Dr. med. Kurt Mosetter

Myoreflex Therapy – experienced biography

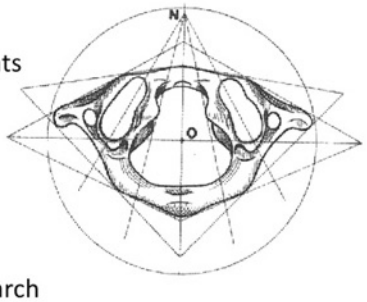
Excerpts

ISBN 978-3-934952-28-7
Vesalius Verlag Konstanz

Kurt Mosetter
Myoreflex Therapy – experienced biography

Dr. B. Mana, Dr. B. Clark, Dr. Y. Donden
Kathmandu, Ayurveda, Tibetian medicine,
nutrition, acupuncture.
1986- 1997

Dr. med. Tilmann Goerttler
Badenweiler/Freiburg
orthopedics, MET
Atlas therapy, Trigger points
manual therapy
1988-1995



Prof. Dr. med. Peter Riedesser 1987- 2008
Prof. Dr. med. Gottfried Fischer 1988 -2013
Prof. Dr. med. Dr. phil. Robert Bering 1999 -2015
Freiburg University/
Hamburg/ Cologne/Krefeld
Child and Adolescent
Psychiatry
Psychotraumatology
Clinical Psycology

Prof. Dr. Dr. Gertraud Teuchert- Noodt
Bielefeld University
Neurobiology, brain research
2002 - 2015

Prof. Dr. med. Dieter Felsenberg
Prof. Dr. med. Eckhardt Schönau
Charité Berlin/Cologne University
Muscle, and bone research, Galileo training
2002- 2015

Prof. Dr. med. Werner Reutter
Charité Berlin
Biochemistry, molecular biology,
Glycobiology, Galactose, GAG
1992 - 2010

Background, teachers and mentor in the development of myoreflex-concept

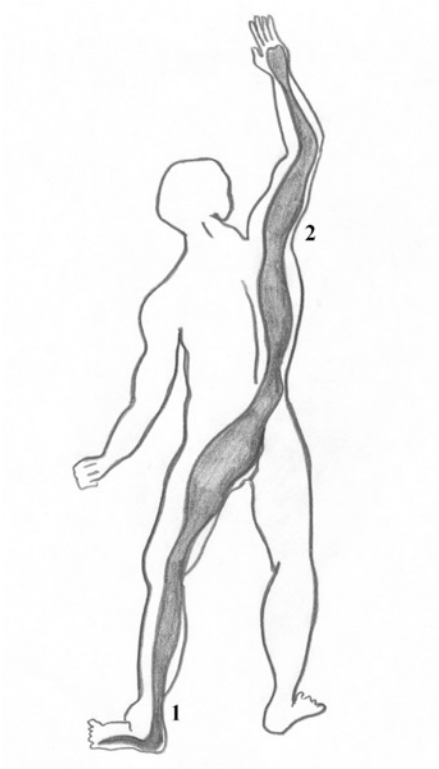
rrr15-037

Part I – Introduction

A Case Study – Functional Chains and Causal Pain Therapy

Myoreflex Therapy is a highly specific form of manual regulation therapy based upon the physical principles of movement. It permits the efficient treatment of pain and limitations of movement. Here is a clinical example:

In February 1998, Mr. Jürgen P. (age 38) presented in our practice. The reason for his visit was severe stabbing pain in his left calf [**1**], which radiated across the entire posterior leg. When asked *when, and during which activity* this pain first arose, Mr. P. stated that it happened while playing tennis, *just after the execution of a serve*. The pain began suddenly and was stabbing in quality. Over the next day, the pain worsened steadily—until it became impossible to place any weight at all on his left foot.



rrr15-049 Tennisspieler

From a mechanical viewpoint, our organism is built in such a way as to permit it to follow the laws of force smoothly, economically and aesthetically. For each movement, the muscle participants [agonists, synergists] must work actively; at the same time, the antagonist muscles must relax. Any break in this specific balance creates corresponding disturbances or impairments.

Therefore, *Myoreflex Therapy* seeks to restore the original balance of force effects in the body. The point of departure is *biomechanics, the musculature in action*; for Mr. P. the execution of a serve. Here, the *active area* of movement with the flexors (pectoral

muscles, biceps) requires the relaxation of the extensors [triceps muscles], the *passive antagonists*.

For Mr. P., *targeted neuromuscular pressure point stimulation* of the triceps muscle at the outer rim of the posterior shoulder blade [**2**; at the infraglenoid tubercle] resulted in the immediate, spontaneous resolution of the calf pain. This may be explained by the *linkage chain* of the muscles involved in the tennis serve. Mr. P. is right-handed and serves with his right arm. The pain was located in the left calf musculature.

[This illustration allows us to describe the two following muscle chains: first, the chain of the *synergists*—forearm flexors, the biceps brachii, the pectoralis major and minor, the external abdominal oblique, the rectus femoris (contralateral), the tibialis anterior (contralateral). Second, the antagonist chain—forearm extensors, triceps brachii, latissimus dorsi, iliocostalis, gluteus maximus (contralateral), biceps femoris (contralateral), gastrocnemius (contralateral), and soleus (contralateral).]

After only a few minutes, the Myoreflex Therapy treatment of the triceps muscle already resulted in one hundred percent pain relief. Of course, to achieve lasting success, it is important to treat the entire muscle chain that is involved during each of several 30-minute sessions.

The foundation for Myoreflex Therapy is living biomechanics, in other words, the physics and functional anatomy of the movement apparatus in action. From this foundation, it is possible to derive the individual steps of a treatment (as Mr. P.'s case clearly shows), and create a targeted and efficient therapeutic strategy. This is helpful not only for sports injuries, but also for everyday maladies, such as lumbago, intervertebral disc conditions, backaches and headaches, tension pain, as well as in many other physical disturbances.

Myoreflex Therapy Vol. II: Endorsements

MYOREFLEX THERAPY is a system that combines a number of medical and research-supported concepts, takes cultural differences into account and provides a new, constructive perspective for improving the quality of life for many individuals. Myoreflex Therapy builds a bridge between basic research at universities and everyday clinical practice and daily life.

During the past decade, the United Nations has devoted itself to publicizing and training practitioners about valuable new developments. UNESCO Ticino wished to make a tangible contribution for disseminating this new and holistic Therapy by funding the translation of the KiD-exercises (Resistance Stretch) and launching a new Myoreflex training program in Bellinzona.

Unesco, Club Tessin;

Michele Casarico, Andrea Del Rosso, Franca Franco, Elisabetta and Roberto Ghini, Caridad Cabanes Lepore, Eleonora Traversi, Elvira Weder

Club UNESCO Ticino

rrr15-050 Unesco Tessin Logo

Bellinzona, May 2009

TWENTY YEARS AGO, when Myoreflex Therapy was just starting out, the focus was on the regulation and self-regulation of the muscular system, but in recent years, attention has expanded to encompass a connection to the pathology, salutogenesis and regulation medicine treatment of widespread "people's illnesses." These conditions range from tinnitus to dyslexia, from attention deficit hyperactivity disorder to the management of chronic and acute pain and Parkinson's disease, and include injury prevention in soccer and the muscular dynamics of goal-kicking. The core concern is always the human being as an emotional, mobile, and self-actualizing center of activity. The consequences of moving improperly or allowing oneself to be moved improperly are the focus of this practical therapeutic discipline founded upon the principles of movement theory. The salutogenic teachings of self-care and this practical therapeutic method take care of whatever is required to restore individuals to their own natural movement.

What makes the work of the "Mosetter brothers" so unique in this field is the way they have brought together the science of functional movement, their extensive clinical experience and a carefully informed philosophical reconstruction of theory and practice.

In Myoreflex Therapy, one can palpably feel the soul of the music and musical movement produced by the wonderful instrument of a soulful body; it is the bearer of harmonic and melodious movement, of dissonances and their resolution, and of perpetual renewal.

Prof. Dr. Gottfried Fischer

Professor of Clinical Psychology and Psychotherapy at the University of Cologne; Chairman of the *Deutsches Institut für Psychotraumatologie* (*German Institute of Psychotraumatology*)

Cologne, March 2009

FOR US, MYOREFLEX THERAPY PROVIDES A CONNECTIVE LINK between traumatizing emotions that have been stored away inside the body and become available once again to psychological awareness through a process of reawakened consciousness, and can subsequently be worked out in a psychosomatic psychotherapy (as practiced at Oberberg clinics).

Our theoretical perspective does not focus primarily upon performance enhancement. However, the release of obstacles caused by emotional blocks, from the inside out, results in an optimization of individual performance by restoring the harmonious interplay of body, spirit and psyche. We approach this through the path of self-awareness (procedures based upon mindfulness), and once the events that have been unconsciously locked away in the body have become accessible once again, this can sustainably rekindle the original, non-traumatizing energetic processes.

The interplay between Western and Asian medical perspectives correlates well with our holistic approach.

We have integrated Myoreflex Therapy into our Oberberg concept as a body therapy, with the goal of providing effective treatment for chronic psychological problems, including depression, burnout and dependency disorders.

This method gives us a possibility, at last, to transcend the division between body and psyche that is so dominant in medicine, and once again to validate the place of the body as the seat of the soul, to take care of it, and to open up and use its full potential.

Dr. Edda Gottschaldt

Director of the *Oberberg Clinics*; Chairperson of the Executive Board of the *Deutsche Suchtstiftung Matthias Gottschaldt*

Berlin, December 2009

BLOCKAGES AND DISCONNECTIONS IN THE BRAIN and the nervous system can result in specific motor and sensory disturbances as well as impairments of thinking and language functions.

In order to improve our understanding of these processes and to make them more visible, we have developed the method of EEG spectral analysis, which is a modification of EEG testing technology that permits us to study functional processes and to display them graphically. We break down the EEG potentials that are customarily measured in medical testing into their individual frequency components by means of a fast Fourier transform, and display them in a spectral-analytic format.

This has permitted highly individualized and precise determinations of the dynamics and interactions of specific brain waves and brain structures. Spectral analysis enables us to distinguish between awareness directed at the outside world and internally directed receptivity; we can visualize the inner images of non-verbal interactional processes between individuals. Similarly, we can measure emotional blocks, such as "anxiety" and "stress." By using sequential examinations, we are able to document the process of change and recovery.

We have performed measurements during many sessions of Myoreflex Therapy and have been able to demonstrate its effects and the changes it produces virtually in real time. With the close cooperation of Kurt and Reiner Mosetter and the *Zentrum für interdisziplinäre Therapien* (Center for Interdisciplinary Therapies), we have been able to examine a large number of patients before and after treatment with Myoreflex Therapy.

We have repeatedly shown and confirmed that the procedure of Myoreflex Therapy has profound and multi-dimensional effectiveness. The statements in this book concerning interoception and self-awareness, neuronal dynamics, potentiality and regulation have been fully confirmed by the results of our measurements.

We at the *Institut für Kommunikation und Gehirnforschung (Institute for Communication and Brain Research)* hope that Myoreflex Therapy will achieve broad public recognition – on the part of patients as well as physicians, therapists and other specialists.

Dr. Günter Haffelder

Founder and Director of the *Institut für Kommunikation und Gehirnforschung* Stuttgart

Stuttgart, December 2009

IN BOTH THE WORLDS OF MEDICINE and high-performance sports, we are always searching for possibilities for improvement. Myoreflex Therapy has rapidly grown from a major component of my approach into a unified system of medical and physiological support for high-performance sports.

Dr. Kurt Mosetter not only found a way to keep me from undergoing urgently recommended disc surgery by means of only a few Myoreflex treatments in the fall of 2008, but has been able to chart a new and more effective path for professional sports, which will doubtless achieve breakthroughs in many places over the next few years.

Medical concepts, fitness training and soccer-specific training work hand in hand in this system – in the service of optimizing the performance of athletes and their successful collaborative play. For the rehabilitation of peak performance athletes, it provides a significant time advantage; very often, it is not only possible to manage painful conditions by treating their root causes using Myoreflex Therapy, but they can even be prevented before they occur.

The geometry of movement, symmetry of tone, motor coordination and the quickest orientation of attention all extend beyond the body to facilitate neuromental fitness as well.

Professional sports is continuing to augment its appreciation for a holistic understanding of the individual athlete based upon a number of different building blocks. In the future, Myoreflex Therapy will undoubtedly be one of these key building blocks.

Jürgen Klinsmann

Munich, September 2009

COMPETITIVE PROFESSIONAL SOCCER at the top national or international level places a relentless heavy burden on all physical systems throughout a long season. As an athlete, I must have all possible energy resources available when I am playing.

Since 2006, professional soccer club 1899 Hoffenheim has been successfully applying insights from Myoreflex Therapy.

For us, this form of therapy represents the perfect bridge and connection between physicians of all specialties, because it is distinguished by a fortunate blend of academic medicine and alternative healing methods, such as traditional Chinese medicine.

Myoreflex Therapy provides us with completely new insights into the function of individual muscles as well as the connections that exist between different muscle groups and chains.

It regards the athlete as a whole person at both a physical and mental level! This comprehensive diagnostic and therapeutic system focuses upon the elimination of underlying causes and upon reconstruction after longstanding injuries. Myoreflex Therapy uses the body's own regulatory mechanisms to correct biomechanical imbalances, as it places central emphasis on synchronizing the work of agonist and antagonist muscle groups.

When it comes to disturbances, blocks and even injuries, in competitive sports we are concerned with the quickest possible recovery of function, but at the same time, we want that recovery to be sustainable. This is facilitated by an intelligent analysis of

weak points as a means for paying serious attention to injury prevention, something that is of such critical importance.

In cases of injuries as well, we have come to clearly recognize that this form of therapy enables faster rehabilitation by means of its high efficiency. We have noted a much smaller tendency for injuries to turn into chronic problems.

A particular advantage of this form of therapy is that quite often, treatments are applied at some distance from the site of injury, and this permits immediate unburdening of injured structures.

Myoreflex Therapy was a critical building block for the athletic development of 1899 Hoffenheim all the way to the *Bundesliga* (German premier league). In professional sports, such knowledgeable preventive approaches mean time savings and are thus a highly valued commodity!

With his extraordinary approach, and together with our therapists, Kurt Mosetter provides an enormous service for the flagship professional team at Hoffenheim.

We are enormously grateful that under the professional leadership of Kurt Mosetter and our team physician, Dr. Beks, our therapists Geigle, Stadler and Grau, Myoreflex Therapy can be regarded as a strong element in the optimal build-up or restoration of performance capacity in our football players.

Bernhard Peters

Director for Sport Promotion and Promotion of Young Talent, TSG Hoffenheim

Hoffenheim, November 2009

IT HAS LONG BEEN RECOGNIZED that the living human organism is not merely a construct assembled from individual components, but rather constitutes an integrated unit that can only achieve ongoing balance in the presence of the cooperative interplay of all parts of the body. The peripheral and central nervous systems unite all the organs into cooperative behavior, and together, they direct them over the course of continuous change. Our contemporary academic medicine has consistently failed to take this sufficiently into account.

Sharpening one's sensibility for this unity is the concern of Myoreflex Therapy training. The physician, Dr. Kurt Mosetter and the philosopher, Reiner Mosetter have produced an impressive and concise system, which is built upon empirical therapeutic experience, the results of long years of joint engagement with both Eastern and Western medicine and upon models from learning theory that have long been striving to be put into practical use.

The brain and the central nervous system are central dialogue partners in Myoreflex Therapy, in order to study somatic, neuronal and psychological illnesses and describe them in an integrated way. The holistic nature of biological events is taken into account, as Myoreflex Therapy is formulated in terms of neuroanatomical, neurophysiological, biochemical and neurochemical descriptions and unites these diverse disciplines into an interconnected network that can be applied in clinical practice.

Following this holistically conceived path is a very worthwhile endeavor. In the end, the practical pathway provided by Myoreflex Therapy can serve as a form of self-

healing for all the fragmentary forms of understanding that our textbook knowledge has imposed upon us.

Prof. Dr. Dr. Gertraud Teuchert-Noodt

Professor of Neurobiology, Bielefeld University

Kiel, July 2009

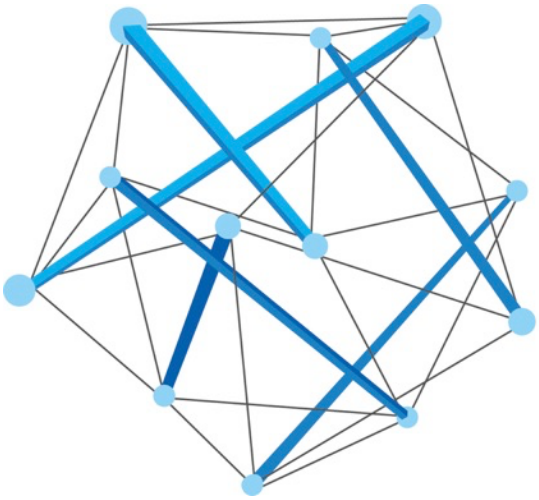
"I was fortunate to have Kurt Mosetter as a very experienced physician at my side, who employed his Myoreflex concept not only to care for my physical balance, but also too coordinate issues of nutrition by reducing carbohydrates and introducing intelligent food supplements with "healthy sugars."

Ralf Rangnick,
Sportsdirector for RedBull professional foodball worldwide and Coach ofRB Leipzig

Myoreflex Therapy and Biomechanics

[1]

Buckminster Fuller, one of the most important pioneers in the field of architecture, and his basic principles of the tensegrity model inspired us as early as 1987 in creating the transfer to develop a concept of the architecture of living moving systems.



rrr16-014

The discipline of anatomy describes the human muscular system in great precision and detail. These anatomical descriptions include the origins and insertions of muscles, their course and their innervation as well as their function in the particular joint. More comprehensive ideas about the function and integration of the muscular system are elucidated when we consider anatomy in motion. The concept of motion ranges all the way from the mechanical concept of locomotion to encompass all the conscious and unconscious processes of movement that are directed by the central nervous system. In life, this involves diverse patterns of movement, where each muscle functions as a participant in a great performance, not unlike a violin in a symphony orchestra. The multiplicity of movements possible for a human being is illustrated by speaking, writing, dancing, and balancing…

The pivotal point and fulcrum for the concept of Myoreflex Therapy is anatomy in function. As we consider the muscular system, we can distinguish a number of different moments that are part of this interactive structure. In what follows, we will define a number of central terms and elements in Myoreflex Therapy and explore them in more detail.

Muscle Loops

Tittel describes a loop-shaped interaction and analogously structured collaboration between several different muscles (controlled and coordinated by higher segments of the CNS):

“The muscles joined together for collective action are designated as ‘muscle loops,’ a term that has since found broad acceptance in both theory and practice; the reader

---

[1] Source: Mosetter, Kurt / Mosetter, Reiner (2006). Myoreflextherapie Band 1: Einführung in Muskelfunktion und Schmerz. (2. Auflage, 1. Auflage 2001). Konstanz: Vesalius. S. 31-84.

should take from this concept that no matter how powerfully developed it may be, it is not a single muscle but only its intimate connections that provides those well-coordinated muscles that are performing the largest share of the work with the assurance of a *smooth*, *economical* and at the same time *aesthetic* sequence of motion. The reader should recognize that the impact of a single muscle is not confined to the joint to which it is directly connected. Therefore, […] we will not be referring so much to the function of this or that particular muscle […], but instead, about those that execute the functions of a *muscle loop* as part of a higher order system. […] even the simplest apparent movements turn out to present many a riddle once we analyze them and their implications for practice, especially since the combinations of muscle groups are so varied and are changing from moment to moment."[2]

According to Tittel, a muscle loop can be described as follows: from the flexor system of the dorsal lower extremity all the way to the ventral flexor musculature of the torso (and back) through the extensors of the dorsal torso, across the spine, all the way to the ventral extensor system of the lower extremity.

Force vectors and kinetic chains

A consideration of the physical principles governing the movement apparatus offers us another way to describe it. It is possible to conceptualize these principles and create representative models by understanding the complex vector systems of dynamic and static forces and force effects that are involved.

By examining vector force effects and vector systems at the muscular level, we can show that every muscle could be likened to a force vector, where the magnitude and the direction of the force must be simultaneously taken into consideration. Once we include all of the different parts of the movement apparatus, such as bones, cartilage, muscles and ligaments, then it is apparent that the biological organism, considered in a biomechanical perspective, is constructed in such a way (obeying the laws of physics and mechanics), as to maintain a specific equilibrium of forces (an overall harmony), which guarantees smooth, economical and at the same time aesthetic postural and voluntary motor activity.

In addition to the concept of muscle loops, we can make use of the related concept of kinetic chains. This term also describes the interaction of complex muscle groups (muscle chains) that is a part of specific movement processes and activities. The foundations of a kinetic or a muscle chain are mechanical force effects based on the laws of physics that govern all anatomic structures in the movement apparatus with respect to their formation and effects. The corresponding movement programs originate, refer back to and operate according to these physical principles.

---

[2] Kurt Tittel. Beschreibende und funktionelle Anatomie des Menschen. Jena, Stuttgart 1994. S. 192f.

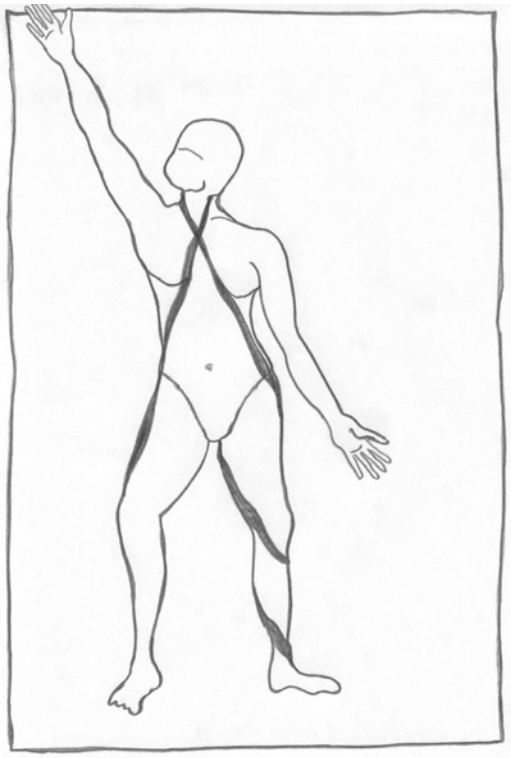


BILD 6(33)

The general laws of gravity and statics apply to the human organism as well. The effect of every force is propagated as a linear phenomenon. A force effect is never limited to a single muscle (from its origin to its insertion). Instead, it exerts its impact in kinetic chains and can only be described in these terms.

For example, a kinetic chain is constituted by the finger flexors and the forearm through the medial humeral epicondyle – the brachioradialis muscle and the biceps brachii through the coracoid process – the pectoralis minor and major muscles – the contralateral external oblique muscle.

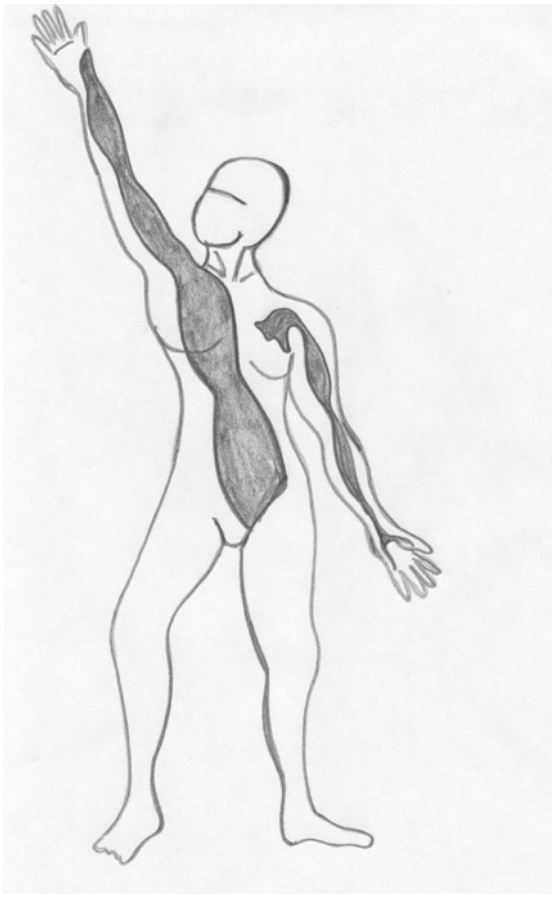


BILD 7(34)

Depending on the moment of movement, there are a number of different possible continuations of this same chain to the bony structure of the anterior superior iliac spine - but now, according to the principle of muscle slings, these do not lead to the flexor system of the lower extremity:

- The quadriceps femoris muscle – anterior tibialis muscle up to the extensors of the toes.
- in a linear continuation of the fiber portions described above, one could describe an imaginary extension of the line in a spiral enlacement of the cone structure of the lower extremity. This line leads over fiber portions of the tensor fasciae latae muscle through portions of the gluteus maximus muscle to the lateral dorsal femur and onwards through portions of the ischiocrural muscles to structures of the adductor longus muscle, the semimembranosus muscle and the semitendinosus muscle and to the pes anserinus. From there, this line leads on through muscle portions of the tibialis anterior muscle to muscle areas of the gastrocnemius muscles, the soleus muscles and further on, to the extensors of the toes.

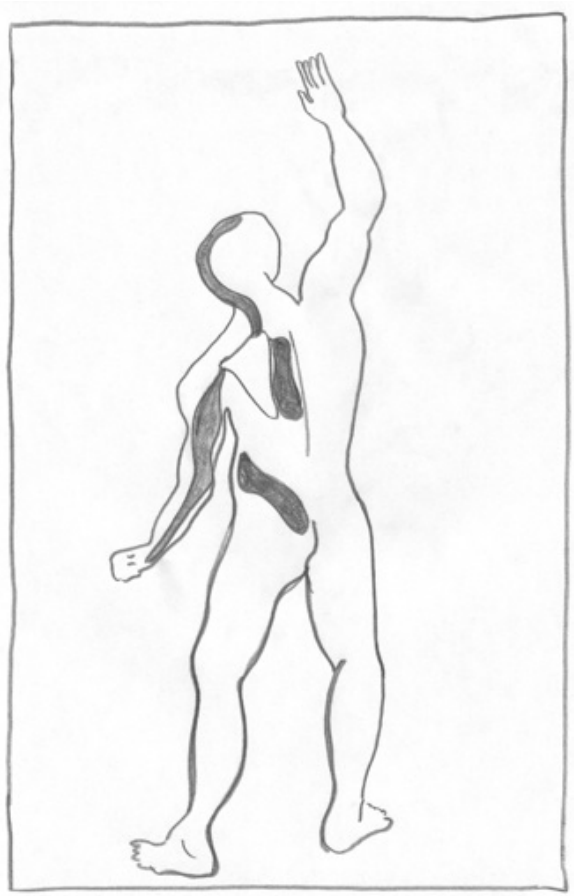


BILD 10(37)

In addition, bony structures may be quasi interpolated with these muscle chains, functioning as hubs and as switches, in both the translation and the diversion and transmission of forces. In the chains described above, there are a number of switch positions possible beginning at the coracoid process; other continuations of the kinetic chain from the structure of the scapula are possible as well:

- over the superior medial angle of the scapula with the levator scapulae muscle to the dorsal cervical spine
- over the glenoid tubercle with the triceps brachii muscle, the lateral humeral epicondyle and on to the extensors of the lower arm
- and (third), over the medial inner edge of the scapula with the serratus anterior muscle through the system of the contralateral external oblique muscle to the previously named continuation (anterior superior iliac spine).

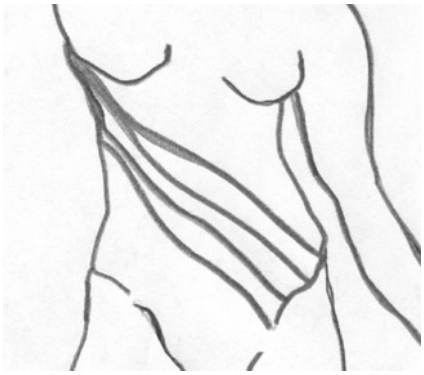


BILD 11(38)

What is critical for kinetic chains are not individual, defined muscles, but rather the linear extension of the respective, activated muscle fiber portions. Thus, for example. every point along the continuation of the anterior serratus muscle produces its own line and specific vector direction.

For every activity, there are muscle groups working together synergistically and others that are working antagonistically. Depending upon each moment of movement, there are functional shifts in this system and smooth transitions. The activation of any chain is always bound up with corresponding reciprocal effects primarily related to antagonist chains.

Muscle Slings and Muscle Chains

The terms “muscle sling” and “muscle chain” basically describe the same entity. The term “muscle chain” puts more emphasis upon the activity and the function of the mobile organism: a motion of bending down in the chest and abdominal areas finds its continuation in a bending movement of the lower extremities. In this case, the slings begin ventrally and shift in a dorsal direction. The term “muscle chain” emphasizes the linear spread of physical and mechanical force effects and their associated kinetic chains. An activity or forceful movement in the chest or abdominal area remains ventral in its continuation and thus leads down into the lower extremities (now, however, in the antagonistic area of activity in the extensors).

Tension banding, vector networks and shock absorption

In this context, the important elements include biological shock absorption systems and the effect of accelerative, braking and frictional forces in the body. In the interplay of bony and muscular structures, it is critical that no individual element be overburdened or misloaded; otherwise it could be injured or destroyed. This requires precise centering and guidance of joints by means of a system of tension bands (forces exerting traction and pressure upon a joint),[3] which must function without friction even in the presence of large forces, and without overburdening or misloading the joints.

---

[3] Pschyrembel: Klinisches Wörterbuch (Berlin, New York 1998, 258. Auflage): "Zuggurtung: (Eng.) tension banding; (chir.) Methode der Osteosynthese (a method of osteosynthesis).” As a result, “the operational traction forces [...] are transformed into pressure forces on the fracture gap." We would like to use the term, “tension banding” to refer more generally to the forces (in the muscular system) working on bones and especially on joint structures. Moreover, the principle of tension banding is also used in architecture. An impressive example is the construction of the *Golden Gate Bridge* in *San Francisco*.

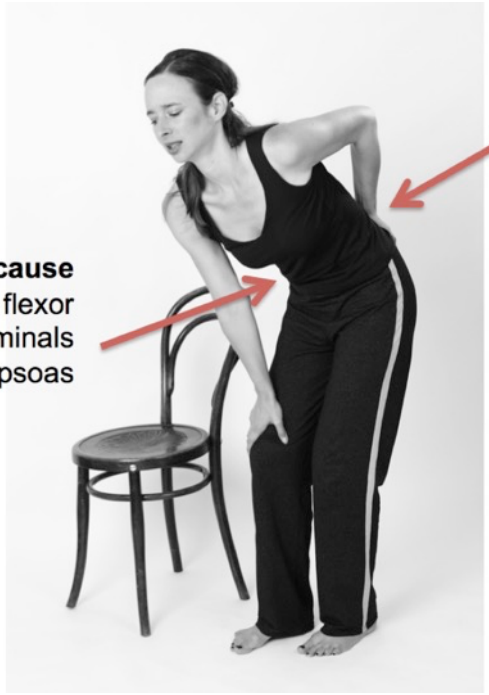


BILD Schmerz Blitz Lisa engl gr

With regard to biomechanics, two basic structures must be differentiated; there is a static structure (bones and joints) and a dynamic structure (muscles, tendons, and ligaments). From the perspective of Myoreflex Therapy, we primarily attend to and treat the dynamic side. However, in its interconnection, this dynamic is actually much more complex and multi-layered than previously assumed. The muscle in function cannot be fully comprehended in a one-dimensional perspective.

Vector Networks and Muscle Chains

Any violation of a specific force equilibrium (disrupting its biomechanical balance) brings along a particular set of injuries and disturbances, and thus may be the cause of pain. Every healthy joint exists in an effective state of force equilibrium. This balance can suffer long-term disruption if the baseline set value of only a single vector component is altered relative to the overall network.

Within the rubric of internal biomechanics, scientists attempt to "calculate the forces on joints and bones by considering the simplest biological parameter, the muscle's lever arm. If a person is standing on the tips of his toes, his entire body weight is concentrated in the raised ankle joint, Baumann explains. In this position the lever arm measures about twelve centimeters. An opposing force can only be provided by the calf muscles that pull on the heel bone through the Achilles tendon. Their lever arm to the ankle is only about four centimeters in length. As a consequence, the muscular force in the calf must be three times as great as the force of the entire body weight. And at the level of the joint, these forces are additive, so that it must bear the burden of four times the weight of the individual."[4]

[4] Christopher Schrader. Wie Bewegung in den Körper kommt. In: GEO Wissen, Körper - Bewegung - Gesundheit, Nr.1 - Mai 1994, (S. 48-60). S. 56.

In the perspective of a biomechanics that would hope to consider the full dimensions of inner processes and the principles that govern them, this form of internal biomechanics would appear to represent only a half-way point. It is clear that such highly selective and sharply demarcated observations are insufficient for understanding the processes of internal movement. The larger context of connections in which individual functional relationships are embedded must also be included in the considerations. In the present example, this means that it is not just a single muscle (the calf) that is affected by an event; all of the muscles that have a direct or indirect connection with this muscle are also integrated into the event. For bearing weight, an entire muscle chain is activated, including an agonist chain and an antagonist chain, and participates in the function of the calf muscle.

Calculations that try to examine an individual component of a larger system in isolation, and remove it from a living, coherent whole, will determine force effects for the joint that, were they real, would actually place pathological, destructive stresses upon the joint in question.

Only by considering multiple individual parallelograms of forces, based upon overall synergist and antagonist chains, is it possible to arrive at an adequate estimation of the actual muscular forces and forces affecting the joint. Because of the interplay of many muscles, these forces must be far smaller than previously assumed – and this is the only way to understand that steady, centered joint units can function smoothly under a full range of physiological loads.

Procedures for calculating the force effects of a single muscle on a joint are an attempt at direct translation of classical physics into functional anatomy. This approach may be useful; however, it has not been consistently extrapolated to account for overall static equilibrium and the interactions of multiple forces. Thereby left out of consideration are the contributions of neurophysiology and its elucidation of complex control and movement programs. Without programming and interconnecting individual muscle activities into kinetic chains and muscle synergies, it would be impossible to imagine either complex or simple movements. Every simple movement is connected to complex movements – both neurophysiologically and (through vector networks) biomechanically.

The coordinated interaction and physical reciprocal effects of the various muscles forming a muscular system are core points that form the foundation for the concept of Myoreflex Therapy. Many types of joint pain, radiating pain and migratory pain can be understood with reference to these interactions, and then become amenable to effective treatment.

Biomechanical shock absorption

In his farewell lecture, Roesler asks, “to what extent the assertion that ‘the double S shape of the spinal column serves for shock absorption’ is actually biomechanically correct, and what we really mean by the idea of shock absorption.”[5] Biomechanics makes use of “mechanical laws of living organisms and their structures.” The true significance of this idea is not so easy to specify – and this becomes quite clear when we consider the following contradiction, which Roesler uses as the impetus for his own deliberations:

---

[5] Heinrich Roesler. Abschiedsvorlesung vom 12. Juli 1996. In: Krankengymnastik (KG) 48 (1996) Nr. 11, S. 1667-1670.

1. The double S shape of the spinal column serves for shock absorption.

2. A fall onto one's buttocks, even from a small height, can result in significant injuries to the spine.

According to Roesler, it is the first statement that should be placed in question. It is founded upon "a false image of the mechanical process of shock absorption." This image is similar to efforts that seek to ascribe "the property of shock absorption to the joint cartilage, the meniscus in the knee joints and certain running shoes." Should this image and this explanatory approach be mistaken, and fail to correspond to the actual mechanics, this would also require a basic reorientation of biomechanics.

According to Roesler, it is essential to take into account the "tendency to explain movement processes in lived nature by drawing analogies from technology." This also applies to the following term (and the corresponding explanatory approach): "The word, shock absorber, which is derived from technology […] leads to misunderstandings in the realm of biomechanics." We have to raise a fundamental question at this point: "What are the tissue structures that living organisms use to brake their movements in such a way that no injuries occur?" The author's deliberations about questions of force, force magnitude, velocity, braking time, braking force, springs and friction make it clear that:

"To prevent destruction in the living body, one has to make braking times (or the corresponding braking distances) sufficiently long so that no excessive forces arise and the body stays undamaged. The only question now is, "How can we effectuate this?"

Roesler emphasizes that previous attempts to explain this process have been inadequate.

"Of course, the joint cartilage, meniscus, intervertebral discs and bones have some capacity for suspension and even some friction, but they more closely resemble hard springs that permit little compression before they are damaged. The braking times that can be achieved simply on the basis of these elastic properties of tissues are insufficient to adequately attenuate the forces that arise."

Roesler's answer or proposed solution is also of fundamental importance to Myoreflex Therapy. This finding provides support for the reorientation or reformulation of biomechanics.

"The spring forces and frictional forces required for destruction-free braking of movement are provided by the muscle-tendon unit as a whole. Both tendons and muscles have elastic properties. The sliding movement of actin and myosin in the eccentrically loaded muscle can be seen as a textbook example of friction. The simple answer to the question asked at the outset about which tissue structures might serve as shock absorbers is: the muscles."

Against this background, the statement that "the double S shape of the spinal column serves for shock absorption" begins to make sense in a different way. If the spinal column were just like a stick, then the shock-absorbing structures could not take hold. This principle is valid for the functioning of all joints. A jump from a chair with fully extended legs would be disastrous for the knee joint. Only in a flexed position, when muscles can play their part, can a jump of this kind be modulated and the forces generated be absorbed and deflected.

Anatomy and Significance of the Sitting Posture

In the days when human beings were still active as hunters and gatherers, their movements were far more varied. We can still observe this today in so-called “native” populations. If we imagine activities like dancing, playing and fighting in addition to the daily routines of hunting and gathering, it is clear that our ancestors exhausted all the possibilities of human movement in the course of a single day. Today, excessive sitting is certainly one of the principal causes of that common disease of civilization, back pain. Sitting places the human body into a permanently flexed position; this habit begins during school years and typically continues throughout a person’s working life. This static load pattern over long periods of time can lead to multiple asymmetries in the movement apparatus and to a wide range of painful conditions.

It is obvious that hard physical labor, which used to be the principal cause of back ailments, no longer is the critical factor in its pathogenesis. This type of physical strain has not increased over the past few decades, but has steadily diminished. Therefore, individuals whose work today involves physical activity are not at greater, but at lesser risk than office workers; in the office chair, the phasic musculature risks becoming slack due to lack of movement, while the tonic musculature loses its ability to perform due to contractions.

As the intervertebral spaces narrow and discs lose elasticity and functionality with increasing age, everything depends upon an active balance between the muscles of the back and the abdominal muscles. The initial changes in the bony structures and early osteoarthritis can be attenuated and alleviated by a balanced muscular system. Besides the stabilizing supportive and connective tissues along the spinal column, it is primarily a balanced, conditioned muscular system that is responsible for both stability and mobility. The better conditioned and balanced the musculature, the lower and more optimal are the pressure and load conditions for the discs and the spinal column.

Given the importance of a healthy muscular system, fewer orthopedists consider it useful these days to recommend rest and immobility for their patients. They realize that movement – precisely because it improves the patient’s relationship to his/her own body and general sense of well-being – is more salutary in the long run and keeps the patient active.

Movement also improves metabolic activity and thus increases the functionality of bony structures, joints, cartilage, supporting and connective tissues. All of the elements of the movement apparatus benefit from activity and suffer from immobilization. Typical examples of this are momentary backaches upon awakening and morning stiffness in persons with arthritis.

Often, backaches resulting from poor posture or a strained muscle system also have additional psychosocial causes. Therapists should never neglect factors such as unhappiness with one’s work, annoyance with colleagues and supervisors, as well as the question of how monotonous and poorly suited the type of job may be for the individual.

The buttocks, hips and the knee area along with the lower legs and thighs are all kept flexed in everyday sedentary life. Besides being in a sitting posture, people are continuously holding their hands in front of them as they go about their daily tasks. Their shoulders are bent forward and rotated inward. This invariant work posture often turns into a permanent position; the shoulder, neck and pelvic areas are mostly loaded in only a single direction. This results in the contraction of those muscles that are used throughout the day in an unchanging, foreshortened functional position.

Persistently flexed posture eventually makes self-stretching impossible. Improper functional loads on the tension banding system of the movement apparatus lead to the infliction of damaging forces to the joint.

In this respect, we should consider the research findings published by Tilscher et al (1991; 1994).[6] They showed that it is primarily the tonic musculature used for maintaining posture that tends to become shortened and contracted. Typically, these specifically include the ischiocrural muscles, and thus the flexor system of the thigh, along with the rectus femoris muscle and the psoas major muscle as the principal flexors of the hip. These muscle groups are responsible for freezing the sitting posture, so to speak. At the same time, the phasic muscles that serve for movement tend to become weak and to atrophy. Primary representatives of this muscle group are the gluteus maximus muscle, the rectus abdominis muscle and the shoulder blade fixators.

Psychological factors, such as stress and anxiety, may further contribute to this one-sided posture. They increase basic muscle tone, which makes a person's posture look cowed and stooped. We can regard the exaggerated degree of flexed posture as a defensive response, something that occurs instinctively and involuntarily in all higher forms of life. Once the fear abates, the individual can resume a normally erect posture. However, ongoing stress and a one-sided posture have a reciprocally aggravating effect, leading to the persistence of a fixed, flexed posture.

A number of other pain syndromes and unbalanced movement patterns can be regarded in a similar fashion. What is missing in all of these one-sided movements is the corresponding counter-movement – placing a work-load on the antagonists and making use of the entire movement apparatus.

A number of movements can only be executed in the middle of the working range of the muscles involved as long as a person is in a sitting position. This results in an imbalance. It is easy to observe this phenomenon; for example, in a prone position, you can hold your head up for a longer time without any support, but when lying on your back, only for a very short time or not at all. The reasons are apparent: the anterior neck musculature with the primarily tonic scalene muscles have been relatively shortened by continuous ventral flexion; they are no longer capable of performing a well-balanced postural function. Here, we are dealing with an imbalance between the posterior and anterior neck musculature. The equilibrium relationship between these two sides has been disrupted. This leads to increased stress for the shortened muscles and thus to unphysiological force effects upon the joint.

In many cases, the frequent use of one's arm (while neighboring parts of the body are in a flexed position) results in shoulder pain, which is an indication of this imbalance. A full range of use of the upper extremity is no longer possible in positions of extension.

Active and passive limbs of movement no longer interact properly, instead; they only relax to a limited degree and are impeded or misdirected during exertion, such that they finally end up mutually braking and overriding one another. Through endurance training, it is possible to develop considerable muscular power over a very limited working range with muscles in their middle range of operation; however, the distal

---

[6] M. Eder u. H. Tilscher: Schmerzsyndrome der Wirbelsäule: Grundlagen, Diagnostik und Therapie. Stuttgart 1991. H. Tilscher u. M. Hanna. Die gestörte Wirbelsäule: Diagnose, Therapie, Rehabilitation, Prävention. (Wiener Internationale Akademie für Ganzheitsmedizin, Schriftenreihe Band 13) Wien 1994.

fiber portions are no longer capable of developing regulated force. This eventually leads to blockages in the system of direct and functional antagonists.

Only those muscles can be activated whose antagonists can relax appropriately. In an orchestra of functional antagonists and agonists, free movement (which proceeds without pain and does not injure bony structures or joints) is only possible if the individual performers play together meaningfully and harmoniously. The disharmonies caused by excessive sitting begin to make themselves noticeable specifically in neck and shoulder tension. Later on, they can also result in more distant symptoms, including headaches, shortness of breath, and paresthesias in the hands. The symptom complex of backaches is especially characteristic. At the onset of pain conditions, the problem is typically limited to muscle aches with a signaling character. Should this stage remain unrecognized, adequately treated and taken into consideration through an active process of responsibility for oneself, this will result in chronic pain conditions. The chronic phase can then proceed to cause degenerative changes in the bony movement apparatus. These, in turn, can go on to result in a secondary, non-productive form of pain.

Autofahrt 4, ## Autofahrt 6,

Autofahrt 8, ## Autofahrt11, ## Autofahrt12

Part IV – LENGTH TRAINING FOR MUSCLES, FASCIA, AND THE BRAIN: PRINCIPLES FOR BETTER EFFICIENCY IN TRAINING

Sense and Nonsense about "Stretching"

One thing stands out in the recurrent passionate discussions of the pros and cons of stretches in sports: many statements by so-called experts are not really based on evidence, taken out of context, one-sided, and insufficiently nuanced. Depending on perspective and investigative design, scientific studies on sports have also yielded contradictory data.

Part of the problem is the frequent lack of a clear definition of the intensity, direction, velocity, duration, amplitude, repetitions, frequency, and type of stretching. In addition, studies fail to adequately differentiate between isometric, ballistic, facilitated, isotonic, passive, static, linear, rapid, slow, and pulsating stretches.

Not least, there is a need for a clear definition of what *precisely* is meant by stretching, that is, which structures are being stretched, and *why* one is paying attention to stretching in the first place. Are the objects of stretching single muscles, muscle groups, fasciae, or movement patterns, or is the goal of these efforts to optimize performance? *When* and at what time point should one stretch, and *for how long* and *how intensively?*

Another question that often fails to be considered is whether stretching is intended to improve performance or used for the purpose of injury prevention. To find clear answers, one must also include consideration of the specific type of sport involved and individual constitutional aspects.

A key issue is also to explain *exactly what* one intends to and is able to change in a positive way. Often, the key role and importance of the brain is completely left out of consideration, along with its own important neurobiological playbook.

At this point, it should be apparent that shortsighted statements of opinion would not serve the interests of clarity. What appears more fruitful would be to query multiple different disciplines and experts about their experience, understanding, and contrasting research findings.

Insights from modern brain research reveal that passive or stereotypical stretches and isolated linear stretch components leave few lasting traces in the brain and show no sustained effects. In this context, too extreme, too rapid, and too frequently performed stretching efforts will have low efficiency, as will stretching at the wrong time or executing too many stereotyped repetitions.

The best multi-dimensional positive progress, adapted to the brain, results from active stretching exercises against resistance. The exercises known as “*Resistance training*

in stretched positions (KiD)" as developed in Myoreflex therapy present requirement notifications to the brain; the brain responds in turn through corresponding adjustments. These training adjustments are also reflected positively in the length of the muscle and fascial chains, in overall performance, in mobility, and in the neuronal control systems. At the cellular level, this type of active stretching has been shown to improve muscle length and to result in skeletal muscle adaptations with respect to the serial growth of sarcomeres.

The principles of strength training from stretched positions have also been shown to result in structural improvements in elasticity, collagen synthesis, and the activity of myofibroblasts in the fasciae. Similarly, researchers have demonstrated increases in the density, quality, sensitivity, and switching velocity of the sensors involved along with improved tissue hydration.

The key message from muscle and fascia research as well as Myoreflex studies is that the antagonist chains and counter movements must always be included in active stretch-strengthening resistance training. By contrast, passive stretching of single muscles and joints at a single level cannot yield any significant positive results.

Some rehabilitation experts agree that strength training by itself is too one-sided and that even passive stretches result in better rehabilitation outcomes than no stretching at all. Without a doubt KiD exercises (resistance training in stretched positions) and active length training from stretched positions have been proven extremely effective in rehabilitation.

The successful former head trainer of the German National Hockey team, Bernhard Peters, helped his team win and defend the Olympic gold, the European championships, and world championships. His analyses showed: stretches are an essential part of all training, for all sports, and for regeneration, and they need to be precisely planned, dosed, varied, and fine-tuned.

We should consider Bernhard Peters as an outstanding pioneer in terms of his consistent and clear choice of the proper kind of stretching. He implemented his perfectionistic choices as early as 2000 and continued to do so up to the second world championship victory in 2006. From 2006 to 2014, as athletic director for the Bundesliga team TSG 1899 Hoffenheim, and since August 2014 at HSV in Hamburg, his competency has also been disseminated to professional football and work with young people.

Two other sports leaders who have consistently sought out the best solutions are the football coaches Ralf Rangnick and Jürgen Klinsmann. An important element of their innovative training concept is the use of active KiD stretches from Myoreflex therapy. From 2006 to 2009, this program of active stretching with intelligent strengthening exercises was established in the Hoffenheim ascension project under the direction of Ralf Rangnick. Setting an ideal example, the exercises were implemented with the *consistent and simultaneous support of the medical department, the rehab trainers, and the athletic trainers* and rewarded with the team's extraordinary ascendancy into the first Bundesliga and the 2008 Autumn Championship. Jürgen Klinsmann integrated the Myoreflex concept with KiD activating exercises the moment he assumed his position as chief trainer of the US National Soccer team in September and has continued to do so until today. These forms of active stretching have also been used very successfully in a range of key Olympic track and field areas by many trainers and physical therapists. In these areas as well, their application *encompasses therapy, rehabilitation, prevention, and athletic strength and performance enhancement.*

Robert Schieferer of the Hessian Athletics Association and Tanja Horbach in Saarbrücken are two of the outstanding trainers working at the interfaces between health, prevention and performance enhancement.

Trend-setting training and fitness centers, such as *INJOY*, the futuristic training apparatus known as the *Flexx-Zirkel (Flexx Circle)* and the *five concepts* as well as the methods of *4D Pro Reaction* all share a long-sighted perspective toward a healthy future inspired by these new discoveries. Their efforts illustrate the great benefit for the general population at the interface between health care, prevention, training, and performance optimization.

The good news is that less is often more! Small doses of aesthetic, elastic, flexible KiD exercises (resistance training in stretched positions) along with short load intervals and longer pause intervals can produce optimal effects with less time expenditure. Active strengthening initiated from stretch positions brings into harmony the only seemingly contradictory theories about stretching and strengthening.

Perfect Movements in Competitive Sports

My personal enthusiasm for "perfect movements" in sports was first aroused when I was only 15 years old. As a counterweight to my experience of our father, whom I knew as a man completely immobilized in a wheelchair, I became a *Bruce Lee* fan. His power and speed, extreme mobility, perfect timing and absolute sense of security in performing complex movement sequences captivated me.

How was it even possible that the entire body, seemingly defying the laws of gravity, could spring into the air with such total speed and without a sound, with dynamic force, cushioned, and then change direction, ultimately sending his opponent or objects flying through the air, all of this with hardly any perceptible impetus?

It was clear that besides the classical laws of force and gravity, there had to be an expanded corrective model of forces at play here. It was also apparent that such great velocities and extreme accelerations must depend upon *a mechanism that resembled a tightly drawn bow releasing an arrow*. Ordinary muscular activations alone could not possibly explain this phenomenon.

These phenomena soon led me to seek out the work of R. Buckminster Fuller and his discovery of *tensegrity* (see below). My encounters with practitioners of the martial arts beginning in 1994 and continuing to the present day have provided further illuminating insights. Two particularly important figures have been Master *Shaofan Zhu* from St. Gallen[7] and *Angela Yan Fan* from Beijing/Buffalo, who have given me multi-dimensional deep insights. According to the concepts of traditional Chinese medicine, *therapy should always lead up to training and disciplined exercise*. Conversely, *training should always also be therapy and medicine.*

My first encounters and experiences with professional athletes took place in 1989 and 1990 accompanying *Walter Packi* (Freiburg i.Br. and Cologne). Most of the athletes at the Cologne Olympic Training Center were rowers, canoeists, and track and field specialists. Foremost among them were high jumpers Heike Henkel and Carlo

[7] Shifu Shaofan not only was brilliant as a gold and silver medal winner in Kung Fu, Tai Chi Fist and Tai Chi Sword, but also teaches and directs a major school for very eclectic treatment and training methods at the Swiss Wushu Academy (see www.chinawushu.ch)

Tränhardt and the hammer throwers around Heinz Weiss. The training components employed by Walter Packi came as an initial shock to the athletes. The core training unit he used for all of the athletes involved maximum stretching of the line of the hip flexor muscles (iliopsoas muscle), the axis of the straight abdominal muscles across the sternum to the extension of the sternocleidomastoid muscles. Despite all their reluctance, not only did this program results in ameliorating problems with back and knee pain, but also improved the athletes' overall performance.

My experiences as a trainer for professional dancers (2001 – 2011) of all kinds opened further deep insights about zones of overuse, stereotypical movement patterns, and the chronic pain directly correlated to them. Ballet, modern dance, and artistic performance dance always involve unusual patterns of strain, which generate specific zones of overuse. Dancers and athletes are capable of elegantly compensating for such strain over long time periods, but to survive from day to day, this unfortunately may also involve medications and injections. At the beginning, these may only be for the purposes of the perfect performance, but over time, the compensations spill over – and take their toll in the form of more severe injuries, such as prolapsed discs or meniscus damage.

Dynamic, playful, flexible, and unanticipated KiD exercises along with strategies to increase body sense, body self-perception and interoception have proved highly efficient for all participants. The core of the strategy is to use exercise units specifically targeted at the antagonist muscle chains, counter-movements, and to integrate multijoint torque effects at some distance from the problem zone as well as central and autonomic de-stressing activities. Activation of the vagus nerve, weak point analysis, and individualized focus exercises have opened a pathway toward impressive sustainability.

Neuromuscular and Fascial Length Training

When we augment the classic components of a balanced training model – strength training, cardiovascular, conditioning and endurance training – with targeted muscle and fascial length training there is significant improvement in mobility, performance, and efficiency. Over two decades of experience in various forms of the martial arts has shown the positive effects of active stretching exercises or *resistance training in stretched positions (KiD),* and these findings have now been confirmed by the results of research on muscle length training and the latest evidence on *fascial stretch training*.

Research has demonstrated that these methods optimizes such parameters as neuromuscular synchronization, coordination, balance, speed, strength, mobility, elasticity, performance and individual performance capacity.

Origins

The integration of high speed, exceptional performance in strength and mobility, smooth, aesthetic and "soundless" movement has been extensively socialized in the practices of Yoga, Kung Fu/Wushu, Karate, and Tae Kwan Do as well as in other martial arts. Thus, Kung-Fu monks from the Shaolin monastery and Japanese Ninja warriors have become virtually emblematic for elegant, flexible, graceful and soundless, rapid and powerful forms of movement. Sudden, lightning-fast high velocities and powerful movements can instantly emerge out of total stillness. As if driven by a magical engine, catapult-like movement patterns appear to explode from nowhere. A

perfect way to describe such movements is the analogy of a tightly drawn bow imparting sudden power and speed to a flying arrow. We will show that these seemingly miraculous achievements are actually based on the secrets of muscle and fascial training in stretched positions.

We can also learn important insights about the intelligent principles of movement, function and structure from the work of the architect and designer R. Buckminster Fuller.[8] The principles of *tensegrity* (Fuller's portmanteau term combining *tension* and *integrity*) describe the dynamic balance between the forces of compression and tension. Fuller's representation of the living relationship of the human body with the forces of gravity and the intelligent lightweight design of the human locomotor system have been critical elements that have shaped the Myoreflex concept together with the work of modern osteopathy and the Myofascial Society. In the *tensegrity* model, muscular and myofascial vectors represent the critical components of a harmonious geometry of movement.

Pioneers of Muscle Chain and Length Training

The rehabilitation medicine specialist *Otto Bergsmann* can be regarded as a pioneer during the 1980s for recognizing the connection between "muscle meridians" and what are known as "kinetic muscle chains."[9]

Walter Packi launched his initial version of "Body Geometry and Pain," biokinematics, and muscle length training between 1989 and 1990. Kurt and Reiner Mosetter's development and description of KiD exercises (resistance training in stretched positions) as a synthesis of Yoga, Qi Gong, meridian stretches, martial arts, and biokinematics also occurred in 1989 and 1990. The first written description of the KiD concept was formulated as part of the course documentation for the first curriculum in Myoreflex therapy training in 1995-1996 and published in 1998.[10] In the years that followed, further descriptions and differentiations emerged (some of them in collaboration with Otto Bergsmann).[11] The textbook *Myoreflex Therapy Volume 2:*

---

[8] Fuller, R. Buckminster (1998). Bedienungsanleitung für das Raumschiff Erde und andere Schriften. [*Operating Manual for Spaceship Earth and other Writings, 1969*. Revised New Edition. Translated into German by Joachim Krause. Amsterdam: Verlag der Kunst.

[9] Bergsmann, O. & Bergsmann, R. (1997). Projektionssymptome. Reflektorische Krankheitszeichen als Grundlage für holistische Diagnose und Therapie. [Projection Symptoms: Reflexive signs of illness as the basis for holistic diagnosis and therapy] Vienna: Facultas.

[10] Mosetter, K., Mosetter, R., Rachl, M. (1998). Myoreflextherapie. Gesundheitstraining und neuromuskuläre Selbstregulation in Prävention und Rehabilitation, bei psychischen Belastungen und zur Leistungssteigerung. [*Myoreflex Therapy: Health training and neuromuscular self-regulation in the prevention and rehabilitation of psychological stress and for performance enhancement*] Konstanz: Vesalius.

[11] Bergsmann, Otto (2000) (Ed.). Myoreflextherapie [Myoreflex Therapy]. Vienna: Facultas. Darin: Mosetter, Kurt (2000). Myoreflextherapie – Neuromuskuläre Traumatherapie. Integrative Neuromuskuläre Regulationstherapie bei psychosomatischen/somatopsychischen Erkrankungsbildern und posttraumatischen Symptomkomplexen.[Myoreflex Therapy – Neuromuscular trauma therapy. Integrative neuromuscular regulation therapy for psychosomatic/somatopsychological conditions and post-traumatic symptom complexes] p. 26-119. // Brügger, O. (Ed.) (2004). Sport. Mit Sicherheit mehr Spass. [Sports: More Fun with Safety] (3. Tri-National Congress: Switzerland, Germany, Austria, Magglingen, Switzerland). Bern: bfu. Darin: Mosetter, K. Dynamik des Muskelsystems im Hinblick auf Unfallverhütung im Sport. [Dynamics of the Muscular System from the perspective of injury prevention in sports] (p. 90-93). // Mosetter, Kurt / Mosetter, Reiner (2006). Myoreflextherapie Band 1: Einführung in Muskelfunktion und Schmerz. [Myoreflex Therapy Volume 1: Introduction to Muscle Function and Pain (2. ed., 1. ed. 2001). Konstanz: Vesalius-Verlag. // Mosetter, K. & Mosetter, R. (2003). Kraft in der

Regulation for the body, brain, and experience offered a detailed description of the principles of biomechanics and muscle length training in sports.[12]

In der 1990s Thomas W. Myers described muscle-fascial pathways and Robert Schleip investigated the dynamic properties and trainability of living fasciae.[13] The sports scientist Stefan Mücke discovered completely new methods for designing effective training based on his studies of lactate metabolism and the development of the lactate test as a performance diagnostic instrument.

Earlier, in the 1960s, Moshé Feldenkrais had been a pioneer in describing and understanding movement sequences, complex functional patterns, and central learning processes with consideration of such elements as mobility, perfection, gradualness, smoothness, aesthetics, and elegance.[14]

Science

The principles and details of the microphysiology of successful muscle training have been researched and described by Marco Toigo (ETH Zürich).[15]

Specific knowledge about the lifelong plasticity of the muscle-tendon-bone unit as well as new training approaches with vibration training have originated from Dieter Felsenberg, Hans Schießl, Martin Runge, and others.[16]

Dehnung. Ein Praxisbuch bei Stress, Dauerbelastung und Trauma. [*Resistance Training in Stretched Positions: A practical manual for stress, chronic strain and trauma*] Düsseldorf, Zürich: Patmos. // Mosetter, K. & Mosetter, R. (2005b). Die neue ADHS-Therapie. Den Körper entstressen. Ein Übungsbuch. [*The New Therapy for ADHD: Relieving Bodily Stress: an exercise book]* Düsseldorf, Zürich: Walter/Patmos. // Mosetter K. & Mosetter R. (2008b). Schmerzen heilen mit der KiD-Methode. Der achtsame Umgang mit dem eigenen Körper. [*Healing Pain with the KiD Method: mindful engagement with one's own body*] Düsseldorf: Patmos.

[12] Mosetter, K. & Mosetter, R. (2010). Myoreflextherapie Band 2. Regulation für Körper, Gehirn und Erleben. [*Myoreflex Therapy Volume 2: Regulation for the body, brain, and experience*] Konstanz: Vesalius.

[13] Myers, T.W. (2001). Anatomy Trains. Myofascial Meridians for Manual and Movement Therapists. London: Churchill Livingstone. // Schleip, R. (1990). Der aufrechte Mensch. Übungskurs für eine gelöste Körperhaltung und einen natürlichen Gang. [The Upright Human, Practice Course for a Relaxed Body Posture and a Natural Gait] Basel: Spinx. // Schleip, R. (2003). Faszien und Nervensystem. [The Fascia and the Nervous System] Zeitschrift Osteopathische Medizin 1. // Schleip, R. / Findley, T.W. / Chaitow, L. / Huijing, P.A. (2012). Fascia: The Tensional Network of the Human Body, 1st Edition. The science and clinical applications in manual and movement therapy. Edinburgh: Churchill Livingstone, Elsevier.

[14] Feldenkrais, Moshé (1968; 12th edition. 1996). Bewusstheit durch Bewegung. [*Awareness through Movement*]Frankfurt am Main: Suhrkamp. // See Johnson, Don Hanlon (2012). Klassiker der Körperwahrnehmung. Erfahrungen und Methoden des Embodiment. [Classics of Body Perception. Experiences and Methods of Embodiment] German Edition ed. by. Thea Rytz. Bern: Huber.

[15] Toigo, M. / Boutellier, U. (2006). New fundamental resistance exercise determinants of molecular and cellular muscle adaptations. Eur J Appl Physiol. 97(6). 643-63. // Vgl. Boakes, J.L. / Foran, J. / Ward, S.R. / Lieber, R.L. (2007). Muscle adaptation by serial sarcomere addition 1 year after femoral lengthening. Clin Orthop Relat Res. 456(250-3.

[16] Felsenberg, Dieter / Runge, Martin (2006). Sanfter Muskelaufbau. [Gentler Muscle Building] München: Knaur. // cf. Item, F. / Denkinger, J. / Fontana, P. / Weber, M. / Boutellier, U. / Toigo, M. (2011). Combined effects of whole-body vibration, resistance exercise, and vascular occlusion on skeletal muscle and performance. Int J Sports Med. 32(10). 781-7. // Belavy, D.L. / Gast, U. / Daumer, M. / Fomina, E. / Rawer, R. / Schiessl, H. / Schneider, S. / Schubert, H. / Soaz, C. / Felsenberg, D. (2013). Progressive

The close connections between experiences of pain and body awareness, interoception, and body memory and the effectiveness of Myoreflex treatment have been shown in the research findings of Dorothea Kilk und Katharina Muth.

Principles of Muscle-Fascia Training in elasticity and length

In what follows, we will summarize the principles and benefits of active stretching against resistance using KiD exercises. The activity units focus less on single muscles and isolated functions and more on muscle chains, neuromuscular movement patterns, and complex functions. What is always of paramount importance in this process is to train *counter-movement* and the *functionally antagonistic muscle chains*.

- ✓ Active resistance training from stretched positions along the length of kinetic muscle-fascia chains
- ✓ Weak point analysis with individualized and dynamic weak point training
- ✓ Training muscle-tendon-fascial chains means training connective tissue and collagen

- ✓ Mobility, Range of Motion (ROM)
- ✓ Central learning
- ✓ Body awareness
- ✓ Coordination
- ✓ Dynamic flexible stability
- ✓ Prevention
- ✓ Improved performance
- ✓ Regeneration
- ✓ Autonomic regulation
- ✓ Anticipation

- ✓ Optimizing performance in high-level competitive sports
- ✓ Myoreflex therapy and KiD (resistance training in stretched positions)
- ✓ Increasing sensorimotor competency
- ✓ Increasing shortening velocity
- ✓ Increasing stretch capacity
- ✓ Decreasing/reducing half relaxation time

adaptation in physical activity and neuromuscular performance during 520d confinement. PLoS One. 8(3). e60090.

- ✓ Pre-activating the joint-leading musculature
- ✓ Activating the fascial network and tendons
- ✓ Shifting motor activity to the earliest phase of movement
- ✓ Optimizing neuronal networking
- ✓ Intelligent training of intra and inter muscular coordination and central movement programs

- ✓ Optimizing spatial and object awareness in the visual system
- ✓ Increasing the brain's pre-motor anticipatory predictive capacity in complex environments
- ✓ Training to optimize relative active muscle length (RAM) in the vector system
- ✓ Analysis and training of weak points/reduction of fitness gaps

Training Central Control

Once we appreciate discoveries from the neurosciences, it is clear that they demand meaningful integration of the "brain's playbook." One important neurobiological principle can be summarized as: "offer and demand."[17] The body, neuromuscular dynamics, and even structural anatomical units are all oriented according to the laws of offer (supply) and demand. Stereotypical demand messages lead to one-sided functional and structural adaptations. Repetitive stereotypical training and multiple repetitions in a shortened position both lead to muscular shortening, losses in elasticity, fascial adhesions, thickening of the collagen connective tissues, and one-sided unphysiological increases of muscle tone in single tonic muscles within the muscle vector network. At the systemic level of the fasciae, stereotypical training of this kind causes deterioration in elasticity, tensional force, and performance capacity of the fascial network. Moreover, overtraining involving frequent, excessive intensities over the same range of movement with selective neglect of other, seemingly unimportant, aspects of movement result in the inhibition of those tendons and fascial components that have been insufficiently integrated in training, which impairs performance and performance capacity.

It is of critical importance to consider weak points in the muscle-tendon-fascia vector space. The weakest components ultimately determine the limits of mobility, transmission of force, biomechanics, biokinematics, and overall performance. Neuronal learning demands dynamics, change, and unanticipated exercise elements, training

[17] Lehmann, K. / Butz, M. / Teuchert-Noodt, G. (2005). Offer and demand: proliferation and survival of neurons in the dentate gyrus. Eur J Neurosci. 21(12). 3205-16.

elements along the principles of "goal-directed behavior," and aspects of "differential learning."[18]

Passive stretching fails to impress the brain in just the same way as boring repetitions, isolated demand on individual muscles, and training to achieve solid-state stability. Dynamic stability in the context of complex movement patterns depends on central learning processes and can only function through neuronal control, supraspinal coordination, neuronal anticipation, and motoric pre-programming.

Body Sense and Interoception

There are quite a few comprehensive scholarly works devoted to the proprioceptive sensors and their role in the cycle of perception, action, and movement. In addition to the more familiar muscle spindle sensors, Golgi tendon organs, Paccini and Ruffini corpuscles, Merkel's and Meissner's corpuscles, joint receptors, and pain receptors, we must also include a number of different fascial receptors. They all play a part in the sense of self-awareness and in perfected movement. Of particular importance are the myriads of unmyelinated free nerve endings in the connective tissue, the periosteum, and in layers of the endomysium and perimysium.

Robert Schleip has highlighted the importance of the fascial receptors by pointing out that the fascia actually contain the largest numbers of sensors, "The fascia are our greatest organ of perception."[19]

Without a doubt, it makes no sense to think about each type of receptor in isolation any more than to ignore the integral quality of the muscle, tendon, fascia, and joint senses. The proprioceptive, somatosensory and somatomotor circuitry and nerve cell networks do not function separately. Even interoception and our inherent sense of self with the modalities of pain, homeostasis, emotion, motivation, and their primary processing in the insular cortex are difficult to understand separately from our other

---

[18] Schöllhorn, W.I., Sechelmann, M., Trockel, M., Westers, R. (2004): Nie das Richtige trainieren, um richtig zu spielen. [Never training right to play right] Leistungssport, 2004 [5], 13-17. // Schöllhorn, W. I. (2005): Differenzielles Lehren und Lernen von Bewegung - Durch veränderte Annahmen zu neuen Konsequenzen. [Differential Teaching and Learning of Movement – different outcomes from changed assumptions] In: Gabler, H. / Göhner, U. / Schiebl, F. (Hrsg/ed.). Zur Vernetzung von Forschung und Lehre in Biomechanik, Sportmotorik und Trainingswissenschaft. [On Networking research and theory in biomechanics, sports mechanics and training science] Hamburg: Czwalina, 125-135. //

[19] Schleip, R. / Findley, T.W. / Chaitow, L. / Huijing, P.A. (2012). Fascia: The Tensional Network of the Human Body, 1st Edition. The science and clinical applications in manual and movement therapy. Edinburgh: Churchill Livingstone, Elsevier. Darin: Robert Schleip.Fascia as an organ of communication. (S. 77-79).

sensory modalities. Arthur Craig's basic research[20] on this theme is summarized in our works, *Myoreflex Therapy Volume 2* and *Neural Knowledge*.[21]

All of these authors are in fundamental agreement about the common features of these systems. thus, they all agree that proprioception, muscle and fascial sensation, and interoception can all be trained. Performance, velocity, balance, coordination, and each particular performance are dependent upon these circuits between the periphery of the body and the brain as well as the circuits between active perception, anticipation, movement planning, movement control, and performance. These dependencies exist at both the micro and the macro functional levels, and these levels also are inseparable.

Interfaces between Manual Therapies and Training Concepts

There is a common denominator that unites *Rolfing* (Ida Rolf, Robert Schleip), *Osteopathy* (Thomas W. Myers) and *Myoreflex Therapy* (Kurt Mosetter), namely that each of these techniques strengthens the "body sense" and applies the hands to treat the same anatomical structures. Based on their treatment approaches, each type of therapy culminates in targeted exercises and training moments. Rolf's and Myer's original treatment models for manual therapy were intelligently augmented by Schleip and colleagues by the addition of active stretch exercises and the introduction of exercises directed at corresponding counter movements.

In his truly groundbreaking work, Schleip describes the natural principles of "catapult functions" in animals and in the human body. By observing and analyzing the powerful leaps of kangaroos and the movement sequences in antelopes, he understood that *the muscles, tendons, and fascia were always preloaded in the counter-direction* and that as a result, the fascial and tendon structures could unfold in catapult-like fashion.

The nature of these processes is identical for multiple movements in the human locomotor system; this insight requires new systems of understanding and training. Knowledge about the importance of elastic, spring-like counter-movements has major implications for athletic performance. The instructions for dynamic fascial network

---

[20] Brooks, J.C.W. / Zambreanu, L. / Godinez, A. / Craig, A.D. / Tracey, I. (2005). Somatotopic organisation of the human insula to painful heat studied with high resolution functional imaging. NeuroImage 27. 201-209. // Craig, A.D. (2002). How do you feel? Interoception. The sense of the physiological condition of the body. Nat Rev Neurosci 3. 655-666. // Craig, A.D. (2003). A new view of pain as a homeostatic emotion. Trends in Neuroscience 26. 303–307. // Craig, A.D. (2003b). Interoception: the sense of the physiological condition of the body. Current Opinion in Neurobiology 13. 500-505. // Craig, A.D. (2003c). Pain Mechanisms: Labeled Lines Versus Convergence in Central Processing. Annu. Rev. Neurosci. 26. 1-30. // Craig, A.D. (2004). Human feelings: why are some more aware than others? Trends in Cognitive Sciences 8(6). 239-241. // Craig, A.D. (2005). Forebrain emotional asymmetry: a neuroanatomical basis? Trends in Cognitive Sciences 9(12). 566-571. // Craig, A.D. (2009). How do you feel - now? The anterior insula and human awareness. Nature Rev. Neurosci. 10. 59-70. // Lumb, B.M. (2002). Inescapable and escapable pain is represented in distinct hypothalamic-midbrain circuits. Specific roles for Adelta- and C-nociceptors. Exp Physiol 87. 281-286.

[21] Mosetter, K. / Mosetter, R. (2010). Myoreflextherapie - Band 2. Regulation für Körper, Erleben und Gehirn. [*Regulation for the body, experience, and the brain*] Konstanz: Vesalius.

training that Schleip presented in "Fascia"[22] were the logical outcome of these insights.

In the Myoreflex concept, training "weak spots" and "relative contractures" in extension plays a major role starting from the very first hour. Inspired by the idea of antagonistic muscle meridian pairs (Yin and Yang in Chinese Traditional Medicine, Yoga, and Qi Gong) and based on the biological principles of biomechanics, torque, biokinematics, and movement geometry, each focus led to corresponding treatment points, as a rule, directed at the *functionally "opposite" side.* These discoveries culminated in KiD exercises (resistance training in stretched positions) for the antagonist chains and their weak spots. For the majority of movements, it was consistently found that the activities of the opposing muscle and tendon junctions and their functional extensions in long "muscle chains" were of critical significance.

Even before the birth of the Myoreflex concept, the classical notion of perception – downstream action – and activation of muscle units had been recognized as short-sighted and "inadequate," as had the stereotypical models of strength training sequences.

For asymmetries "above" one needed to prescribe exercises "below," and for problems "behind" one needed to prescribe training in extension "in front." For asymmetries that are observable on the "right," weak points need to be ameliorated on the "left" and for those seen on the "left" side, it training is required on the right. Typically, performance problems on the right side could be re-equilibrated by treatments and length training of the contralateral quartet (oblique abdominal muscles, hip extensors, hip flexors, and gluteal muscles).

Moshé Feldenkrais developed the idea of an internalized synthesis of therapy, movement training, and perceptual training with multi-dimensional learning processes (see above). His emphasis on coordinated performances, supple mobility, aesthetic movement sequences, playful micro-movements, delicate movement patterns and "slowness with pauses" has experienced a veritable renaissance as a result of fascia research and modern brain science.

In summary, we can state with confidence today that each treatment should be transferred seamlessly into individualized training. And vice versa: every weak point in performance, function and every instance of "soreness" should receive targeted treatment and be "trained away."

Special Advice!

We should always check the weakest part of the myofascial chain. It's important to observe, to treat and afterwards to train vulnerabilities. These are:

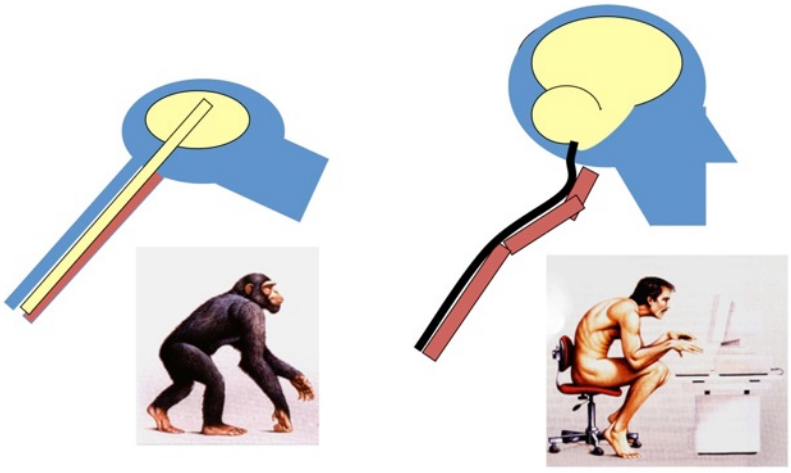
- pain disorders
- head joints
- anterior neck muscles
- diaphragm
- abdominal ganglion

---

[22] Schleip, R. / Findley, T.W. / Chaitow, L. / Huijing, P.A. (2012). Fascia: The Tensional Network of the Human Body, 1st Edition. The science and clinical applications in manual and movement therapy. Edinburgh: Churchill Livingstone, Elsevier.

- autonomic nervous system
- tonic muscles
- relative shortenings
- balance
- coordination
- jaw muscles

Important aspects of the Myoreflex concept are the neuromuscular alignement between the skull, atlas, axis and also the other segments of the cervical spine.



rrr15-025

Disturbance of the cerebral blood flow, the equilibrium system and fields in the service of social competence

If the upper region and joints in the neck are blocked, crazy symptoms may occur:

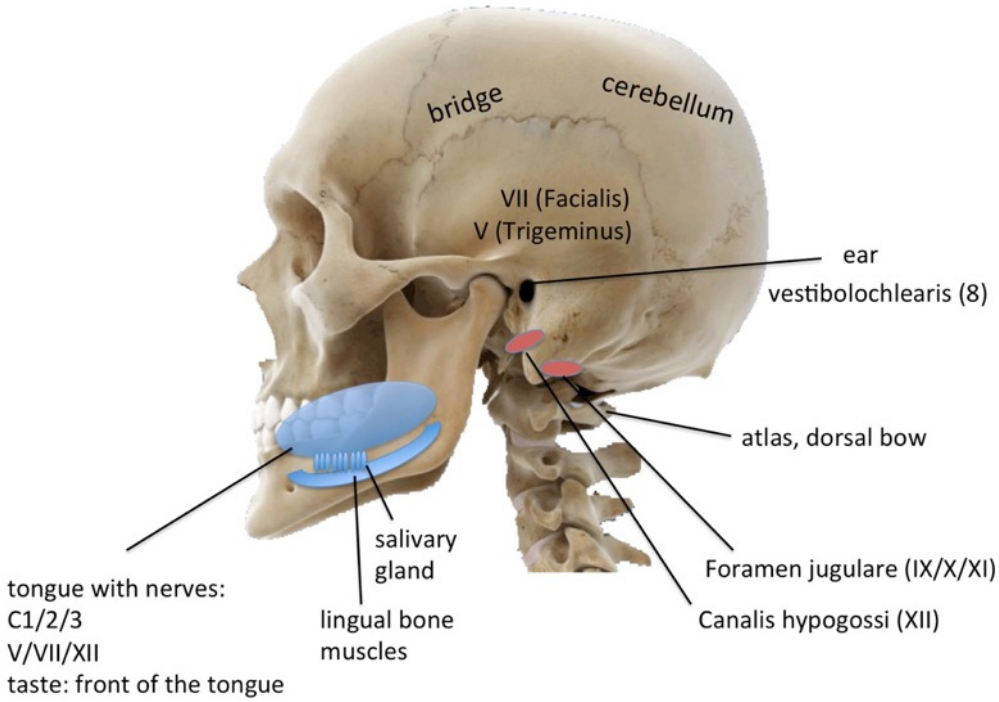
- itching ears
- whistling in the ears
- numbed tongue
- disturbed speech
- vertigo
- irritated vision
- irritated taste
- confused orientation
- disturbed concentration
- burning sensation in the face
- headaches
- migraine
- lump-feeling in the throat
- palpitations
- fear
- disturbed sleep

Myoreflex Therapy specializes in the successful treatement of a wide range of syndroms. Especially the area of the cervical spine and the neuromuscular system a scalenii connections is a huge topic:

- numbness in the fingers
- carpal tunnel syndrom
- tennis elbow (epicondylitis)
- "golfer arms"
- shoulder/arm afflictions
- angina pectoris
- short breath
- thoracic spinal pain
- scapula problems
- neck pain
- fear syndrome
- rip blockage
- Tietze syndrome

Unfortunately most established training approaches are focused on isolated muscles, e.g., the abdominals, and are not aware of shortening these muscles most of the time. Moreover most of the time even in rehabilitation there is no vulnerability assessment of the neck. **That way, wrong training causes exactly these symptoms we talked about**.

Frequently we are invited to develop a very specific view on brain nerve functions and around the atlas.



rrr15-026

Propper function of brain nerves is wired with the spinal nerves in the upper spine (C1 - C3) and is organized by perfect synchronization – like an orchestra. As an example we will take a detailed look at the tongue network with its lingualis nerve:

- N. hypoglossus
- N. fascialis
- N. mandibularis, root of N. trigeminus
- Ansa cervicalis of roots of C1 to C3
- parasympathic head ganglia
- taste (2/3rd front of the tongue)
- lower lingual bone muscles
- salivatary glands
- pharyngal muscles

Apart from the irritation of brain nerves the spinal cord layers are frequently disturbed by a biomechanical impact which causes dysfunctions:

Dorsal vascular tissue: Tractus cuneatus and Tractus gracilis can be afflicted through relative misalignments and mismatched angles between the skull and the posterior arch of the first cervical vertebra. Muscle weakness, loss of strength, weak posture, deficits of the stability sense, security and fine motor skills are bio-logical consequences.

Ventral vascular tissue: Tractus spinothalamicus ventralis and lateralis can be disturbed through relative dorsal dislocations of the Dens axis. Pain, numbness, instabilites, vertigo, and dysregulated interoception can lead to a multitude of symptoms.

The following Resistance Stretch exercises may suggest an idea of an intelligent approach:

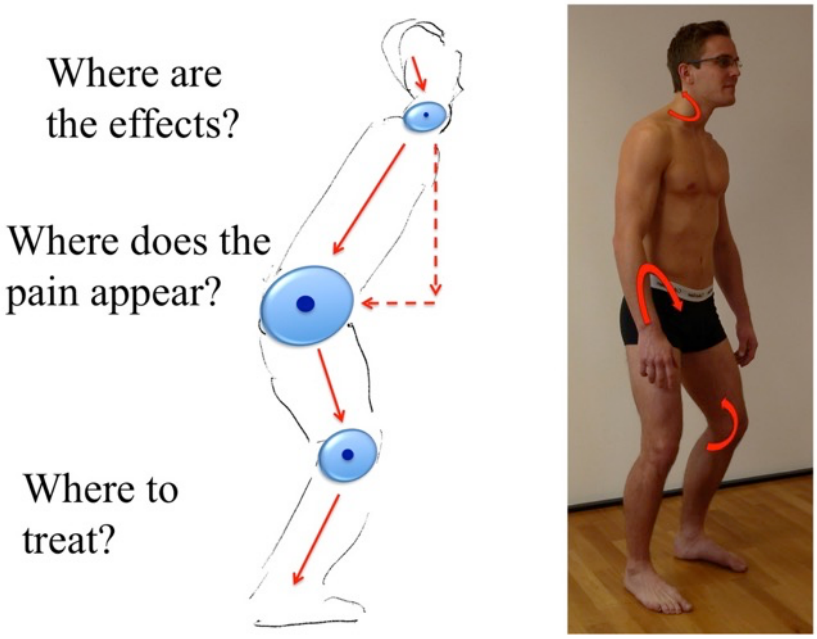
017C4890 Claviculagriff

017C4894 Tanz

017C4924 Gitarre 2

rrr15-033 flexx

Movement Analysis: Physics and Torque



rrr15-035

This chapter is reprinted from: : Mosetter, Kurt (2012) Das Myoreflexkonzept. Schmerzfrei über die Physik funktioneller Anatomie [The Myoreflex Concept: Freedom from Pain through the Physics of Functional Anatomy]. medicalsports network 1. 4 - 7.

The treatment of injuries and trauma in mass and professional sports is characterized by high levels of specialization and great medical progress. Moreover, the integration of simple but fundamental physical principles by the application of neuromuscular mechanics has provided elegant and successful solutions. Consideration of *torques* opens the door to promising new forms of treatment by means of calculating the causal muscle vectors.

As part of the *Myoreflex concept*, it is possible to ascertain, specifically treat, and prophylactically regulate the relieving postures resulting from previous injuries along with compensations in the context of current problems and individual abnormal postures – weak points.

Myoreflex therapy is a manual regulation therapy: it offers an effective treatment model for a large number of painful conditions related to an interplay of nerve, muscle, joint, and bone structures. The starting point is the biomechanics of the musculature in action. Muscular asymmetries can be regulated through targeted neuromuscular pressure point stimulation, thereby achieving a functional symmetry of tone.

This method has proved especially successful in mass and professional sports. Important elements of a successful program include rehabilitation and therapy on the one side, and on the other (upstream), targeted performance optimization and injury prophylaxis.

When muscles act upon the rotational axes of joints, torque is generated. The principal torque effects that appear to be localized in individual joints are actually amplified and maintained by multiple synergistic and antagonistic muscle chains and by their force effects, ancillary torques and interactions along complex lines of muscular force (muscle vectors).

Blocked and reduced torque in the joint axes of the pelvis across the iliopsoas muscle system lead to compensatory torques in neighboring joint axes – all the way to the cervical spine. These corrective muscle activities and their force effects frequently lead to excessive strain from increased levels of tension. Overloads and disruptions of the movement geometry are signaled by pain: from the surface and corresponding to the structure of the muscle chains involved, the pain is transferred to the involved joint structures. Asymmetrical muscle vectors and dysfunctional torques lead to losses of control in the joints, menisci, and disc structures (Figure 2).

These biomechanical weak points can turn into structural breaking points. Against this backdrop, many painful conditions and structural injuries cannot be explained on the basis of local causes or the material properties of the particular structure that is hurting. Instead, the causes have to do with dysfunctional torques along other joint axes. The recognition of asymmetrical torques that are transferred into excessive force and tension in the associated muscle vectors, makes it possible to direct treatment at the underlying causes located in muscular triggers hidden under protective postures in distant areas. Thus, one specific deviation in movement geometry and its torque can result in quite different symptom patterns in quite different parts of the body depending on the particular kind of sport and individual movement patterns.

Thus, a *single* underlying cause can trigger quite disparate and diverse pain phenomena. At the same time, a pain that *appears identical* in different athletes can require entirely different treatment strategies.

a) Via the pelvis, asymmetrical torques in the iliopsoas muscle can lead to secondary corrective strain through the quadratus-lumborum muscle system, and thus cause back pain.
b) Similarly, abnormal torques in the pelvis can cause abnormal torques in the knee with loss of guidance and centering functions in the knee joints. Terminal limitation of extension in the knee can lead to lateral knee pain, pain in the patellar pole via the fibers of the tensor fasciae latae muscle, or as a result of the increased tension or enhanced torque force effects across the plane of the iliotibial tract, lead to direct strain and hip pain (Figure 6)
c) Depending on the specific movement and movement patterns, adductor problems may also be initiated via the same pathways. In these cases, the adductors are overburdened as an active movement arm because the tensor system is no longer sufficiently unblocked to participate in the action as a passive antagonistic wing. In this way, the "antagonistic brake that no longer releases," with its torque in the pelvis, becomes the cause of adductor irritation.
d) Analogous to the torque changes across the hip joints and the iliosacral joint, comparable compensatory torques can become synchronized in the service of alignment and orientation in the upper cervical spine. These torques are associated with strain and muscular unbalance in the shoulder and neck areas. At the same time, rotation and rapid orientation behavior becomes impaired. (Figures 5 and 6)

Often, the forces of acceleration and braking left over from "old injuries" can lead to changed torques in the neighboring joints involved in the muscle vectors and movement sequence. The movement components specific to a particular kind of sport at the moment of injury and their torques are critical factors in determining the right therapy.

The way that individual torques can have completely different effects can be illustrated by the example of bruised ribs. Bruised ribs often affect the muscle vector networks of the oblique abdominal muscles (internal oblique muscle), causing increased tension and relative shortening. The unbalanced activity of the abdominal oblique muscles is associated with synchronous increases in tension and protective or relieving activities in the synergistic flexor system of the iliopsoas muscles. These dysregulated forces are projected in a direct functional anatomical extension along the course of the tensor fasciae latae muscles and the iliotibial tract.

Tracing the process further, the increased tension and dysfunction can extend across the fibular head to the peroneal muscles, the shinbone and the Achilles tendon. Limitations of torque can also impair the smooth functioning of the upper and lower ankle joints and even cause strains of the plantar fasciae.

Depending on the movement sequence and strain in cases of bruised ribs, the changes in torque described in the pelvis can be transmitted symmetrically "upwards" to the cervical spine and "downwards" to the knees; in addition, they can lead to diagonal contralateral compensations. (Figures 5, 6, 10 and 11).

In the context of balanced alignment, the neck muscles on the contralateral side must exert a counterforce. In the presence of muscular dysbalance, this region becomes overstrained. The specific sign of such a disturbance in the movement geometry is neck and/or shoulder pain contralateral to the bruised ribs.

The resulting dysbalances have different effects depending on the type of sport involved: torque changes in the pelvis have different implications for handball players than for football players. For the handball player, torque asymmetries with increased tension across the diagonal abdominal muscles have the effect of a rigid brake lever against complex shoulder and arm movements. Shoulder pain upon movement, pain in the deltoid muscle area, or in the supraspinatus muscle can be explained on the basis of relative over-strain of these muscle vectors against the excessively strong "brake tugs" from the adjacent pelvis (Figures 10 and 11).

Bruised ribs on the left site with changes in torque and increased tension in the internal oblique muscle will lead in left-handed athletes to left shoulder pain with rotator cuff syndrome. Given the identical weak point (the left internal oblique muscle), right-handed players develop problems with their right shoulder. The strain is derived from the "pursuit" of the active movement arm through the functional anatomical reins of the right anterior serratus muscle to the passive branch of the left internal oblique muscle.

When they have left rib bruises, "right-footed" football players develop pubic bone and groin symptoms and right adductor irritation. In addition, hamstring pains and medial knee joint crossovers to the left side can aggravate the dysfunctional muscle vector network.

By contrast, "left-footed" players with left rib bruises develop pain radiating from the area of the bruised ribs struck by the goal kick or "long ball" to the left hamstring and irritation in the right iliosacral joint. In both cases, the causally specific effective treatment target for these quite different "pain problems" is primarily located in the origins and insertions of the internal oblique muscle and the iliopsoas system. Depending on body weight and muscle vector ration, this will also include additional directly synergistic or antagonistic muscle chains. The focus is always on the "passive" movement wing along with its functional anatomical continuation.

As we begin from the primary pain experience and seek to evaluate the puzzle of relieving postures, movement analysis, findings on palpations, and whole-body functional examinations, it is essential to uncover what are called the "primary points" in the functional antagonists. The roadmap for these determinations is provided by the physical principles governing the corresponding torques and by the functional anatomy. Primary points can rapidly clarify and permanently resolve complex problems. In the pre and post surgery setting as well, Myoreflex concepts offer fundamental assistance in promoting and accelerating the course of healing and protecting the individual from further injury over the long term.

Abb1_0a und Abb2_0b

Figures 1 and 2: Posture with free torques and symmetrical muscle vectors. Blocked, diminished torques in the joint axes of the pelvis lead to compensatory torques in the shoulder/cervical spine region as well as the knee joint.

Abb3_1_ und Abb4_1b_

Fig. 3 and 4: Shooting motion with free torques and symmetrical muscle vectors

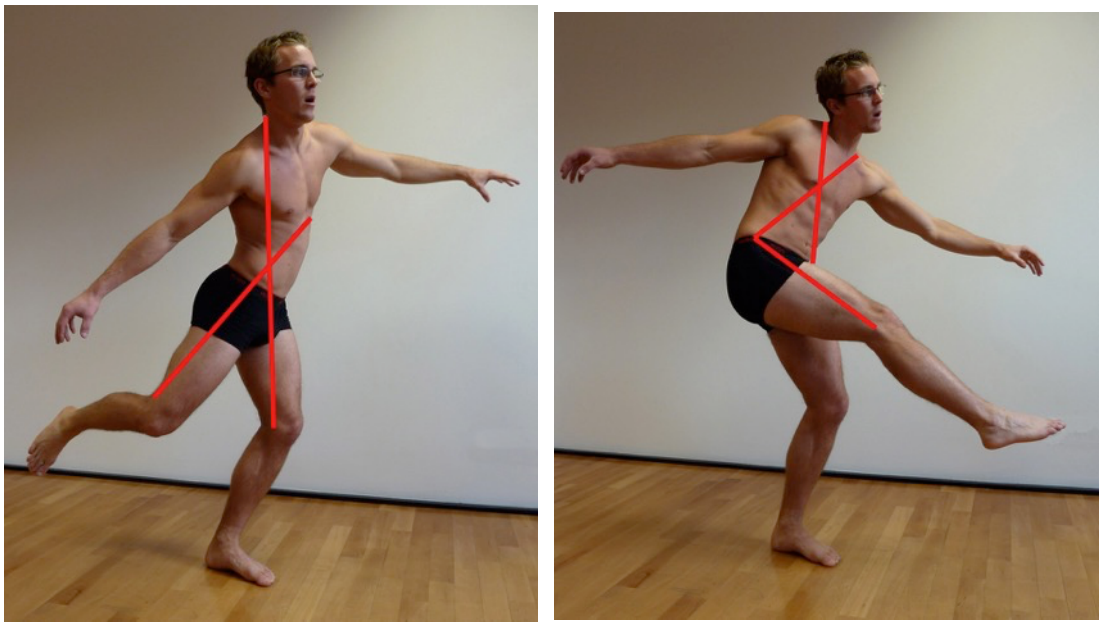


Abb5_2 und Abb6_2b

Fig. 5 and 6: Shooting movement with blocked torques and asymmetrical muscle vectors, which are projected in a compensatory way from the pelvis to the (contralateral) neck and shoulder areas and the knees.

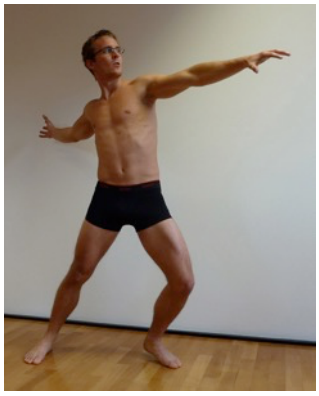
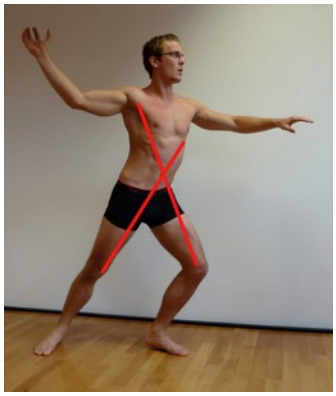
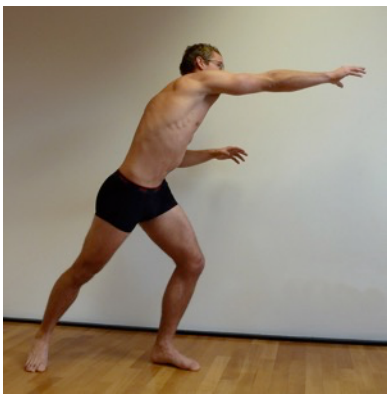




Abb7_3 , Abb8_3a und Abb9_3b

Figs. 7 to 9: Throwing movement with free torques and symmetrical muscle vectors

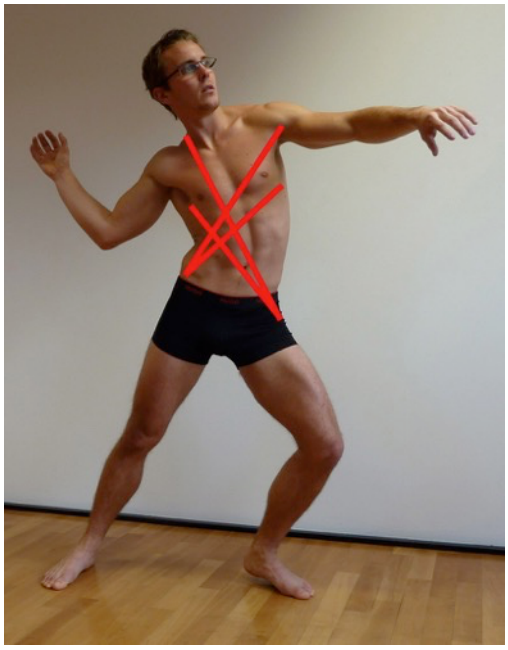
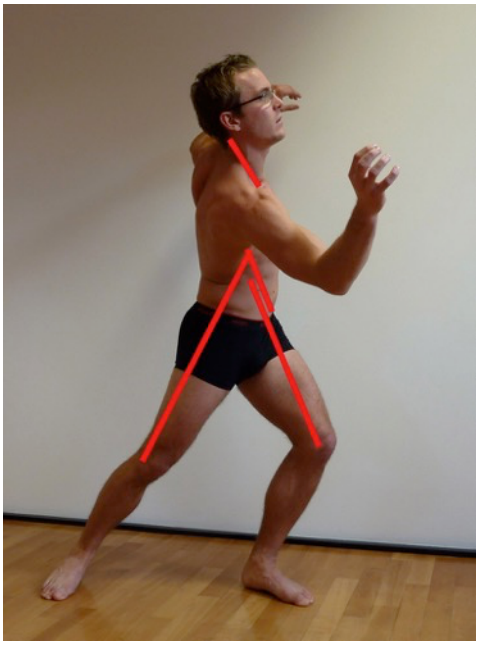



Abb10_3c und Abb11_3d

Figs. 10 and 11: Throwing movement with blocked torques and asymmetrical muscle vectors, which are projected in a compensatory manner from the pelvis to the (contralateral) neck and shoulder areas and the (contralateral) shoulder and chest areas.

Movement Geometry and Examples of Muscle-Tendon Vector Systems

Insufficiently trained antagonists or antagonist chains can impair performance:

- Un-physiologically hypertonic and relatively shortened ischiocrural muscle groups with restricted mobility can impair the performance and explosive capacity of the quadriceps musculature.
- Hypertonic and over-strained back extensors can reduce optimal functioning of the extensor muscles of the thigh.
- Relatively shortened abdominal muscle vector networks can shift the ideal acceleration pole downward in an uneconomical way, leverage out the back extensors,

trigger groin pain, and seriously compromise the ideal positions of the iliosacral and hip joints.

- Hip flexors that are hypertonic in their mid functional range and limited in their range of motion can leverage out and weaken the function and structure of the flexors in the lower extremity, the posterior thigh muscles, and the calf.
- In this setting, if the iliopsoas muscle is over trained, shortened in its relative active muscle and fascial length, and restricted in its range of motion can impair all components of performance.
- In a similar way, the "blind spot" of insufficiently trained cervical musculature and relatively shortened scalene muscles can become a weak point and cause a drop in performance.

Fasciae and Critical Background Information

Thanks to the latest discoveries about the remarkable importance of the fasciae, this major organ system has finally awakened from its Sleeping Beauty slumber and connective tissue has emerged from the shadows into the spotlight. These changes are helping to revolutionize and further develop a number of therapeutic approaches. The book *Fascia* provides a comprehensive overview (see above). New understanding about the aliveness and plasticity of connective tissue, the dynamic adaptability of collagen, and the biochemical components of what is known as the intercellular substance has far-reaching implications.

To be healthy and perform optimally, the fasciae must be saturated with fluid, or in other words, they have to be "slippery." Immobilization, partial immobilization, one-sided training in a shortened position and poor nourishment of this tissue causes drops in performance on many levels. Excessive fascial adhesive forces, corresponding areas of thickening, losses of elasticity and tensile power along with lack of energy in the system can provoke and perpetuate multilayered weak points, increase susceptibility to injury and set off pain syndromes.

Summary and outlook – Variability of training

- Vulnerability assessment, vulnerability training (special consideration: cervical spine, relative shortenings)
- Myoreflex Resistance Stretch, active lengthening stretch of muscle fasciae chains
- Flexx training, a circle of exercise devices to gain length through efficient guiding lines
- Galileo training, vibration training for muscles, fasciae, spinal cord and the brain
- 4D Pro Reaction Trainer
- Inline/Injoy concepts, assisted muscle training

The Structural Dynamics of Fasciae and Muscles

This section will present the "ground substance" or the biochemistry of the extracellular matrix and its dynamic signaling and communicative behavior. [23]

The Intercellular Substance/Ground Substance

The discovery of cells and their internal life around four hundred years ago was a milestone in the history of modern Western medicine. Cellular mechanisms, the activities of the cellular nucleus, and the details of genetics have gradually become known with ever-greater precision.

However, for a long time, the extracellular space between the cells – the intercellular substance – was relegated to the background and a shadowy existence. This space and its milieu are existential requirements for life with respect to nutrition, control, signaling activity, and the basic nature of cellular processes, both physiological and pathological. Thus, extracellular processes affect and control the cells themselves through contact with the cell surface, ligands, and biochemical pacemaker processes. The intercellular substance is a critical element for understanding bacterial and viral infections, the pathways of carcinogenesis and metastasis, inflammatory processes, and neurodegenerative changes. Beginning from the earliest developmental stages of the central nervous system, structures of the extracellular matrix are essential for maturation, growth, migration, and cell control, differentiation of neurons and glial cells, and organization of the connective tissues and fasciae.

The Ground Substance
(Synonyms: intercellular substance, extracellular matrix)

Composition:

Glycosaminoglycans, proteoglycans, messenger substances, cytokines, myoblasts, fibroblasts, glial cells, osteoblasts, collagen, elastin

Properties:

Viscoelastic network

Functions:

• Pressure-tension-stretch-perceptual network
• Tensegrity-shock absorption system
* Communication and Signaling system
* Transport system
* Factory for replenishing all cell lines

In addition, the activity and complex regulatory functions of nerve cell growth factors, target-region dependent growth factors, and growth factors for collagen would

[23] This section is taken from a handout for the ebi-pharm company and from the current print version of our book, "Kinderwissen" [*Children's Knowledge*] // Kurt Mosetter (2014, in preparation). Kinderwissen – für eine erweiterte Heilkunde. [*Children's Knowledge – Toward an expanded art of healing]* Band/volume IV - Entwicklungsaktivierung mit Kindern. Therapien die helfen, neuromuskulären Erkrankungen und Muskeldystrophien. [Developmental activation with children: therapy that help neuromuscular diseases and muscular dystrophies] Konstanz: Vesalius.

not be possible without the fundamental functions of the substances located in the extracellular matrix.

Special Features of the Extracellular Space

The extracellular matrix is made up of a jelly-like substance that holds cells together and provides pathways to individual cells for the diffusion and transport of nutrients, signal carriers, oxygen, and messenger substances. The extracellular matrix is also referred to as the intercellular substance or ground substance, and consists of an interwoven network of proteoglycans (PG) and glycosaminoglycans (GAG). These specifically include heteropolysaccharides and fiber proteins such as collagen, elastin, fibronectin, syndecans, and the glycocalyx. The heteropolysaccharides are known as glycosaminoglycans, and are composed of recurrent disaccharide units consisting of the monosaccharides N-acetylglucosamine or N-acetylgalactosamine bound to a carboxylic acid such as D-glucuronic acid or L-iduronic acid. Glycosaminoglycans are esterified with sulfate at the hydroxyl groups (-OH) of their amino sugar, and thus, very high negative charges develop in their side chains from the combination of sulfate and carboxylate groups.

To minimize repulsive forces between neighboring charged groups, these molecules assume a long, strung out conformation in solution. The characteristic distribution of sulfated and non-sulfated sugar residues in glycosaminoglycans offers a specific recognition pattern for a large number of protein ligands that are ionically bound to these molecules. Their binding, communication, and interactive behavior is also influenced by this distribution. In combination with extracellular proteins they form proteoglycans. Typical examples of glycosaminoglycans include hyaluronic acids or hyaluronidase, which serves as a lubricant in joint synovial fluid. In addition, their interactions with the extracellular matrix assure tensile strength and elasticity in cartilage, tendons, and connective tissue.

Chondroitin sulfate is responsible for the tensile strength of cartilage, tendons, and connective tissue. Dermatan sulfate assures the suppleness of skin, vessels, and heart valves. Keratin sulfate is found in cartilage and bone as well as the cornea and the nails. The anticoagulant heparin sulfate or heparin is of particular importance, and has the greatest negative charge density. This substance is produced by mast cells in the extracellular matrix and released into the bloodstream, where it inhibits clotting in electrostatic interaction by binding with antithrombin III. In the extracellular matrix, the network of proteoglycans and glycosaminoglycans mature to become a functional series of small molecular cytokines, growth factors and chemokines. They reside in the extracellular matrix and contribute to its spatial quaternary structure while also serving as a standby reservoir in the proteoglycan receptors of syndecans.

These structures assure super-fast extracellular information processing along with fine regulation of the extracellular matrix with autocrine, paracrine, juxtacrine, and endocrine control of cell response. Through surface recognition structures, receptor binding activity, cell adhesion processes, targeting, and cell-cell interactions, biochemical and electromagnetic processes in the extracellular matrix also determine extracellular matrix cell migration and immune response behavior, nerve cell growth, detoxification, and clotting processes. The glycosaminoglycan component typically accounts for (in terms of mass) the largest fraction of proteoglycan molecules, dominates the structure, and is often the principal site of biological activity. In many cases, the biological activity consists of creating a large number of binding sites, which

offer extensive opportunities for the formation of hydrogen bonds and electrostatic interactions with other proteins on the cellular surface or the extracellular matrix.

In addition, there are glycoproteins and glycolipids located in the extracellular matrix and on the external surface of the plasma membranes. These substances are also found inside lysosomal cells, secretory granules, the endoplasmic reticulum, and the Golgi apparatus. Complex oligosaccharides bound to proteins are extremely diverse and highly specific in their recognition and binding activities. Glycolipids in the cell membrane function similarly as highly specific contact and signaling sites for carbohydrate-binding proteins and receptors. Moreover, the extracellular matrix also contains core proteins with covalently bonded glycosaminoglycans.

"Together, the extracellular matrix and cells form a viscoelastic system, which maintains a self-stabilizing structure when impacted by external forces ('tensegrity'). Therefore, the extracellular matrix represents an attractor for all external and internally acting forces similar to a coupled spring, whereby small causes can have very large effects."[24]

The attachment points are typically serine residues. In addition to the proteoglycans secreted in components of the extracellular network, several of these compounds work as integral ECM cell-bridging membrane proteins. Transmembrane domains are thus controlled by extracellular domains, regulated by extracellular ligands, and altered with respect to their biological activity in terms of three-dimensional shape, receptor specificity, and cell surface recognition sequences. Matrix proteins have distinct domains for reciprocal binding, and the same is true for the plasma membrane protein family of integrins. Integrins organize signal transmission between the interior of cells and the ECM. The resulting interactive effects between cellular and extracellular molecules assure a differentiated and milieu-specific flow of essential information in both directions in the service of cell migration and development and the growth of respective types of tissues. The families of lectins and selectins also participate in this process.

Matrix proteoglycans are critical elements for the cellular response to certain extracellular growth factors. For example, fibroblast growth factor (FGF) – an extracellular protein signal that stimulates cell division – initially binds to heparin sulfate components of the syndecan molecules in the target cell's plasma membrane. Syndecan then "presents" the FGF to the specific FGF plasma membrane receptor, and only then can FGF effectively interact with its receptor to initiate cell division.

The ECM is also populated by the interferon and interleukin cytokine families. Hidden and "sleeping" within this ground substance are myoblasts, fibroblasts, glial cells, chondroblasts, osteoblasts, and mast cells, all of them activated, transported and regulated according to need. There is a complex balance between situationally directed tissue restructuring in inflammation, apoptosis, and growth. The principles of equilibrium in the ECM can be beautifully demonstrated on the one side by potent inflammatory substances including tumor necrosis factor alpha (TNF alpha), interferon gamma (IFN gamma), and the interleukins (IL 1, 2, 4, 5, 6, and 12), and on the other side, growth factors, including transforming growth factor beta (TGF beta) and nerve growth factor (NGF). In this setting, pro-inflammatory messenger substances such as

---

[24] Heinrich, H. (2005). Die extrazelluläre Matrix als Attraktor für Verschlackungsphänomene. [The extracellular matrix as an attractor for slagging phenomena] *Ärztezeitschrift für Naturheilverfahren* **46**(5). 236-266.

prostaglandins, histamine, proteases, leukotrienes, along with proteolytic enzymes such as serine, metalloproteinases and collagen protease typically function as rapid responses to emergency situations, which subsequently return to baseline to be replaced by anabolic processes. It is only when these processes are derailed by chronic stress and its metabolic equivalents that they become persistently activated and pathological. Thus, the ECM takes on importance as a key factor for understanding a wide range of disease states.

So elements of the extracellular matrix serve to direct intracellular processes.

Metabolic stress results in energy deficiency and disturbances in energy utilization in muscle and brain metabolism. Over time, it has been demonstrated that along with the pH level in the ECM, the intracellular pH level and the cytoplasmic redox potential shifts toward acidosis in the cellular milieu.

In the stress response there is increased formation of oxygen radicals and activation of the pro-inflammatory scenario that involves TNFα, acute phase proteins, and a series of disparate, synchronous changes such as disturbances in glucose utilization, insulin resistance, hyperlipidemia, AGEs, and lability of the clotting system.

The Extracellular Matrix and Signal Control

The interaction of cells and their surface structures with components of the extracellular space has a profound impact on the development and behavior of individual cells.

Signals related to mechanical stress and associated burdens from the outside shape the living world of this ground substance. Depending on the nature of the signals, very different forms and types of connective tissue can be synthesized. Depending on use and activation, these signals will induce production of collagen and elastin or the synthesis of myofibroblasts. Even those structures that appear more solid and self-contained such as bones and joints are thus highly dependent on function at the cellular level. And even in the context of severe developmental restrictions and dysplasia, they remain shapeable and modifiable well into advanced age.

The form, development, growth, polarization, movement, and at times the nature of individual cells and their functions typically reflect corresponding shifts in the cellular environment.

Interactions and water binding between glycosaminoglycans and proteoglycans also generate fluctuations in charge and electrical and chemical gradients, which open information bridges and transport pathways. This mobility of the ground substance helps maintain the proper organization of connective tissues, fasciae, the cytoskeleton, and biochemical communication cascades.

Key players in extra-intra-inter cellular communication between cells and their microenvironment include the integrin families. Integrins connect structures of the cytoskeleton within the cell through two trans-membrane domains that extend across the membrane and bind the outward-turned external cell surface to extracellular substances. They take hold of the divalent cations of the ECM across an alpha subunit-binding site and by means of their terminal regions in the extracellular space, they are able to bind matrix proteins, cell adhesion molecules, and extracellular ligands. This process creates bridges and guiderails made of laminins, fibronectin, collagen, and a series of glycans (glycosaminoglycans and proteoglycans). In the cytosol, integrins, which have no enzymatic activity of their own, bind to actin and α-actinin pieces of

the cytoskeleton via the adapter proteins vinculin and talin. These fundamental key and nodal points between extracellular and intracellular structures are known as focal adhesion (FA) sites.

Focal adhesion sites are the switch-points for integrin-mediated signal cascades. As integrin binds to extracellular components, this activates and auto-phosphorylates focal adhesion kinase (FAK), which binds across SH-2 domains with cytosolic src kinases and finally, after forming a bridge with Grb2-SH3 domains, activates Ras kinase. This process triggers the more familiar MAP kinase pathway with mitogenic effects on the cell nucleus and sustained gene expression patterns.

Thus, integrins serve as multidirectional messengers. They direct change signals from the extracellular space to the intracellular and intra-nuclear space but also from the cell interior in an outward direction. Depending on the signal state, integrins can modify and structurally influence the cell's docking behavior to components of the extracellular matrix.

Thus, the extracellular space plays a superordinate part in all of the processes and events described up to this point.

The Body's "Semiconductor Chips"

Supersensitive Perception and Superfast Information Transfer

In addition to its many other activities and vital functions, the extracellular matrix also plays another key role.

The extracellular space or intercellular substance provides the human body with an extensive and multiply interconnected and fine-tuned perceptual, communicative, and information network. Electrical potentials are generated by charge distributions along the various long chains and interconnections of branched glycosaminoglycans and proteoglycans. Differential charge gradients can develop depending on the shape, configuration and conformation of the sugar-protein-sugar molecules. Depending on the pressure and tensile forces in the glycosaminoglycan grid, shifts and changes occur in charge, electricity, pH levels, and field strengths. The configuration of geometrical angles and structural patterns within the gel-like intercellular substance is expressed in the form of fluid crystal variations with additional electricity. The form of electricity generated within these grid-like structures is called piezoelectricity. The energy flows and charge gradients vary depending on the geometrical patterns.

Analogous to modern microchips in computer technology, which are information carriers and rapid semiconductors based on silicon and quartz crystals, the extremely finely interconnected and ubiquitously distributed network of the ECM may be regarded as a sensor system, an energy storage device, an information carrier, and a super-fast guidance system.

Water molecules are an important component of this network system, with their specific lattice structures, their interconnections through hydrogen bonds, and their bridge formations with ions and minerals. Minerals such as magnesium, manganese, copper, iron, and zinc always act in their ionic-colloidal form within the gel-like network of charges; in fact, this is the only form in which they generally can be utilized by the body. In this context, metal transporters such as transferrin also act as messenger substances in the ECM. Bonds and bridges with glycoproteins, glycolipids, transmembrane glycosaminoglycans, and integrins modulate the shifts of charges and

tension gradients and the resultant electric currents. Each individual component can be configured according to need and the prevailing pressure and tractile forces and the structure can be extensively adapted through charge distribution and chemical gradients. Even the major families of growth factors and cytokines are activated and controlled through such gradients, and directed in their migration.

Parallel electromagnetic fields function as attractors and order parameters within the electrical potentials and streams. These electromagnetic fields constitute a fine-tuned sensory apparatus, an information storage system, and a flexible online communication system. Different levels of energy, electricity, charge, pressure and tractile forces regulate the preferential absorption, amplification, modulation, transformation, and transmission of different wavelengths. This information network is further synchronized by vast numbers of embedded interstitial receptors, free nerve endings, and ramifications of the autonomic nervous system. Interoception and our sense of self are thus based to a large extent on the intercellular matrix.

Charge patterns, electricity, geometrical configuration, pressure and tractile forces are correlated with specific rhythms of frequency patterns.

In this respect, water molecules represent the geometric structural pattern of a tetrahedron. With their fluid crystalline structure, they have specific energy and wavelengths. Arranged in groups, they form clusters with hydrogen bonds; specific fluid crystal forms are created including the icosahedrons found in the tensegrity model. Wavelengths, frequencies, and energy potentials can be modulated through geometrical variation. This can result in the generation of harmonic, resonant energy patterns or dissonant chaotic patterns depending on the energy, charge, and wavelength.

These patterns can be altered by quanta of pressure, weak electrical currents, ultrasound, or light.

What does physics teach us about these phenomena? The atomic physicist and Nobel prizewinner Dr. Carlo Rubbia was the discoverer of the ratio of form-giving energy to material particles in what is known as the mathematically calculable natural constant. Approximately 1 billion energy units (one to 9,746 times 10^{108}) are required to create one particle of matter. Formative effective forces include quanta of pressure, charges, electrical potentials, electromagnetic fields as well as biophotons and light.

Light imparts its effects through wavelengths and through specific light-sensitive ion channel receptors. Scientists in the field of optogenetics have shown that there are actually “light switches” in the brain that can be measured and activated. Light can influence or control electrical excitability, the cell membrane potential, pH value conditions, and the influx or outflow of ions through their channels. Light can be absorbed by clear crystals and split in such a way as to generate the colors of the rainbow from white light.

Charge patterns, chemical gradients, liquid crystal structure, and piezoelectric currents within the ECM are systematically interwoven with the cytoskeleton, the cell membrane, and the intracellular structures. Depending on the nature of the external signals, all required growth factors, messenger substances, and cell lines can be synthesized in the extracellular space. The maturational processes, normal cell migration, cell growth and the production of the respective glycoproteins, glycosaminoglycan and proteoglycan, are all regulated within the communication network of the ECM.

Several glycosaminoglycans are anchored and interwoven in the cytoskeleton. In their charge-dependent binding patterns, collagen, elastin, laminins, alpha dystroglycan, and dystrophin all form bridges to and within the cytoskeleton. Filamins, alpha actinin, vinculin, paxillin, and talin are anchors to which the glycosaminoglycans from the cytoskeleton can dock. The geometric pattern, piezoelectric potentials, and the organizational patterns within the fluid crystalline structure thus play a key role in the construction and functioning of the cytoskeleton.

Membrane-bound proteoglycans such as syndecan and beta glycan are involved in the normal configuration of the cytoskeleton, in cell adhesion, and in the synchronization of binding activity of FGF and TGF.

Basal membrane proteoglycans such as agrin are responsible for the aggregation of acetylcholine receptor complexes. Perlican functions as a filter – or filtration barrier – for all materials in the intra and extracellular space. Aggrecan provides the key material for hyaluronic acid, chondrocytes, cartilage, and a hydrated joint gel. As part of its anchoring function, versican helps fine-tune pressure and tension forces between the ECM and the cytoskeleton.

A family of leucine-rich proteoglycans is responsible for binding collagen and related fibril formations.

‘Cell adhesion’ proteins function as bridges from the interior of the cell to the outside extracellular space. These protein families are also charged and involved in maintaining homeostasis, electrical tension patterns, chemical gradients, and electromagnetic field potentials.

Major members of this group include the integrins, selectins, cadherins and the immunoglobulin families.

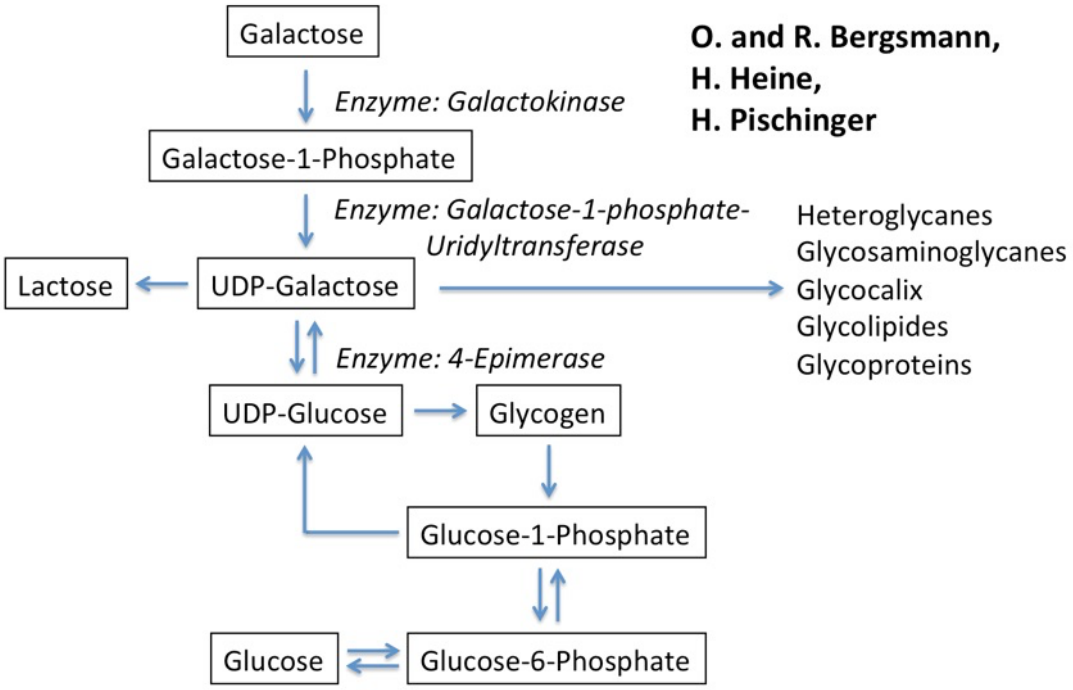
Donald E Ingber is the scientist most responsible for the basic research on the organizational structure and function of the cytoskeleton based on the principles of tensegrity.

The economic construction and maintenance of the cytoskeleton in a maximally harmonious geometric vector model is inextricably linked to the structural laws governing the system of the ECM.

Synthetic Pathways for Components of the ECM

All of the synthetic pathways for glycosaminoglycans and proteoglycans as well as the heteroglycan group depend upon galactose. The synthesis of GAGs and PGs and heteroglycans is characterized by a specific metabolic biochemical pathway. The key substance galactose and its biochemistry have been researched in detail and are documented in major academic textbooks.

The biochemical metabolic pathway for galactose shows how galactose, as the terminal component of all heteroglycans, represents the substrate for biosynthesis and is a metabolic anchor in cells and the intercellular space.



The Biochemistry of Galactose and the ECM

rrr15-014

With the processes of glycosylation, the synthetic metabolic pathway toward the glycosaminoglycans also represents a critical biochemical genetic regulatory mechanism for what is known as post-translational modification. This process involves large numbers of essential substrates, hormones, enzymes, messenger substances, receptors, and life-sustaining components of the intra and extracellular space. Together with the signal communication and cell recognition sugar sialic acid (N-acetylneuraminic acid), galactose plays an vital role in cell adhesion, cell signal cascades, immune regulation, neuroregeneration, and neurobiochemical processes

The World of Myokines

New horizons in medical treatment and prevention

The Communication and Performance Module in the Musculature as a Metabolic Organ is intended to introduce a paradigm shift in medicine.

Myokines may also provide the definitive argument for overcoming artificial divisions between the various disciplines in medicine. The neuromuscular system, the world of connective tissues and fascia, the brain, metabolism and its organs, the immune system and the gastrointestinal tract are essentially and inextricably interconnected as part of a super system. Energy metabolism, the basic principles of biochemistry, the laws of neurobiology, and the basic rules of evolutionary biology around the field of nutrition constitute the underlying basis for all medical disciplines. They are

at once the fertile ground for the emergence of a host of different maladies and the keys for understanding and treating them.

Methodological divisions by tissue type and structure need to be eliminated to reflect our current state of knowledge. Inevitably, the muscles, brain, connective tissue, fasciae, bones, and the extracellular matrix operate as an integral synergistic unit, and thus can only be properly understood in terms of their complex interrelationships and functions. Multidimensional principles of self-regulation and synchronization are critical to the life of the body.

The muscles – an endocrine organ!

Research findings and publications about those almost miraculous messenger substances from the inner world of the muscle known as myokines are heralding a paradigm shift in medicine. The evidence and data are clear: the muscular system is a secretory, hormone-producing organ system and at the same time, plays a key role in sugar and energy metabolism.

In the future, along with ever-more-popular and exploding interest in the gut-brain system and the liver-brain axis, these new dimensions in the world of the muscles will prove to be a highly promising are for virtually all medical disciplines.

A large family of known cytokines, including interleukins, interferons, and neurokinins, are synthesized by the muscles and in the muscles.

- Interleukin 1 and 6 have anti-inflammatory and analgesic effects.
- Interleukin 6 regulates AMPK (AMP-activated protein kinase), the emergency power generator in mitochondrial energy metabolism. It enhances metabolic processes in the cells of the liver and pancreas.
- Interleukin 15 regulates muscle-fat crosstalk, reduces visceral fat and amplifies or activates bone formation.
- Sirtuin, SIRT 1, improves energy utilization and inhibits inflammatory metabolic states.
- BDNF, GDNF, NGF, and neurotensin A affect neuroplasticity and neurogenesis in the brain. BDNF improves the functional ability of mitochondria by promoting fat burning.
- NO (nitrogen monoxide), an important messenger substance in the brain, is secreted in larger quantities from the muscular system to the CNS as a result of physical activity and promotes neurocognitive function.
- IGF-1 is produces inside muscle cells and has anabolic effects in the muscles and induces muscular growth.
- Ins6, insulin like growth factor 6 and LIF stimulate the proliferation of “muscle reserve cells” known as satellite cells.
- FGFs, especially fibroblast growth factor 21, control dynamic adaptation processes in the fasciae and connective tissues. They induce the synthesis of collagen and elastin.
- As a central transcription factor for neuronal and neuromuscular cell families, CREB stimulates the expression of all anabolic proteins and neurohormones.

- Fstl1 Follistatin regulates natural restructuring processes in muscles. In this way, senescent muscle cells can be disposed of and at the same time, room made for the functional replenishment of myoblasts.
- SPARC (secreted protein acidic and rich in cysteine) or osteonectin inhibits carcinogenesis.
- The Peroxisome receptor PGC 1 alpha economizes energy consumption in muscle cells and mitochondria.
- AMPK represents a sensitive sensor system for ATP regulation and at the same time, serves as an emergency power generator and regulates circadian rhythms. In addition, AMPK regulates the efficiency of mitochondrial functions.
- VEGF activates the development of new vessels (to improve the oxygen supply).
- Musculin inhibits muscle breakdown, stimulates muscle growth and activates bone formation
- As intrinsic myokines, TNF alpha and interleukin 1 are downregulated by physical activity; interleukin 6 is finely adjusted in this way. Together, such immunomodulation leads to stimulation of the immune response and activates lymphocytes.
- LIF (leukemia inhibitory factor) inhibits the growth of cancer cells.
- Leptin and GLP-1 economize eating behavior and induce natural feelings of satiety.
- p38 MAPK (mitogen activated protein kinases) regulate, lengthen, and repair telomeres (protective ends of the chromatid genetic material).

Helmut Hinghofer-Szalkay of the University of Graz suggests the following summary:

"Adequate muscular activity leads to extensive change in the system of messenger substances, which has an overall health-promoting effect through the formation of cytokines that suppress inflammation (such as IL-10) and inhibition of cytokines that promote inflammation (TNF--α), among others.

Many cytokines are produced in increased quantities through (intensive) muscular activity:

IL-3 activates reserve cells and assists in muscle hypertrophy;

IL-4 fosters the maturation of myotubules and thus muscle growth;

IL-6 stimulates lipolysis, the mobilization of glucose from the liver, as well as muscle and blood vessel growth;

IL-7 increases muscle growth

IL-8 promotes capillarization; IL-13 increases muscle growth and promotes healing after muscular trauma

IL-15 promotes muscle development and counteracts muscle wasting in chronic illnesses and old age."

25

The overall result is the reduced incidence of cardiovascular diseases, high blood pressure, stroke, the metabolic syndrome, type 2 diabetes, breast cancer, colon cancer, depressed mood, and the tendency for falls and bone fractures. In fact, regular muscular activity has a greater protective effect than supplementation with polyunsaturated omega-3-fatty acids.

Different myokines are associated with different muscular activities. One-sided loads, excessive loads, stereotypical training approaches, and a predominance of similar requirement profiles lead to asymmetries and disturbances in homeostasis. Highly intensive training units without appropriate pauses for regeneration can shift many points in the direction of illness, inflammation, pain, and injury.

By contrast, broadly balanced and accurately directed muscle training can work better than any medicine.

In keeping with the dynamic sensor system in the muscle-fascia-bone trio, all components that are involved should be activated in targeted doses – as a way of stimulating all of the myokine families in a balanced equilibrium.

Myokines are inseparably interconnected with the sensory system in muscles and the fascia.

Cytokines

"Cytokines and other peptides are secreted from skeletal muscles in response to exercise and function as hormones either locally within the muscle or by targeting distant organs. Such proteins are recognized as myokines, with the prototype myokine being IL-6. Several studies have established a role of these muscle-derived factors as important contributors of the beneficial effects of exercise, and the myokines are central to our understanding of the cross talk during and after exercise between skeletal muscles and other organs. In a study into the mechanisms of a newly defined myokine, CXCL-1, we found that CXCL-1 overexpression increases muscular fatty acid oxidation with concomitant attenuation of diet-induced fat accumulation in the adipose tissue. Clearly this study adds to the concept of myokines playing an important role in mediating the whole-body adaptive effects of exercise through the regulation of skeletal muscle metabolism. Yet, myokines also contribute to whole-body metabolism by directly signaling to distant organs, regulating metabolic processes in liver and adipose tissue. Thus accumulating data shows that myokines play an important role in restoring a healthy cellular environment, reducing low-grade inflammation and thereby preventing metabolic related diseases like insulin resistance and cancer". […]

"Taken together, with the identified pleiotropic effects of myokines on multiple tissues, leading to fine-tuning of fuel utilization and energy homeostasis in these tissues, we believe that these secreted myokines are able to restore a healthy cellular environment, reduce low-grade inflammation and thereby prevent metabolic related diseases like insulin resistance and cancer."[26]

---

[25] Cited from: http://user.medunigraz.at/helmut.hinghofer-szalkay/XVIII.6.htm

[26] Pedersen, L. / Hojman, P. (2012). Muscle-to-organ cross talk mediated by myokines. Adipocyte. 1(3). 164-167.

Energy Metabolism

The critical point that is pertient to all myokine families: the conditions of energy lack (!), hyperglycemia, hyperinsulinemia, insulin resistance, and silent inflammation trigger a cascade of stresses and disturbances in homeostasis.

Persistent high extracellular sugar levels lead to excess extracellular insulin. The anabolic effects of performance training depend on the availability of insulin within cells. Excessive insulin amounts in the blood lead to inflammation, neuropathy, impaired regeneration, fatigue, and the risk of injury!

The better the body learns to metabolize of energy sources, the more seamlessly and efficiently will be the course of the citrate cycle and ATP synthesis. When the mitochondria can work under aerobic conditions, when medium-chain triglycerides (MCT) can be burned, when the sensitivity of the insulin system is optimally regulated at HBA1c levels below 5, when glucose transporters can work economically with each other, when co-factors for ATP synthesis, such as B-vitamins, magnesium, iron, manganese, calcium, and Vitamin D are present in adequate quantities, the body as a whole will function optimally. At the same time, these conditions stabilize and bolster the synthesis of major neurotransmitters such as GABA, acetylcholine, glycine, and serotonin.

Galactose binds and detoxifies ammonia and transfers ammonia to the synthesis of amino acids, neurotransmitters, and proteins.

Heteroglycans – the key original elements for all myokines and fascia

Heteroglycans are the basic structure elements for all glycosaminoglycans and proteoglycans and all share a terminal galactose moiety as part of their fundamental structure.

Similarly, synthesis of the various glycoproteins and glycolipids is dependent at this step in the realm of synthetic and regenerative metabolism.

Outlook: Myokines and the gut-brain-muscle axis

It may be hard to believe, but the gut-brain axis is the central hub for a host of neurotransmitters and cytokines. Made in the enteric nervous system and the gastrointestinal tract, their binding sites are located in the spinal cord and the brain. This fact has long been understood by natural scientists but has found new impetus and practical applications as a result of recent research. Many diseases of metabolism, the brain, the immune system and the psyche can only be understood in this context and the new discipline of neuro-gastroenterology. Many of these cytokines and messenger substances from the gastrointestinal tract are also synthesized and sensed in the muscles. A large number of these of these GIPs (gastric inhibitory peptides) are also myokines!

Many of these neuropeptides are sensed by receptor systems in the brain and synthesized in various areas depending on need.

Energy Metabolism (with Stefan Mücke)

“I had the good fortune to have Kurt Mosetter, a highly experienced physician, by my side, who not only took care of my physical well-being but also perfectly coordinated

my care by addressing dietary issues such as avoiding carbohydrates and intelligent nutritional supplementation."

"The magic formula contained in Dr. Mosetter's concept is 'metabolic learning.' So I began to reeducate my metabolism away from rapidly available energy such as normal sugars and pasta and toward sustainable nutrition with "good" sugars such as galactose and more vegetables, fish, organic meats, berries, gluten-free muesli, and nuts. I had the astonishing experience of discovering that I held the key to better health through nutrition in my own hands."

Ralf Rangnick (Football trainer and sports director)

Classical Parameters for Monitoring Training

This chapter is a reprint from: Mosetter, Kurt / Mücke, Stefan (2014). Leistungsfähigkeit, Ernährungssteuerung und Regeneration. [Performance Capacity, Dietary Regulation, and Regeneration] medicalsports network 2. 16-21.:

The analysis and interpretation of creatine kinase levels, urea and uric acid concentrations and the amounts of various electrolyte and trace elements in the serum such as magnesium, iron, potassium, zinc, sodium and calcium are among the established instrumentarium for monitoring training in professional sports. The standard repertoire also includes performing a diagnostic test for endurance, with measurements of lactate concentrations, pulse rates, and maximum VO2 levels.

The depletion of energy stores through frequent intensive physical stress leads to elevated lactate concentrations and also results in increases in ammonia, a substance known to impair cognitive performance.[27] Yet, recent studies have clearly shown that these parameters are not sufficient by themselves for uncovering brakes to the achievement of optimal physical performance. Alongside "peer pressure" in team sports, there are other pitfalls that complicate an individualized perspective on existing problems.

Factors Affecting Physical Performance Capacity

As a complement to sports medicine performance tests and team sport analyses by the teams of trainers for each sport, a detailed biochemical examination of major blood parameters can provide valuable additional data for monitoring training.

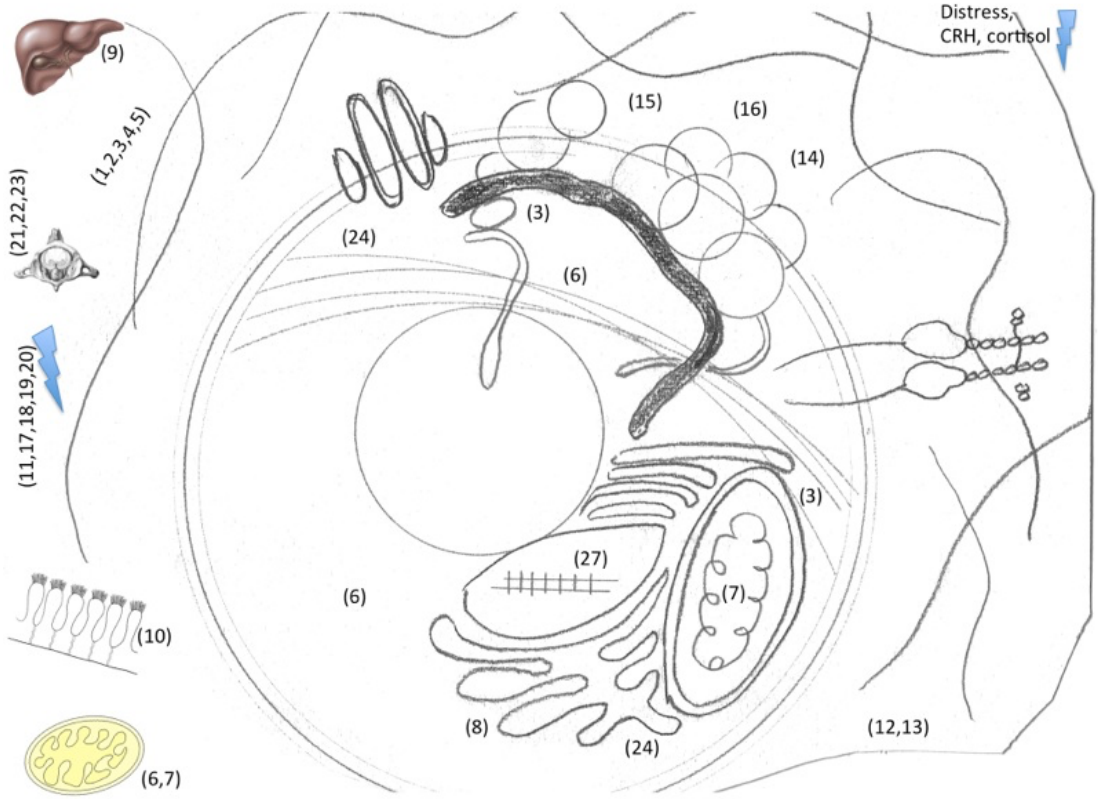
Rather than considering only single laboratory test results and their upper and lower limit values, new discoveries from neurochemistry and biochemistry have shown that seemingly isolated parameters actually function in a complex reciprocal relationship with each other. Thus, when considered together, liver function tests, lipid tests,

---

[27] Schulz, H. / Heck, H. (2006). Laktat und Ammoniakverhalten bei erschöpfenden Dauerbelastungen. [Lactate and Ammonia levels during exhausting continuous stress] In: Bartmus, U. u.a. (Hrsg.) (2006). In memoriam Horst de Marées anlässlich seines 70. Geburtstages. Beiträge aus Sportmedizin, Trainings- und Bewegungs-wissenschaft. [In honor of Horst de Marée on theoccasion of his 70th birthday. Essays from sports medicine, training science and movement science] Köln: Sportverlag Strauß. S. 97-107.

laboratory parameters of sugar metabolism, iron levels, minerals, and vitamins can all provide valuable insights.

The relative balance between these laboratory parameters can yield major insights on energy metabolism, stress tolerance, regeneration potential, susceptibility to injury, and performance capacity versus performance decline. Imbalances and asymmetries in energy balance, disturbances of homeostasis, and relative problems in sugar metabolism are reflected quite early in fluctuations in the balance between laboratory test results, even if no single result yet exceeds any limit value. The basic equation for cellular processes involved in the metabolism of performance and regeneration can be graphically illustrated as follows:



rrr15-006e

Fig. 1: A functional and highly sensitive insulin receptor assure uptake of glucose in the cells via the insulin-dependent glucose-4-transporter (GLUT 4). Within the cell (in the citric acid cycle) ATP is generated or glycogen stores are deposited. In the next steps ATP is used and recycled. Only during anaerobic metabolism do lactate, urea, and ammonia increase.[28] In the final step, physical exercise stress leads to oxidative stress and an increased burden from free radicals.

[28] Schulz, H. / Heck, H. (2006). Laktat und Ammoniakverhalten bei erschöpfenden Dauerbelastungen. [Lactate and Ammonia levels during exhausting continuous stress] In: Bartmus, U. u.a. (Hrsg.) (2006). In memoriam Horst de Marées anlässlich seines 70. Geburtstages. Beiträge aus Sportmedizin, Trainings- und Bewegungs-wissenschaft. [In honor of Horst de Marée on theoccasion of his 70th birthday. Essays from sports medicine, training science and movement science] Köln: Sportverlag Strauß. 97-107.

The precondition for normal and economical metabolic processes in the body is efficient nutrient transfer. Glucose utilization plays an especially vital role. The cellular energy carrier ATP transfers its stored energy to other molecules in the form of the third phosphate unit by forming a phosphorylated energy carrier or metabolite (e.g. glucose-6-phosphate, fructose-6-diphosphate, among others) and continuously regenerates its breakdown product ADP via creatine phosphate. Creatine phosphate is required for muscle contraction. At times of high performance demands, however, a increased metabolic breakdown of nucleotides occurs, and under anaerobic and chronic ischemic conditions, the accumulation of their breakdown products includes toxic end products such as ammonia and uric acid. An additional end product is the superoxide radical, and in excess amounts, such as occurs in conditions of poor nutrition or infection, superoxide radicals can damage the molecular structures of the cell. Under conditions of oxygen lack, hypoxia-inducible factor 1 alpha (HIF-1-alpha) intervenes (this new parameter could be useful for monitoring training), in the interests of protecting the system as best as possible, and for adapting to the extreme anaerobic conditions.[29]

Step 1:

ATP formation begins with the metabolic pathways of glycolysis and fatty acid breakdown, which culminate in the citric acid cycle (Figure 2) and introduce the resulting reduction equivalents NADH or FADH into the respiratory chain. To produce the energy carrier ATP during acute energy demand (glycolysis), an absolute requirement is that glucose pass from the outside to the inside of the cells. This step involves an insulin receptor located on the surface of muscle cells, and when it is activated, a cascade of reactions is set off within the cell, which ultimately activates the glucose-4 transporter (GLUT 4). Now glucose can be absorbed into the cell.[30]

Carbohydrate overload can result in significant disturbances at this key step in energy metabolism by causing the phenomenon of insulin resistance.[31]

---

[29] Finkel, T. (2012). Signal transduction by mitochondrial oxidants. J Biol Chem. 287(7). 4434-40. // Mason, S.D. / Rundqvist, H. / Papandreou, I. / Duh, R. / McNulty, W.J. / Howlett, R.A. / Olfert, I.M. / Sundberg, C.J. / Denko, N.C. / Poellinger, L. / Johnson, R.S. (2007). HIF-1alpha in endurance training: suppression of oxidative metabolism. Am J Physiol Regul Integr Comp Physiol. 293(5). R2059-69. // Mason, S. / Johnson, R.S. (2007). The role of HIF-1 in hypoxic response in the skeletal muscle. Adv Exp Med Biol. 618(229-44).

[30] Richter, E.A. / Hargreaves, M. (2013). Exercise, GLUT4, and skeletal muscle glucose uptake. Physiol Rev. 93(3). 993-1017. // Sylow, L. / Kleinert, M. / Pehmoller, C. / Prats, C. / Chiu, T.T. / Klip, A. / Richter, E.A. / Jensen, T.E. (2014). Akt and Rac1 signaling are jointly required for insulin-stimulated glucose uptake in skeletal muscle and downregulated in insulin resistance. Cell Signal. 26(2). 323-31.

[31] Westman, E.C. / Yancy, W.S., Jr. / Mavropoulos, J.C. / Marquart, M. / McDuffie, J.R. (2008). The effect of a low-carbohydrate, ketogenic diet versus a low-glycemic index diet on glycemic control in type 2 diabetes mellitus. Nutr Metab (Lond) 5(36). Cordain, L. / Friel, J. (2009). Das Paläo-Prinzip der gesunden Ernährung im Ausdauersport. [The Paleo Principle for healthy nutrition in endurance sports] Betzenstein: Sportwelt Verlag.

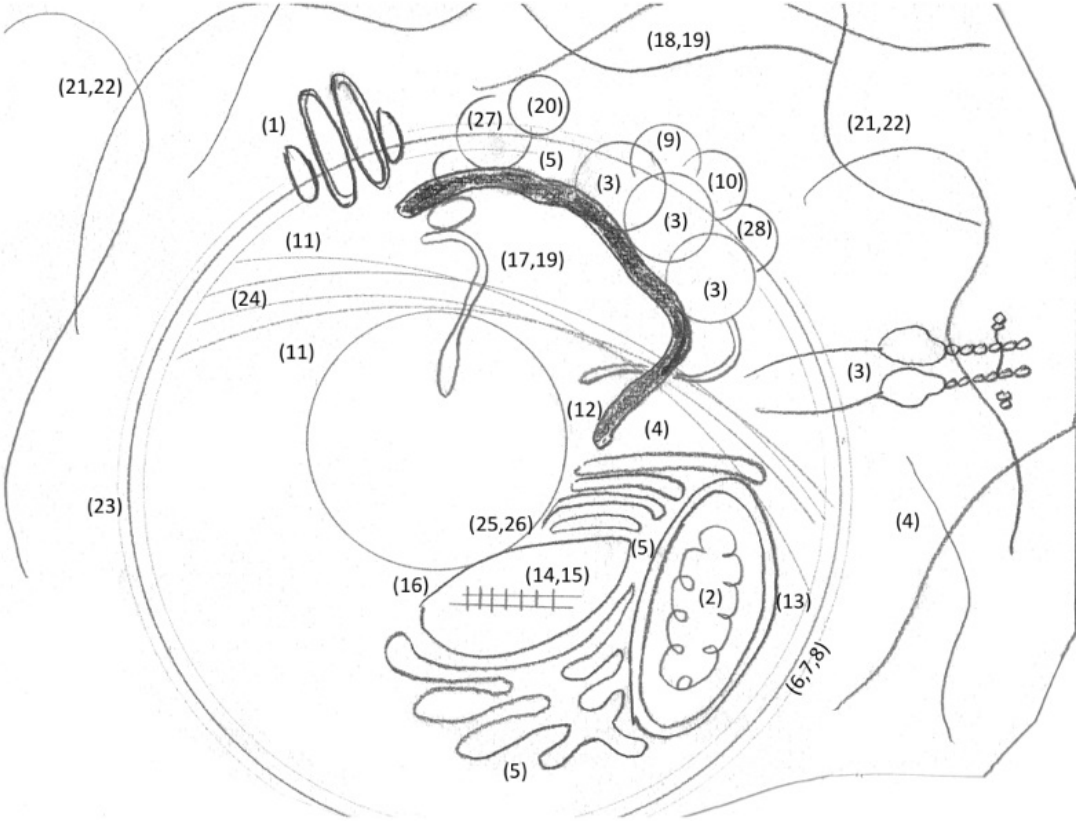
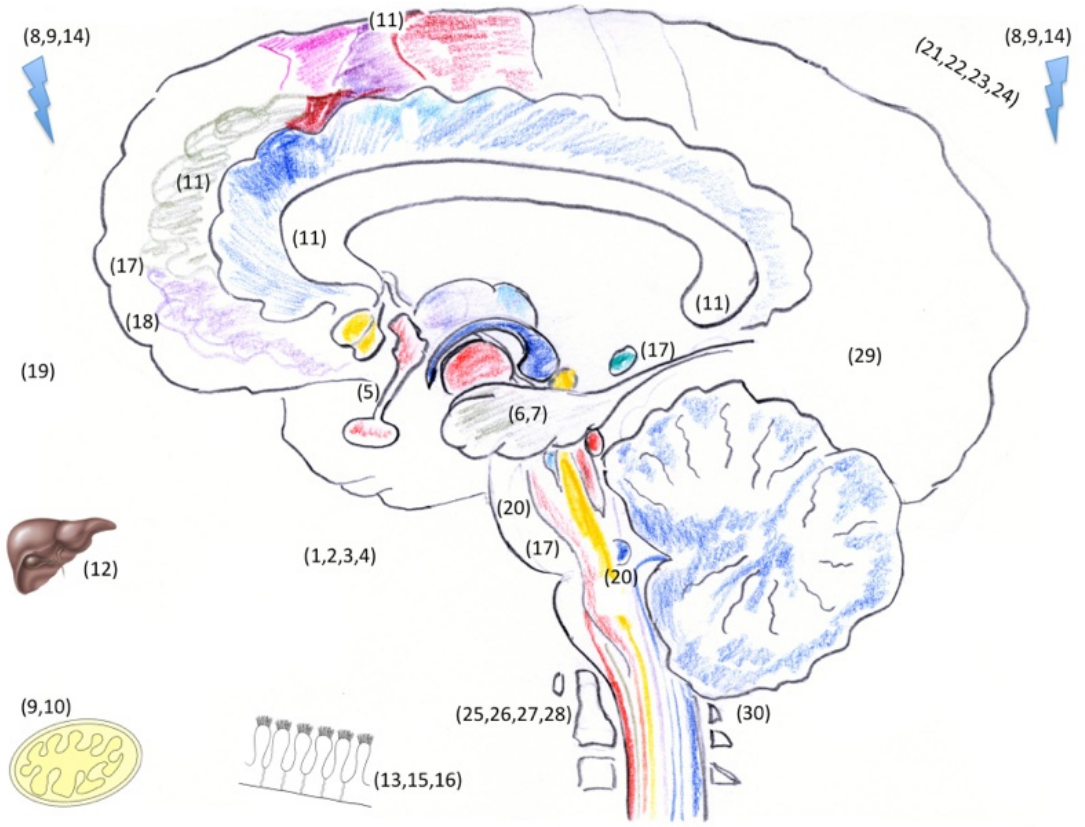


Fig. 2: Citrate cycle under physiological conditions of insulin metabolism.

Step 2:

In high-performance sports medicine, great attention tends to be given to glycogen stores, since the glycogen they contain can be broken down into glucose to obtain energy (see above). The emphasis is always on the notion that amply filled glycogen stores are the key to high performance. However, “filling up” these energy stores and subsequently mobilizing the stored energy are contingent on stable conditions of insulin metabolism with properly functioning insulin receptors and open insulin signal pathways within the cells.

The critical point about oversaturating the body with carbohydrates is that following an overshoot in the insulin response with depletion of glucose from the plasma, hyperglycemia occurs, and the hypothalamus orders renewed secretion of insulin. This pendulum-like movement of the insulin response destabilizes metabolism as a whole. Recurrent elevated insulin levels impair the breakdown of fatty acids from fat cells, and this may impair the ketogenic metabolic state that could provide energy for sustained performance. Hyperglycemia, hyperinsulinemia, and partial insulin resistance prevent normal deposition of glycogen stores and interfere with the perfect timing of glycogen mobilization (Figure 2).



rrr15-008e

Fig. 3: Insulin cascade with glycogen storage or mobilization.

Step 3:

The breakdown of ATP to ADP and AMP is reflected in the muscular system by an increase in creatine kinase (CK). Using the creatine stores in the body (approx. 150g), ADP that has been produced in the cytoplasm is recycled back to ATP in the mitochondria.

Step 4:

When ATP is utilized in an intact metabolic state, the resulting ADP is continuously regenerated. However, if a crisis of supply occurs, such as takes place with very frequent stressful activity, a number of metabolites and breakdown products are produced. This shifts the equation in the direction of performance-limiting metabolic pathways. The ratio of lactate to pyruvate is a major indicator of the ratio of aerobic to anaerobic breakdown of glucose and fatty acids. The performance-limiting role of **ammonia** is also well known and extensively described.[32] **Ammonia** levels rise

[32] Schulz, H. / Heck, H. (2006). Laktat und Ammoniakverhalten bei erschöpfenden Dauerbelastungen. [Lactate and Ammonia levels during exhausting continuous stress] In: Bartmus, U. / Jendrusch, G. / Heneke, T. / Platen, P. (Hrsg.) (2006). In memoriam Horst de Marées anlässlich seines 70. Geburtstages. Beiträge aus Sportmedizin, Trainings- und Bewegungswissenschaft. [In honor of Horst de Marée on theoccasion of his 70th birthday. Essays from sports medicine, training science and movement science] Köln: Sportverlag Strauß. S. 97-107.

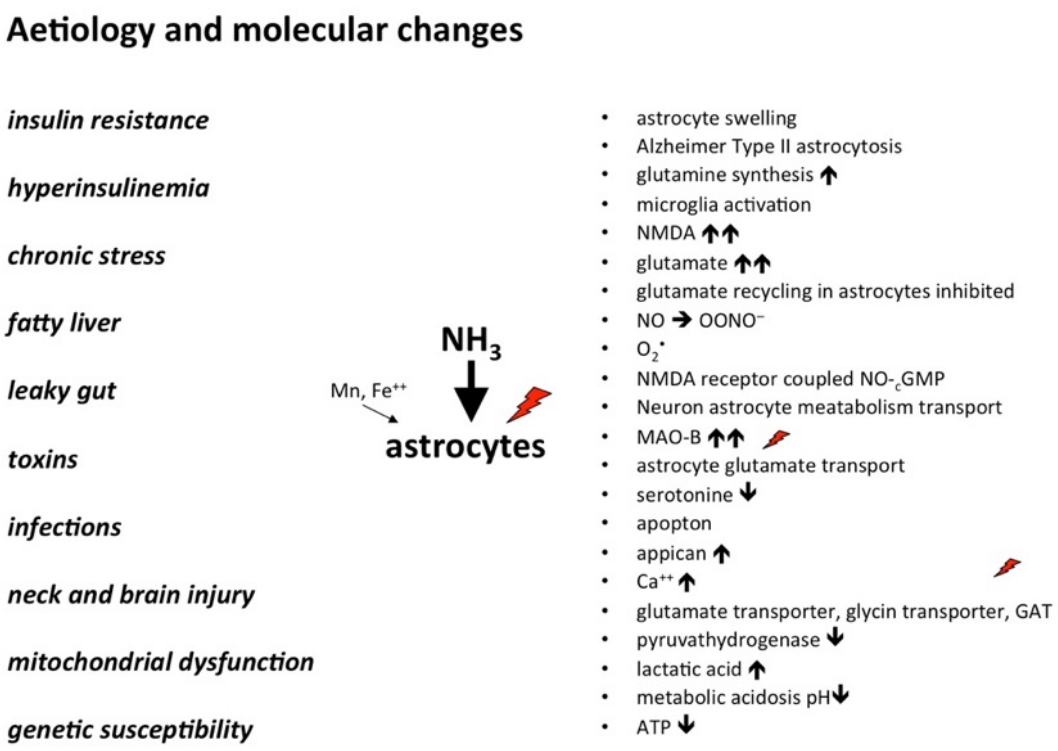
during a steady state of **lactate** loading and have a limiting effect on cognition that is both perceptible and measurable.[33]

An additional metabolite during high-performance energy consumption is **urea,** which represents an excretion product for the ammonia produced by the breakdown of amino acids such as glutamine.

Step 5:

Uric acid is a breakdown product of metabolized nucleotides such as ATP and functions as an anti-oxidant (see above). Urea and uric acid levels rise under conditions of anaerobic energy metabolism and also from overloading with glucose and fructose. Fructose directly causes to an increase in blood pressure and uric acid inhibits the physiological effects of nitrogen monoxide (NO).

Overconsumption of starch, glucose, and fructose leads to conditions of relative insulin resistance with reduced activity of insulin-dependent GLUT-4 transporters. This is correlated within the cell with a deficiency of energy and ATP and changes the normal deposition of glycogen stores. At the same time, this imbalance can cause of rising lipid levels, increases in glycosylated hemoglobin (HbA1c) and disturbance of liver metabolism (gamma-GT).



rrr15-009e

Figure. 4: Loss of glucose and insulin sensitivity leads to failure of storing the glucose 4 transporter (GLUT 4) in the cell membrane and loss of its functionality, while

[33] Mosetter, K. & Mosetter, R. (2010). Myoreflextherapie Band 2. Regulation für Körper, Gehirn und Erleben. [Myoreflex Therapy Volume 2. Regulation for the Body, Brain, and Experience] Konstanz: Vesalius.

within the cells, the lack of glucose and ATP predominates. Under these conditions, there are increases within the cell of lactate, ammonia, uric acid, oxidative stress, and in HIF-1-alpha. Outside the cells and in the blood, unmetabolized sugar burdens the liver, lipid metabolism, and results in increased glycosylated hemoglobin levels.

Step 6:

Carbohydrates damage insulin-producing cells through oxidative stress. The final brake affecting performance and regeneration in this basic energy metabolism equation is represented by the increased amounts of free radicals and end-products, especially the superoxide radical O2- [34] Normally, this highly active form of oxygen is produced in small quantities (2-3%) in the respiratory chain as electrons penetrate through Complexes I-IV until they are properly transferred to oxygen. When, instead, they drop out of this chain and are directly transferred to oxygen, this results in the formation of superoxide radicals. Normally, these radicals are captured by SOD (superoxide dismutase). Excessive quantities of free radicals, as are found from a diet containing too many foods with short-chain carbohydrates, leads to an increased and no longer manageable formation of free radicals and thus to cell damage and weakening.[35]

The superoxide radical is produced under conditions of intensive physical stress and can cause persistent tissue damage, especially in the presence of iron, which results from the breakdown of erythrocytes. Under normal conditions, however, superoxide radicals can help macrophages in the immune system to kill pathogens and thus have a protective function in the body.

Step 7:

When superoxide radicals react with NO, which is naturally present and functions in physiological doses as a vasodilator, this leads to the formation of peroxynitrite ($OONO^-$), one the most significant destructive agents of cellular substructures and macromolecules. Superoxide that has not been physiologically captured (Fig. 4; Step 6) ultimately reacts with hydrogen peroxide, and in combination with iron (Fe^{++}), this results in the formation of $OH^{\bullet}$- radicals, which can be regarded as the most aggressive of the free radicals, because no intrinsic biological defense against it exists. These anaerobic and ischemic metabolic conditions summon up HIF-1-alpha (hypoxia inducing factor IA), which functions as a system for short-term protective adaptation.

Step 8

The metabolic strains involved in this step develop synchronously along the regulatory cycle of sugar utilization in the insulin receptor. While capture of glucose by the glucose transporter builds up intracellular sugar levels, the excess sugar outside the cell is metabolized to create lipids and leads to the glycosylation of important enzymes, and among others, becomes a burdensome attachment to hemoglobin, and

---

[34] Alessio, H.M. (1993). Exercise-induced oxidative stress. Med Sci Sports Exerc 25(2). 218-24.

[35] Olias, G. (2009). Kohlenhydrate schädigen Insulin-produzierende Zellen durch oxidativenStress. [Carbohydrates damage insulin-producing cells through oxidative stress] DIfE - Deutsches Institut für Ernährungsforschung, [German Institute for Nutrition Research]Potsdam-Rehbrücke (Presse-undÖffentlichkeitsarbeit). (12.11.2009).

interferes with liver metabolism (GGT↑, cholesterol ↑, HbA1c ↑). Products of glycosylation are called AGE (advanced glycation end products) and are readily measurable. Glycosylated hemoglobin (HbA1c) is widely used as the reference parameter.

Goals

From these metabolic principles, we can infer two principal goals for optimizing performance, energy metabolism and regeneration processes:

1. The whole body will be more stable and robust to the extent that we increase the amount of ATP available inside the cell, (or *better regulate ATP)* and reduce the quantity of free radicals generated (or increase the efficiency of their elimination).

2. The function of the ATP economy improves in proportion to the availability of more glucose or free fatty acids in the cells. The more economically insulin release is regulated and the better insulin receptors function, the more stable the entire system will be, reducing the likelihood of excessive plasma concentrations of free glucose, which burden cell membranes, hemoglobin, and other enzymes and proteins as a result of glycosylation. Earlier reference limits that regarded HbA1c levels under 6.1 as "normal" for diabetics are outdated. Healthy individuals, especially high-performance athletes, should strive for "virginal" HbA1c levels less than 5. Even l HbA1 levels of 5.5 already suggest significant impairment of optimal oxygen binding and release capacity, since active centers of the hemoglobin are 'clogged up' and energy metabolism is burdened. This means that when HBA1c levels exceed 5, **glucose utilization** no longer functions optimally. The result can be partial insulin resistance, thereby causing impaired performance and delayed regeneration.[36]

See below: *Background: measuring stress metabolism*.

Physical and Mental Fatigue

One can find an abundance of studies and papers about fatigue just in the realm of the sports sciences. There are a host of different causal mechanisms for fatigue throughout the body, and even attempts to define and quantify "fatigue" turn out to be quite diverse and different.[37] [38]

There are differences between individuals, different kinds of loading and training, gender-specific characteristics, differences in testing procedures, and lots of studies focused on specific muscle groups and single metabolites. This chaotic diversity suggests a need for a more comprehensive unifying perspective. Along with the periphery of the body, the autonomic nervous system and brain regulation of energy metabolism also play a critical part. Thus, ever-larger numbers of studies of neuromuscular

---

[36] Mutter, J. (2009). Gesund statt chronisch krank. [Healthy instead of chronicaly ill] Weil der Stadt: fit fürs Leben Verlag. S. 207.

[37] Enoka RM, Duchateau J. 2008. Muscle fatigue: what, why and how it influences muscle function. *J Physiol* 586: 11-23.

[38] Bogdanis GC. 2012. Effects of physical activity and inactivity on muscle fatigue. *Front Physiol* 3: 142

fatigue have emphasized the key role of central fatigue – fatigue affecting the brain and central energy metabolism.[3940414243]

The economical guidance of central energy metabolism optimizes energy utilization and mitochondrial performance through a process of "metabolic learning"[44] and the biogenesis of mitochondria.

In the following section, we will summarize the critical central and peripheral metabolic mechanisms that are responsible for fatigue processes through their synchronous interactions.

Fatigue

Physical and mental fatigue is grounded in energy metabolism. The economy of sugar utilization plays a central role in the liver-brain axis and the liver-brain-muscle axis. The worse sugar utilization becomes due to sugar overload and hyperglycemia, the more unphysiological are the effects of excessive basal insulin release on performance capacity. Sugar transporters and cellular glucose uptake suffer under conditions of insulin resistance. This leads to a deficiency of ATP energy and fatigue. A central mechanism of fatigue has to do with relative hypoglycemia.[45] When there are excessive sugar loads and disruptions in the economical cascade of insulin signal translation, the control system for depositing and mobilizing glycogen stores does not function properly.

On the one side, insufficient stores are deposited in the liver – and on the other side, precious glycogen stores are emptied too rapidly and for too long a time. In the process of ATP use, the amounts of ADP recycled by the mitochondria become

---

[39] Arieli R, Constantini N. 2012. Energy balance among female athletes. *Harefuah* 151: 82-5, 128

[40] Gibson ASC. 2003. The Conscious Perception of the Sensation of Fatigue. *Sports Med* 33: 167-76

[41] Mottram CJ, Jakobi JM, Semmler JG, Enoka RM. 2005. Motor-unit activity differs with load type during a fatiguing contraction. *J Neurophysiol* 93: 1381-92

[42] Lexy H. 2011. *Eine explorative Querschnittstudie zur Darstellung der Interaktion zwischen Muskel und Knochen bei Senioren-Master-Athleten während der 15. Leichtathletik-Europameisterschaften.*

Dissertation zur Erlangung des akademischen Grades doctor medicinae [An exploratory cross-sectional study on the presentation of the interaction between muscle and bones in senior master athletes during the 15th European Athletic Championships] Dr. med.) vorgelegt der Medizinischen Fakultät Charité - Universitätsmedizin Berlin

[43] Gollhofer A, Taube W, Leukel C. 2006. Zentrale Ermüdung als leistungslimitierender Faktor bei schnellkräftigen Kontraktionen: Evaluation der Ermüdungswiderstandsfähigkeit vor und nach Training mit Hilfe von elektrischer Nervenstimulation und transkranieller Magnetstimulation.[Central fatigue as a performance-limiting factor in quick and powerful contractions: evaluation of the ability to resist fatigue pre and post training using electrical nerve stimulation and transcranial magnetic stimulation] In *BISp-Jahrbuch – Forschungsförderung 2006/07*, pp. 203-07. Universität Freiburg. Institut für Sport und Sportwissenschaft

[44] Mosetter K, Mosetter R. 2010. *Myoreflextherapie - Band 2. Regulation für Körper, Erleben und Gehirn*. [Myoreflex Therapy – Volume 2. Regulation for the Body, Experience, and the Brain] Konstanz: Vesalius

[45] Alessio HM. 1993. Exercise-induced oxidative stress. *Med Sci Sports Exerc* 25: 218-24

insufficient. Creatine phosphate falls to insufficient basal levels. Functional creatine deficiencies thus play an important part in the process of fatigue.[4647]

The conversion of ATP into ADP and AMP in situations of chronic and excessive strain lead to the accumulation of IMP (inosine monophosphate), ammonia, uric acid, and lactate. Ammonia plays a central part in the process of mental, subjective, and physical fatigue. High ammonia levels are also responsible for muscle cramps.[48]

Excessive lactate levels are similarly associated with phenomena of fatigue. At a more detailed level, one has to differentiate between two phases. The first phase of the fatigue associated with metabolic acidosis is not triggered by lactate.[4950] Rather, each instance when ATP breaks down to ADP releases acidic H^+ ions. Under conditions of aerobic metabolism in the mitochondrial respiratory cycle, these protons are immediately utilized through oxidative phosphorylation, and thus, no acidosis results.[51]

In anaerobic metabolism, when ATP is not produced through the mitochondrial system but must be generated through glycolysis and direct oxidation of sugar, twice as many H^+ protons are produced, thereby promoting metabolic acidosis and additional fatigue. During this phase, the body tries to compensate for pyruvate accumulation and boost the NAD(+) supply by means of increased lactate production.[52] Without such compensation, the muscular system and neuronal controls would become fatigued even faster. However, in the decompensated phase, H^+ protons and lactate produce the fatigue state of metabolic acidosis.

In this process, the negative energy balance leads to an uneconomical increase in oxidative stress. The accumulation of free radicals (ROS)/O^2 superoxide radicals, and OH-radicals causes prolonged fatigue with very poor regeneration. At the same time, there is increased risk of injury to muscles and tendons, as well as the risk of fatigue fracture.[53]

---

[46] Wallimann T, Dolder M, Schlattner U, Eder M, Hornemann T, et al. 1998. Creatine kinase: an enzyme with a central role in cellular energy metabolism. *MAGMA* 6: 116-9

[47] Prass K, Royl G, Lindauer U, Freyer D, Megow D, et al. 2007. Improved reperfusion and neuroprotection by creatine in a mouse model of stroke. *J Cereb Blood Flow Metab* 27: 452-9

[48] Cordain L, Friel J. 2009. Das Paläo-Prinzip der gesunden Ernährung im Ausdauersport. [The Paleo Principle of Healthy Nutrition for Endurance Athletes Betzenstein: Sportwelt Verlag

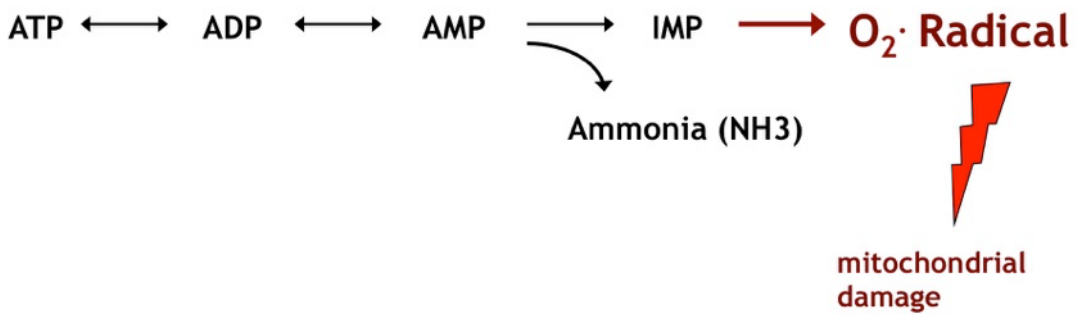
[49] Schulz H, Heck H. 2006. Schulz, H. / Heck, H. (2006). Laktat und Ammoniakverhalten bei erschöpfenden Dauerbelastungen. [Lactate and Ammonia levels during exhausting continuous stress] In: ed. Bartmus, U. / Jendrusch, G. / Heneke, T. / Platen, P. (Hrsg.) (2006). In memoriam Horst de Marées anlässlich seines 70. Geburtstages. Beiträge aus Sportmedizin, Trainings- und Bewegungswissenschaft. [In honor of Horst de Marée on the occasion of his 70th birthday. Essays from sports medicine, training science and movement science] pp. 97-107. Köln: Sportverlag Strauß

[50] Alessio HM. 1993. Exercise-induced oxidative stress. *Med Sci Sports Exerc* 25: 218-24

[51] Robergs RA, Ghiasvand F, Parker D. 2004. Biochemistry of exercise-induced metabolic acidosis. *Am J Physiol Regul Integr Comp Physiol* 287: R502-16

[52] ebd.

[53] Alessio HM. 1993. Exercise-induced oxidative stress. *Med Sci Sports Exerc* 25: 218-24



rrr14-011e gr

When we measure performance capacity, we find that high uric acid levels are associated with fatigue. In this process as well, we should distinguish between at least two phases. The body uses uric acid as a physiological anti-oxidant protective system in order to throttle the accumulation of dangerous structurally compromising superoxide radicals. In the first phase of rising uric acid levels, the uric acid is serving as a protective molecule – and only in the second, decompensated phase of very rapid increase do elevated uric acid levels correlate with exhaustion, fatigue and poor regeneration. Lack of energy and relative hypoglycemia in the face of depleted glycogen stores lead to increase plasma levels of fatty acids, This increase in fatty acids then introduces a further step in the process of fatigue.

Free fatty acids initiate an increase in free plasma tryptophan. As tryptophan crosses the blood brain barrier, there is an increase in the neuronal levels of 5-hydroxytryptophan, which cause an additional burden in the process of fatigue. The greater the supply of branched-chain amino acids (BCAAs), the better optimized the ratio of free tryptophan to BCAA. Thus, BCAAs can serve to retard the process of fatigue.

Vitamins, Trace Elements, etc.

Along the individual steps that make up the citric acid cycle, the availability of iron, magnesium, manganese, calcium, and chromium is essential. Deficiencies in supply can only be measured in whole blood, but at the mitochondrial level, they can fundamentally impair ATP synthesis and at the same time lead to increased ammonia levels. The smooth functioning of the respiratory cycle in the mitochondria requires Vitamin B1, Vitamin B2, Coenzyme Q10, and Vitamin B3.

Deficiencies can cause premature fatigue both as a result of low Coenzyme Q10 and ATP levels as well as from unphysiologically elevated production of free radicals in the mitochondrial membrane.

Deficiency states in amino acids as well as minerals and vitamins can block key enzymes in energy metabolism in the citric acid cycle. Reduced and asymmetrical activity ranges for pyruvate dehydrogenase, the lack of α-lipoic acid, deficits in tetrahydrobiopterin, deficiencies in Vitamins B1, B2, B3, B6 and B12 are thus also key elements in fatigue processes.

The solution to this aspect of the fatigue problem seems simple enough: a diet composed of ⅓ high-quality fats, ⅓ high-quality protein, and ⅓ healthy carbohydrates. One can infer important principles of a healthy low-carbohydrate diet from the human

paleo-diet.[545556] This 33 percent distribution of nutrients was already being advocated in the sports sciences in 2000.[57]

More protein before and during activity has been studied as a useful measure by a number of different working research groups. .[585960616263] The value of a greater proportion of fats has also been well demonstrated.[646566676869]

The utilization of high-quality carbohydrates such as galactose has shown great benefit. By means of the broad spectrum of activity of this replacement carbohydrate, one

---

[54] Cordain L, Friel J. 2009. *Das Paläo-Prinzip der gesunden Ernährung im Ausdauersport*. Betzenstein: Sportwelt Verlag

[55] Cordain L, Friel J. 2005. *The Paleo diet for athletes. A nutritional formula for peak athletic performance*. New York: Rodale

[56] Paul S. 2012. *Paläopower: Das Wissen der Evolution nutzen für Ernährung, Gesundheit und Genuss*. [Paleo power: benefiting from the wisdom of evolution for nutrition, health and enjoyment] München: C.H.Beck

[57] Pendergast DR, Leddy JJ, Venkatraman JT. 2000. A perspective on fat intake in athletes. *J Am Coll Nutr* 19: 345-50

[58] Miller SL, Maresh CM, Armstrong LE, Ebbeling CB, Lennon S, Rodriguez NR. 2002. Metabolic response to provision of mixed protein-carbohydrate supplementation during endurance exercise. *Int J Sport Nutr Exerc Metab* 12: 384-97

[59] Farnsworth E, Luscombe ND, Noakes M, Wittert G, Argyiou E, Clifton PM. 2003. Effect of a high-protein, energy-restricted diet on body composition, glycemic control, and lipid concentrations in overweight and obese hyperinsulinemic men and women. *Am J Clin Nutr* 78: 31-9

[60] Layman DK, Shiue H, Sather C, Erickson DJ, Baum J. 2003. Increased dietary protein modifies glucose and insulin homeostasis in adult women during weight loss. *J Nutr* 133: 405-10

[61] Layman DK, Boileau RA, Erickson DJ, Painter JE, Shiue H, et al. 2003. A reduced ratio of dietary carbohydrate to protein improves body composition and blood lipid profiles during weight loss in adult women. *J Nutr* 133: 411-7

[62] Ivy JL, Res PT, Sprague RC, Widzer MO. 2003. Effect of a carbohydrate-protein supplement on endurance performance during exercise of varying intensity. *Int J Sport Nutr Exerc Metab* 13: 382-95

[63] Ivy JL, Goforth HW, Jr., Damon BM, McCauley TR, Parsons EC, Price TB. 2002. Early postexercise muscle glycogen recovery is enhanced with a carbohydrate-protein supplement. *J Appl Physiol* 93: 1337-44

[64] Muoio DM, Leddy JJ, Horvath PJ, Awad AB, Pendergast DR. 1994. Effect of dietary fat on metabolic adjustments to maximal VO2 and endurance in runners. *Med Sci Sports Exerc* 26: 81-8

[65] Vogt M, Puntschart A, Howald H, Mueller B, Mannhart C, et al. 2003. Effects of dietary fat on muscle substrates, metabolism, and performance in athletes. *Med Sci Sports Exerc* 35: 952-60

[66] Stannard SR, Johnson NA. 2004. Insulin resistance and elevated triglyceride in muscle: more important for survival than "thrifty" genes? *J Physiol* 554: 595-607

[67] Johnson NA, Stannard SR, Thompson MW. 2004. Muscle triglyceride and glycogen in endurance exercise: implications for performance. *Sports Med* 34: 151-64

[68] Dyck DJ, Putman CT, Heigenhauser GJ, Hultman E, Spriet LL. 1993. Regulation of fat-carbohydrate interaction in skeletal muscle during intense aerobic cycling. *Am J Physiol* 265: E852-9

[69] Lambert EV, Speechly DP, Dennis SC, Noakes TD. 1994. Enhanced endurance in trained cyclists during moderate intensity exercise following 2 weeks adaptation to a high fat diet. *Eur J Appl Physiol Occup Physiol* 69: 287-93

can favorably stimulate mitochondrial function and even promote the biogenesis of mitochondria.[70][71][72][73]

To support homeostasis and energy metabolism and to activate self-healing processes the balance of our inner rhythm is essential. A natural sleeping behavior supports regeneration and vegetative regeneration, enhances performance and supports central learning processes.

As a rule of thumb, one can count *on the fingers of one hand* the essential ingredients of the ultimate power drink:

- the **essential sugars**: galactose and ribose
- sulfur-containing, branched-chain **amino acids**
- high-quality **fats** with high omega-3 proportions
- the **minerals** magnesium^{++}, zinc^{++}, chromium^{++} and iron
- the individual members of the **Vitamin-B** family

As supplements, Coenzyme Q10, α-lipoic acid and NADH can optimize performance metabolism as needed.

Summary: Economical Training for the Basic Sextet

Brain – Muscles – Fasciae – Ground Substance – Bones – Energy Metabolism

Objectives:

- ✓ Greatest performance capacity
- ✓ Optimal regeneration
- ✓ Symmetry of tone
- ✓ Aesthetics
- ✓ Mobility
- ✓ Elasticity
- ✓ Neuro-mental fitness

---

[70] Aguer C, Gambarotta D, Mailloux RJ, Moffat C, Dent R, et al. 2011. Galactose enhances oxidative metabolism and reveals mitochondrial dysfunction in human primary muscle cells. *PLoS One* 6: e28536

[71] Davis JM, Murphy EA, Carmichael MD, Davis B. 2009. Quercetin increases brain and muscle mitochondrial biogenesis and exercise tolerance. *Am J Physiol Regul Integr Comp Physiol* 296: R1071-7

[72] Mosetter K. 2013. Schmerzen als Ausläufer von Stoffwechselerkrankungen. [Pain as a trigger for metabolic diseases] *Schweiz Z Ganzheitsmed – Swiss Journal of Integrative Medicine* 25: 33-38

[73] Roser M, Josic D, Kontou M, Mosetter K, Maurer P, Reutter W. 2009. Metabolism of galactose in the brain and liver of rats and its conversion into glutamate and other amino acids. *J Neural Transm* 116: 131-9

- ✓ Accident prevention

Principles:

- ✓ Length training for muscles and fasciae
- ✓ Antagonist training
- ✓ Muscle chain training
- ✓ Individually targeted incremental loads through tensile, pressure and vibrational stimuli
- ✓ Micro-movements, rocking, elastic, slowly resilient end-stage movement components, small load intervals, sufficient pauses, etc.

Methods:

- ✓ ***KiD*** – Resistance training in stretched positions and the Myoreflex concept (Mosetter)
- ✓ Training as developed by Walter Packi – ***flexx*** and ***five***
- ✓ ***4 D Pro Reaction*** Trainer (Gharavi)
- ✓ ***Galileo*** (Schießl)
- ✓
- ✓ Controlling metabolism and the ***5 Fingers of one Hand*** method

Source:
Mosetter, Kurt / Mosetter, Reiner (2010). Myoreflextherapie Band 2: Regulation für Körper, Gehirn und Erleben. Konstanz: Vesalius. S. 295-307.

Part V – Dynamics of Knee and Groin Pain in Professional Soccer Players

Physics is inscribed within the great book that lies open before our eyes…But we can only begin to read it after we have learned its language and become familiar with the symbols in which it is written. (Galileo Galilei)

Microtrauma

Improper loading or excessive stress combined with insufficient regenerative intervals can lead to changes in muscles and tendons. Insufficient elasticity, insufficient relaxation capacity, increased tone, non-optimal performance parameters and muscle stiffness thereby initially result in reduced resilience. If the relative improper loading continues unchanged, then degenerative changes are likely to develop.

Recurrent excessive stress then establishes manifest microtraumatic changes, with muscle pains, periosteal irritation, and irritated muscle-tendon junctions manifesting as insertional tendinopathies.

Aseptic inflammatory changes, improper loading and excessive stress with insertional tendinopathies and microtraumas are all potentially reversible with appropriately precise, targeted and individually tailored treatment.

In this process, it is quite difficult to determine the stress capacity and individual properties of individual components such as ligaments, tendons, muscles and joint and bone structures.

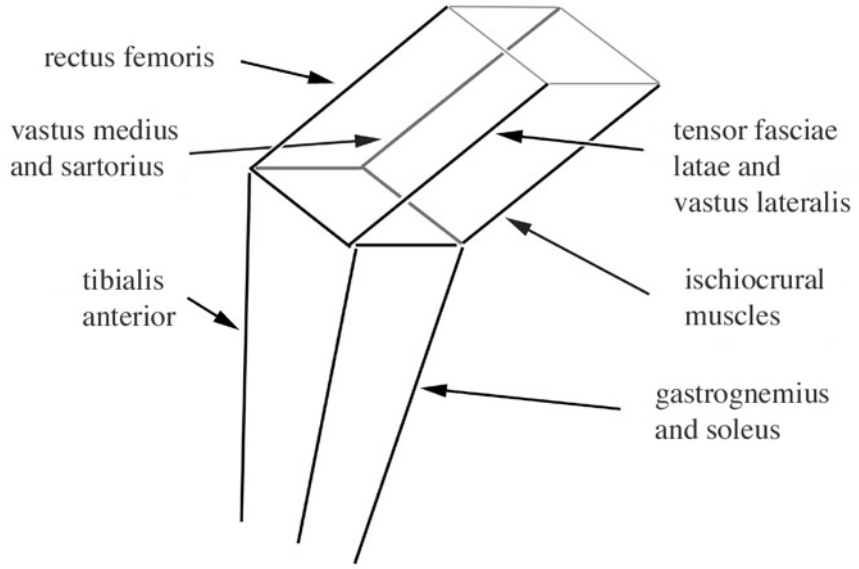
Great differences may exist within a single individual and between individuals, along with individual asymmeteries resulting from previous injuries or stereotyped stress patterns and special stresses dependent upon movement. An individual's capacity to respond to medical treament is just as wide-ranging as the variability of time factors.

From the perspective of biomechanical laws, vector calculations based upon deductions from movement geometry lead to a completely new level of understanding – and thereby to new treatment and optimization strategies.

The dynamics of the muscular system and neuromuscular synchronization in kinetic synergist and antagonist chains precisely regulated for all functions makes it possible to gain a more profound understanding of the passive elements in the movement apparatus (ligaments, tendons, cartilege and bones). In complex three-dimensional tension band systems there are fixed points, moments of static loading and dynamic movement with pressure, traction and relatively force-free nodal points.

In the context of this *relative movement model*, it is no longer “pain points” or local stress areas that are the focus of our attention, but instead the passive elements that hold back the actors in their impulse to move.

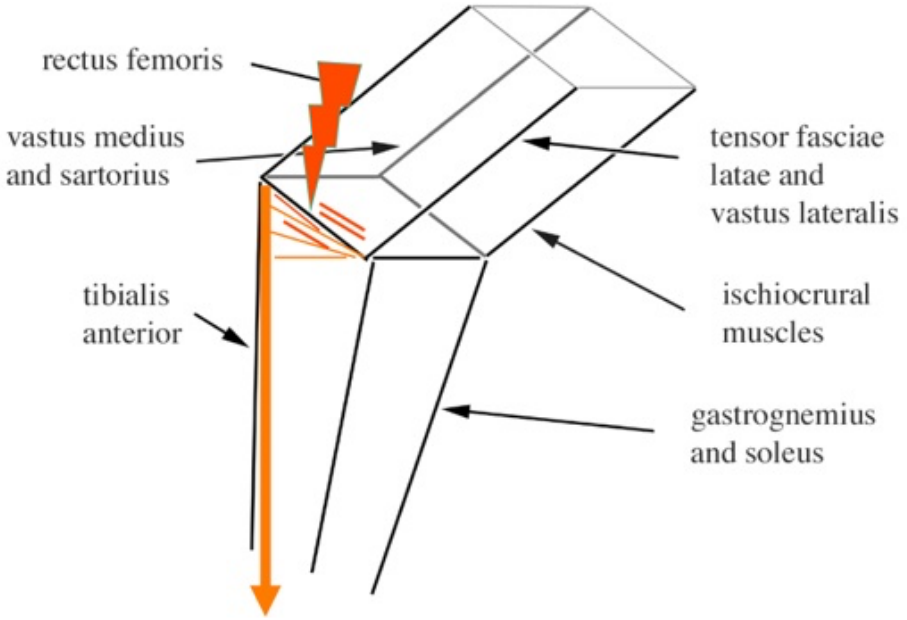
This concept will be presented here in simplified form using the example of the knee joint.



Knie 7Mai15

The framework, dynamics and every activity within the three-dimensional vector analysis of the thigh and the knee joint are all highly dependent on the position of the pelvis, the iliosacral joint and the lumbar spine.

When there are changes in the relative length of the active muscle fibers (raM), relative shorening or elevated resting tone of the iliopsoas muscle system in its over-trained middle working range, then all vectors of the lower extremity and their relative angles are altered. Stereotypically over-trained abdominal muscles together with rectus femoris sections of the quadriceps muscles that are relatively over-trained in their middle working range synergistically lead to an escalation and overt manifestion of these vector and angle alterations in muscle origins and insertions. These functional changes also affect the ligaments and the tendon apparatus and have a structural impact on the meniscus, the cartilege, and the joint. Sections of the iliopsoas muscle that are not optimally trained and restricted thus have a direct impact on the rectus femoris muscle — with nodal points at the anterior inferioar iliac spine (groin) or the upper (rectus insertion) or inferior (patellar ligament) pole of the patella.



Knie schlecht 7Mai15

Even when considered only from the perspective of the direct kinetic chain, the problematics of patellar tendinitis (jumper's knee) and weakness in the anterior cruciate ligament can be seen to be located not in the patellar pole but can be calculated back to the anterior inferior iliac spine or the iliopsoas muscle.

The passive element of this chain that is responsible for the release of ventral activity is thus the ischiocrural muscles. Relatively restricted ischiocrural muscles functioning as "brake levers" can be sensed as a signal in the active element, that is, in the location where tension should occur.

The stereotypical presentation of problems in the ischiocrural group, which is frequently less adequately trained in professional soccer players than the quadriceps muscles, can be manifested in the control of the medial meniscus as meniscus signs, as medial knee pain or may be expressed antagonistically in the area of the patella and the rectus femoris muscle.

Even alterations in a single vector lead to asymmetries, changes in angles, and to high stress points in the entire force parallelogram and in the passive portions of the meniscus system, the anterior and posterior cruciate ligaments and cartilege. Loss of symmetry of tone and disturbances in the geometry of movement then lead to deficits in the economy of motion, dexterity, agility, speed, strength and performance capacity.

The tensor fasciae latae muscle is an important physiological synergist of the rectus femoris muscle. The angular changes in the pelvis described earlier, accompanied by restrictions in the iliopsoas muscle, can lead to a reversal of function in the tensor fasciae latae muscle. Either directly or indirectly by means of shortened portions of the tensor muscle at the lateral anterior superior iliac spine, this vector can lead to lateral pain in the knee joint, patellar movement disorders (lateral displacement) or to pseudo hip pain. Because of the change in angle, many fibers of the tensor fasciae latae muscle now work as flexors in the knee joint. In extreme cases, this alone can lead to extension lags in the knee joint of up to 18°.

Groups of fibers in this muscle actually end up working against each other as their own antagonists. Very clearly, the causes of this symptom are not located in the spot where it hurts, but in the asymmetrical geometry of movement—in the passive element. Through activities of the passive element, changes in the tensor fasciae latae muscle may sometimes show up in the medial knee joint, in the control of the medial meniscus (the semimembranous muscle) or in the adductors. Thus, pain, muscle strains, irritation, inflammation, and insertional tendinopathies of the adductor system may not be primarily caused by the adductors themselves, but instead by the tensor muscle, its iliotibial tract and the iliopsoas muscle.

Acute and chronic sports injuries, muscle strains, inflammation and insertional tendinopathies most often do not require treatment directly where the symptoms are located. The classical strategy of orthopedics sports medicine, which is to treat the problem at the site of symptoms, to place the site at rest, obtain radiographs, use anti-inflammatory injections and perform operative interventions (discissions, surgical notching) frequently prove inadequate as therapeutic methods. Degeneration and sports injuries such as ruptures, ligament tears, and meniscus lesions are thus first and foremost the consequences of misunderstanding the nature of the problem and using short-sighted local interventions. As a rule, local therapy for the weakest member of a chain in the presence of an excessively short leverage arm ends up causing excessive stress and overstimulation.

In the best case, signal symptoms may be suppressed, concealed or disguised. The result is the development of asymmetrical restrictions of the musculature, damage to the running economy and strength capacity as well as deficits in all areas of regeneration. Recurrent, degenerative damage and more serious injuries resulting from even small force impacts, sometimes seeming to appear from nowhere, are the logical consequences of these persistent asymmetries.

Pulled muscles, tears, and damage in the domain of muscles, tendons, cartilage and bones frequently take place on the basis of non-local alterations. Unidimensional considerations of reduced biomechanics (see Bauman 1989), such as shin-ankle-foot calculations, analyses of individual properties, measurement of the visco-elasticity of a tendon, measurement of local metabolism) are not sufficient to meet the needs of professional soccer players. Theories that focus on local pathological changes to conceptualize etiology, pathogenesis and treatment planning are frequently reductionistic to an extent that is hard to believe. As a result, chronic sports injuries in particular have often remained unexplained until now. Thus, apophyseal tears in the rectus femoris muscle or the ischiocrural muscle in professional soccer players are not instances of simple structural overload, but instead the consequences of dysfunctional biomechanics.

Injury prevention

“I visited Hoffenheim on one of those days when the training area next to the gas station at the entrance was once again transformed into an international pilgrimage destination…Dr. Mosetter from Bodensee happened to be the guest of the physiotherapists. While the myoreflexology specialist was hanging out around defenseman Andreas Beck, he explained that many professional soccer players lost speed simply on the basis of incorrect body posture and at the same time, became more injury-prone.” (Christoph Biermann. Die Fußball-Matrix - Auf der Suche nach dem perfekten Spiel. [The Football Matrix: the quest for perfect play])

The most important preventive measure is optimal biokinematic training.

Besides classical sports medicine examinations, this also includes “point of weakness analyses” —not merely with regard to structural functions but also for vector analyses of the geometry of movement.

Therefore, based upon the specific nature of the sport as well as attention to the individual’s point of weakness, strength training must be directed at the weakest link, the passive element, the direct and indirect anatagonist, and must improve its strength.

These measures not only promote injury prevention, but also optimize performance. Besides the running economy, this affects all strength capacities, both aerobic performance capacity and capacity for recovery. On the ground power reaction capacity, maximal velocity of contraction and relaxation half-life can all be improved significantly in this way.

Thus, just the extensors and the quadriceps muscle all by themselves are not sufficient for sprints and running speed during the first 10 meters.

Starting from preparatory activation of all involved joints in a fixed position, connected to a certain degree of pre-stretching of the extensor muscles of the back (for both crouched and running starts), entire groups of muscles are preactivated.

The sudden explosive contraction of the extensor system involves the synchronous contraction of back extensors all the way to the occiput. Not only the flexors of the upper thigh and the ischiocrural musculature, but also the calf musculature and the flexors of the trunk, the iliopsoas muscle and the abdominal muscular system must all “unleash the explosion” together during this process.

Constriction of these muscle groups and loops has the effect of limiting the passive element and thus “braking” acceleration and contraction. At the same time, it alters the body’s center of gravity (in the area of the sternum) away from its ideal position. With regard to this parameter of the dynamic vector calculation, a number of muscles play important collaborative roles, including the chest muscles (the pectoralis major and minor), the serratus anterior muscle, the insertions of the rectus femoris muscle up to the 5th intercostal space, the fibers of the internal abdominal oblique muscle to the lower costal arch and the diaphragm. Assymetries and constrictions along with single-sided overtraining of the chest and abdminal muscles thus restrict both overall acceleration, the acceleration of the body’s center of gravity, maximal velocity, the targeted velocity of contraction as well as “slackness” due to alterations in the overall vector networks.

Dysfunctional neuromuscular tensions in the area of the antlanto-axial joints and the cervico-thoracic insertions (especially through the scalene muscles) also enter into the vector equation, as if by a secondary neurogenic innervation substrate with inhibition of the phrenic nerve and its controlling function for the diaphragm.

Not least, the collatoral movements of the arms (in terms of their looseness and capacity for relative take-off movements) also have an impact on aspects of performance optimization with acceleration, speed, and maximal velocity potentiality. Asymmetric hypertonicity and stiffness without elasticity shut have a restraining effect upon all elements of performance. Sprinting speed, the capacity for repetitive sprints, initial acceleration and sprint-to-stop capability thus turn out to be dependent variables upon a multi-dimensional asymmetry of tone in a three-dimensional vector network.

Muscular Dynamics of Goal Shots

Goal shots involve very high tensile loads, pressure loads and twisting loads for the knee joint in the supporting leg.

In this position, the entire vector equation of the muscular system is required to provide the supporting leg with stability, support, traction and equilibrium functions, and at the same time to provide the active leg with mobility, acceleration and maximal dynamic activation. In the trunk, there are activities in lateral inclination with simultaneous rotation of the trunk.

Some of the important kinetic chains and their muscle loops should be specified at this point:

1. Levator scapulae muscle – serratus anterior muscle– internal oblique muscle, pubic intersection (with the rectus abdominis) – supporting leg adductors– peroneus longus muscle, biceps brachii muscle on the side of the supporting leg.
2. Pectoralis major and minor muscles – internal abdominal oblique muscle– tensor fasciae latae muscles – gluteus medius muscle in the active leg–anterior tibialis muscle–levator scapulae muscle.
3. Triceps muscle – Serratus anterior on the supporting leg side–external abdominal oblique muscle – junction of the pubic bone with the rectus abdominis muscle– adductors in the active leg– peroneus longus muscle
4. Extensor hallucis longus muscle – extensor digitorum longus muscle – tibialis anterior muscle – rectus femoris muscle – rectus abdominis muscle –sternocleidomastoid muscle
5. Trunk rotation in the direction of the internal oblique muscle – internal abdominal oblique muscle – rectus sheath
6. Passive element of the active leg: plantaris muscle – Achilles tendon – gastrocnemius muscle –biceps femoris and semimebranous muscles – gluteus maximus muscle – iliocostal muscle – erector spinae muscle (contralateral) – semispinalis muscle – splenius cervicis muscle
7. Passive element of the supporting leg: Tibialis posterior and soleus muscles – tensor fasciae latae muscle – internal abdominal oblique muscle – quadratus lumborum muscle –latissimus dorsi muscle (contralateral) – biceps brachii muscle – flexor carpi ulnaris and radialis muscles.

The contractile power of each individual component along with the synergistic activity of individual parts of the kinetic chain as well as the stretch capacity and relaxation qualities of the immediate antagonists and the antagonist chain are all critical for smooth coordination in dynamically synchronized movement sequences. Super-fast anticipatory synchronization is made possible in this way, and can be summoned at will; it guarantees exceptional performance.

Besides the principal vectors that have been described, this beautifully exemplifies the individual anatomical vector chains, organized in such an amazing way in the abdominal muscle system and its connections with the serratus anterior muscle.

Groin pain

Chronic groin problems are among the most common of soccer injuries. The symptom of groin pain can be caused by a number of different pathologies in this setting. Besides insertional tendinopathies caused by strains in the musculature that inserts in the pubic bone (the pectineus, adductor longus, gracilis, and the rectus abdominis muscles), the most commonly occurring factors in the genesis of groin pain are hernias, urological abnormalities, neurological causes, ailments affecting the pelvic ring and the hips, and more rarely, tumors or lymph node abnormalities. These must be elucidated by means of a process of differential diagnosis.

The groin region is the site of insertion for the powerful muscle groups of the iliopsoas, the rectus abdominis, and the abdominal oblique muscles (both internal and external), the adductor muscles, etc., which are all placed under great strain in soccer and transmit high moments of force to the hips. At the same time, the area of the groin represents a soft, sensitive structure, which serves as a passageway through its fascial openings for blood vessels, nerves and the spermatic cord in men. Since this complicated structure so often goes out of whack in intense athletic activity, the groin region is often described as an anatomical point of vulnerability.

Once complex pain syndromes are considered from the perspective of biomechanical vector equations and one undertakes a precise analysis of the synergistic and antagonistic force vectors, causally based rational therapy for persistent pain syndromes becomes feasible. Very often, *earlier injuries discovered from the biographical history provide guidance* for understanding current symptom presentations. Hidden compensatory postures and injury-specific forms of compensation may thereby result in individual points of vulnerability dependent upon a person's personal history; and these points may well be located in a *totally different place*. New injuries very frequently must be understood as the result of decompensation in a vector model that was already slightly constrained in its flexibility.

Groin pain, muscle cramps in the muscular systems of the groin, insertional tendinopathies, elements of "athletic pubalgia," (also known as "sports hernia") inflammation in the groin area and functionally relevant points of weakness in the vector network along with hernias may thus be clearly and fundamentally understood according to the laws of clinical anatomy and through the biokinematics of vector equations. From an understanding of the clinical anatomy, it is possible to directly infer an entire range of vector candidates for each particular problem.

I. Active Element

1. Iliopsoas muscle – in the course of its passage under the inguinal ligament to the lesser trochanter (see figure above)
2. Pectineus and adductor brevis muscles (pubic ridge) – pubic tubercle – lesser trochanter
3. Internal oblique abdominal muscle (intermediate zone of the iliac crest and lateral inguinal ligament) – anterior superios iliac spine– inguinal ligament – cremaster muscle

4. External oblique abdominal muscle– linea alba of the aponeurosis – inguinal ligament – pubic tubercle
5. Transverse abdominal muscle– aponeurosis – cremaster muscle – tuberculum
   ↓
   Internal abdominal oblique muscle
6. Rectus femoris muscle (anterior inferior iliac spine)

(Mosetter and Mosetter 2006)

II. Passive Element

1. Tensor fasciae latae muscle
2. Gluteus medius muscle
3. Gluteus maximus muscle
4. Quadratus lumborum muscle
5. Piriformis muscle and internal obdurator muscle
6. Ischiocrural musculature
7. Contralateral abdominal muscle group
8. Contralateral shoulder girdle

Differential analysis

1. The specific muscle vectors responsible for the symptoms in each individual case must be analyzed precisely.
2. Optical determination of postural patterns
3. Manual functional orthopedic examination
4. Palpation
5. Precise historical review regarding the initial occurrence of the symptoms (associated with which function, with which movement sequence)
6. Analysis of the principal individual passive element
7. Association of pain intensification with specific functions
8. Vector analysis of the prior history, pain, relieving posture — compensation

Specific Biokinematics in “athletic pubalgia”

Groin pain and “athletic pubalgia” are very common symptom complexes diagnosed in professional soccer players whose causes are difficult to pinpoint. From the viewpoint of classical therapeutic strategies, one must ask how it could be that apparently well trained young athletes should have such a tendency to develop this condition. In the tension band model of biokinematics, all “weaknesses” or “gaps” are at the same time associated with contracted, tense fiber lines. This understanding leads to new solution strategies based upon clinical anatomic pathways.

From the perspective of physics and biokinematics, there are three-dimensional vector systems throughout the body. The anatomical and functional-kinematic architecture of the groin and its vector model are the basis for understanding a broad range of symptomatology, including groin pain, “athletic pubalgia,” and groin hernias. Wall structures composed of tension band systems along with physiological openings play an important part in the conception of potential new ideas for treatment.

Together with the fiber insertions of the transverse abdominal muscles, the internal abdominal oblique muscle forms the roof of the inguinal canal. In this process, the abdominal oblique muscle releases fibers for the formation of the cremaster muscle in the spermatic cord. The anterior wall is formed by the aponeurosis of the external abdominal oblique muscle and the superficial abdominal fascia. At the same time, these belt components also form the inguinal ligament with their cranial portion and delimit the external (superficial) inguinal ring. Besides a portion of the external aponeurosis, the tight interweaving with the fascia lata of the upper thigh helps to create the structure of the caudal floor. The dorsal wall structures are formed by the tight interweaving of the transversus abdominis muscle, the fascia transversalis with its invagination in the inguinal canal, the interfoveolar ligament and the peritoneum.

“The aponeuroses of the lateral abdominal muscles surround the anterior straight abdominal muscles like a quiver on both sides and, together with the fascia of the abdominal wall, form the rectus sheath. The muscle compartment constituted in this manner includes an anterior and a posterior leaf (lamina anterior and posterior). While above the navel, the aponeuroses of the lateral abdominal muscles take part equally in the formation of the lamina anterior and posterior, both leaves combine together about 3-5 cm below the navel (at the level of the linea arcuata) into a single (and thus stable) leaf, which pulls in front of and along the rectus abdominis muscle. Below the linea arcuata, the posterior leaf of the rectus sheath is thus formed only by the fascia transversalis and the peritoneum.”

(Schünke et al. 2005)

The Differential Diagnosis of Groin Hernias

a.) The anatomical point of weakness is Hesselbach’s triangle–the hernial gap for direct inguinal hernias. It is situated under the epigastric vessels and medial to the inguinal ligament.

b.) The inguinal canal represents a second point of weakness for “ruptures” within the abdominal wall.

c.) The internal inguinal ring above the inguinal ligament and lateral to the epigastric vessels represents the weakest anatomic point for indirect, lateral inguinal hernias.

d.) Femoral hernias run along their internal hernial path below the inguinal ligament through the lacuna vasorum. The description of more specific details will be omitted in this kinematic and sports-related dynamic vector consideration (details in Schünke et al. 2005, p. 182-191.).

e.) Extremely rarely, dorsal inguinal hernias penetrate through the muscular transitional zones between the quadratus lumborum muscle and the dorsal portion of the internal oblique muscle.

f.) Occasionally, and especially in women after pregnancy or surgery, residual scarring situations may also develop into umbilical hernias.

Managing points of weakness

For myoreflexology, the relevant function-dependent and training-dependent points of weakness along with their treatment are defined as disturbed or asymmetrical vector equations with angular deviations within a three-dimensional parallelogram. Therefore, every point of weakness or relatively unstable gap is coupled with horizontal tensed connecting bands within the muscular vector model. Muscles in the middle working range of the ventral abdominal musculature that are relatively over-trained on a chronic basis become shortened, leading to excessively high power peaks at specific levels and ventral restriction. At other levels of possible strain, rotational levels and muscle vectors crossing horizontally at a 90° angle thereby experience relative weaknesses in their function.

For treatment of the groin, the external oblique muscle represents the first priority. Laterally, at the insertion of the aponeurosis of this muscular system into the pubic bone and above it, the fibers diverge and thus contribute to the formation of the gap in the external inguinal canal, the superficial inguinal ring.

The internal abdominal oblique muscles create both the rectus sheath and are interwoven with the aponeurosis of the external abdominal oblique muscle, and likewise with the transversus abdominis muscle. The latter radiates at the same time with the upper portions in the posterior wall of the rectus sheath, with the lower portions in the internal abdominal oblique muscle and with the anterior leaf in the anterior portion of the internal abdominal oblique muscle.

The outer groin, the inguinal ligament and the inner groin are thus interwoven into an ingenious elastic dynamic tensed belt system. The many layers of this vector network guarantee its stability, elasticity and seamlessly close all gaps. Stability and dynamism are not maintained by the individual parameters of the individual properties themselves, but instead achieved by means of the multiple layers of the tensed belt system. Soft, hard, strong or weak all depend directly upon the physically balanced conditions of the geometry of movement with its muscle vectors.

Under asymmetrical conditions, with relative shortening and corresponding angular changes, points of weakness arise along with “soft gaps.” In particular, the shortening and stiffening of a portion of the muscle vector system inevitably leads to corresponding soft points of weakness.

In particular, stereotypical abdominal muscle training in the middle working range thus leads to relative weakness outside the middle movement range in interfaces and transitional zones in contact with the muscles, tendons, aponeuroses and the periosteum. Similar to the way that elastic-dynamic sealing rings securely seal, while hardened, inelastic materials lead to leakage, over-trained, stiff muscular systems inevitably lead to points of weakness.

Under the great stresses that occur in professional soccer, it is precisely at the points of particular weakness and in the nodal points that pain, strains, tears and ultimately recurrent symptom and injury complexes arise.

It is possible to very clearly conclude at this point that it is frequently not the “structural point of weakness” itself that is responsible for the problems. Much more often, in its biokinematic “retrospective calculations,” the clinical anatomical perspective

leads back to the therapy-relevant key points derived from each individual athlete's biography of movement.