the Office of continuing education of the University of San Diego for the World congress on lumbopelvic pain (and chairman). → 130



H. Vránová is from the Department of Anatomy and Biomechanics, Faculty of Physical Education and Sport Charles University in Prague, Czech Republic. → 248



Scott C. Wearing, PhD, is an RCUK Academic Fellow within the Bioengineering Unit, University of Strathclyde. His research has focused on the application of medical imaging techniques to investigate the effect of limb biomechanics and loading on musculoskeletal morphology, adaptation and injury. → 243



Yan Wen, MD, is currently a researcher in the OB/GYN department at Stanford University, studying the mechanism involved in the development of female pelvic floor prolapse. → 49, 53

Frank Willard, PhD, is located at the University of New England. His human dissection projects in the low back demonstrate the functional organization and innervation patterns of muscles and ligaments, in order to understand pain generating mechanisms and their role in spinal cord facilitation. → Fascia anatomy and biomechanics panel chapter 5



Can Yücesoy has BSc and MSc degrees in Mechanical Engineering. He received a PhD on Biomechanical Engineering from University of Twente. He is a fulltime faculty member at Biomedical Engineering Institute in Boğaziçi University. His research is in biomechanics with a focus on myofascial force transmission. → 212



Adjo Zorn, PhD, has been working for many years as a physicist for German car manufacturing companies for more than 20 years, and is also an Advanced practioner of Rolfing Structural Integration with his own practice for 13 years. He is a member of the Fascia Research Project of the University of Ulm, Germany. His research work focuses on the biomechanical function of connective tissue. → 81, 82, 188

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