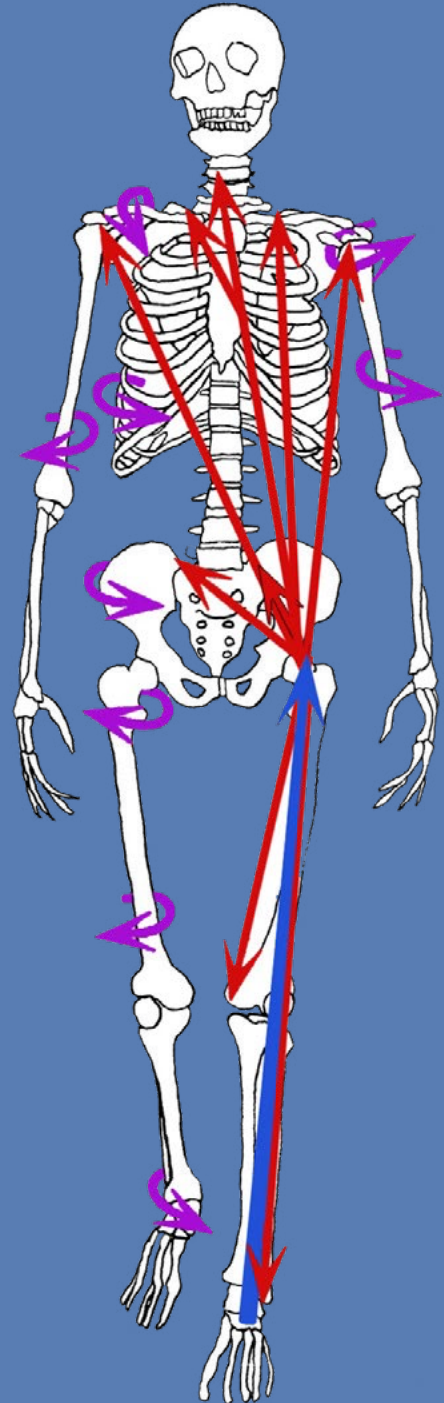


Neural Logic: The Strategies of Adaptation

Don Cohen, DC



If it na go so, it go near so.

—*Jamaican proverb*

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Preface

Much of this book has been compiled from notes I made to myself over the years as I observed how things seemed to work in practice. Observations in the clinical setting have come first, and it has been encouraging to find, as I went back to the books, that there was frequent validation from anatomists and researchers who knew the often microscopic details.

As a chiropractor, I was confused with the clinical approach of my training, which involved repeating the same procedure repeatedly. I needed things to make sense. My constant thought was that there is always a logical mechanism going on; our first job is to try to understand the behavior before us from the managing point of view of the organism.

When I first went into practice in 1982, I was immediately confronted with a confusion about the chiropractic model. The Chiropractic understanding is that a functional (not anatomical) short leg indicates a rotated pelvis. The solution is to adjust the pelvis, which in many cases restores the leg length to equal. But frequently on the next visit, the same leg is short again. The solution is to again adjust the pelvis. Again and again.

Why, when the pelvis was restored to a normal state, did it return to the previous state? Is this intelligent behavior, as chiropractic teaches, or is it clueless behavior, as chiropractic also seems to teach, needing to be reminded again and again of the same need to unrotate the pelvis? What if the organism is choosing to rotate the pelvis for a good reason, for example to avoid, as best it can, a repetitive shock to the hip? In this case, are we helping or frustrating the organism by returning the pelvis back into the shock conflict against its better judgment?

And yet, chiropractic holds to the understanding that the organism has innate intelligence, that “the power that made the body heals the body.” It focuses on the primary role of the nervous system in facilitating internal communication. This seemed like common sense, something better understood than ignored.

Patients come to us because they are in pain, always earnest in the hope that we can relieve their pain, hopefully today, and permanently.

My intention is to address both the professional and the patient in a single volume. Many of the concepts discussed are simple and obvious. Sometimes so simple and obvious that it can almost seem absurd to point them out. But it seems to me that much of the simple and obvious are somehow being missed. The most common comment I hear from patients when I describe this model is “That makes sense.”

Name _____

Date _____

	R	L	B		R	L	B		R	L	B
Straight Leg Raise				Thoracic Rotatores				Iliofemoral Ligament			
Vastus Lateralis				Thoracic Multifidus				Ischiofemoral Ligament			
Vastus Intermedius				Semispinalis Thoracis				Zona Orbicularis			
Vastus Medialis				Thoracic Inter/Suprasp Ligaments				Ligamentum Teres			
Rectus Femoris				Lumbar Inter/Suprasp Ligaments				Quadratus Femoris			
Anterior Gluteus Medius				Iliocostalis Lumborum							
Tensor Fascia Lata				Iliocostalis Thoracis							
Gluteus Medius				Spinalis Thoracis				Posterior Tibial-Fibular Ligament			
Gluteus Minimus				Longissimus Thoracis				Tibialis Posterior			
Psoas				Lumbar Multifidus				Plantaris			
Iliacus				Lumbar Rotatores				Soleus			
Psoas, Diaphragmatic				Lumbar Intertransversarii				Gastrocnemius, Lateral Head			
Iliopsoas Tendon				Quadratus Lumborum				Gastrocnemius, Medial Head			
Inguinal Ligament				Lumbosacral Multifidus/Sacral Lig				Tendo Calcaneus			
Iliopectineal Arch				Thoracolumbar Aponeurosis				Achilles Tendon			
Pubofemoral Ligament				Lower Costal Unit				Peroneus Longus			
								Peroneus Brevis			
				Posterior Sacroiliac Ligaments				Peroneus Tertius			
				Anterior Sacroiliac Ligaments				Calcaneotibial ligament			
Patellar Retinaculum Medial				Interosseous Sacroiliac Ligament				Calcaneofibular ligament			
Patellar Retinaculum Lateral				Oblique Sacroiliac Ligament							
Transverse Ligament of the Knee				Sacral Interspinous Ligaments							
Anterolateral Ligament of Knee				Coccygeoiliac Ligament				Bifurcate Ligament			
Tibial Collateral Ligament				Lumboiliac Ligament				Inteross. Talocalcaneal Ligament			
Fibular Collateral Ligament								Deltoid Ligaments			
Patellar Ligaments 1 2 3 4				Iliolumbar Ligament				Lisfranc Ligament			
Anterior Tibial Fibular Membrane				Lumbocostal Ligament				Plantar Calcaneonavicular Ligament			
Anterior Tibial Fibular Ligament				Iliotibial Band				Plantar Calcaneocuboid Ligament			
				Posterior Gluteus Medius/Minimus				Quadratus Plantae Medial			
				Quadratus Femoris				Quadratus Plantae Lateral			
				Gluteus Maximus				Flexor Digitorum Longus			
Piriformis Rotation				Piriformis				Flexor Hallicus Longus			
Pectineus				Internal Obturator				Flexor Digitorum Brevis			
Quadratus Femoris				Superior Gemellus				Flexor Hallicus Brevis			
Sartorius				Inferior Gemellus				Abductor Hallicus			
Gracilis				External Obturator				Adductor Hallicus, Transverse			
Pes Anserine				Sacroteruberous Ligament				Adductor Hallicus, Oblique			
Popliteus				Sacrospinous Ligament				Long Hallicus Ligament			
				Sacrococcygeal Ligament				Long Plantar Ligament			
				Iliococcygeus				Flexor digiti minimi			
								Abductor digiti minimi			
Extensor Digitorum Longus				Biceps Femoris, Long Head				Opponens Digiti Minimi			
Tibialis Anterior				Biceps Femoris, Short Head							
Tibiotalar Capsule				Semitendinosus							
Tibionavicular Ligament				Semimembranosis							
Talofibular Ligament				Hamstring Central Tendon				Transverse Abdominals			
Calcaneofibular Ligament				Adductor Magnus				Rectus Abdominus			
Calcaneotibial Ligament				Adductor Longus				Internal Oblique Abdominals			
Plantar Calc.Nav/Spring Ligament				Adductor Brevis				External Oblique Abdominals			
Extensor Hallucis Longus				Adductor Minimus				Posterior Abdominal Oblique			
Extensor Digitorum Brevis				Popliteus				Anterior Intercostals			
Extensor Hallucis Brevis				Oblique Popliteal Ligament				Posterior Intercostals			
Superior Lisfranc Ligament				Arcuate Popliteal Ligament				Transversus Thoracis			
				Popliteal Femoral Ligament				Serratus Anterior			
				Post. Meniscofemoral Lig				Latissimus Dorsi			
				Menscal Lig (Root) M L				Superior Transverse Scapular Lig			
				Anterior Cruciate Ligament				Inferior Transverse Scapular Lig			
				Posterior Cruciate Ligament							

Illustration: A neuromuscular bitmap examination form. The form is organized by body position and neurologic hierarchy. The left column of above lists the supine lower body muscles, major ligaments and fasciae. The middle column lists the posterior torso, pelvic and lower limb structures, continuing in the right column. The lower right column lists the anterior torso structures.

The grid to the immediate right of the muscle names shows check boxes for right, left and bilateral failure. The bilateral column is important as bilateral dysfunction often indicates a behavior differentiated from unilateral failure.

Each muscle or ligament will show no checks (bilateral locking), one check (unilateral failure), or three checks (bilateral failure). In this way the chart is easily scanned for unilateral and bilateral patterns of dysfunction.

Name _____

Date _____

	R	L	B		R	L	B		R	L	B
Coracobrachialis				Rib 1 Ligaments				Longus Colli			
Supraspinatus				Acromioclavicular Ligament				Longus Capitus			
Deltoid, Clavicular				Sternoclavicular Ligament				Cervical Intertransversarii			
Deltoid, A/C				Acromiohumeral Ligament				Scalene, Anterior			
Deltoid, Scapular				Coracoacromial Ligament				Scalene, Middle			
Teres Major				Coracohumeral Ligament				Scalene, Posterior			
Biceps Long Head				Coracoclavicular Ligaments				Sternocleidomastoid			
Biceps Short Head				Costoclavicular Ligament				Levator Scapula, Anterior			
Bicipital Aponeurosis				Sternocostal Ligaments				Upper Trapezius, Clavicular			
Lattissimus Dorsi				Glenohumeral Ligaments, Anterior				Upper Trapezius, Scapular			
Serratus Magnus				Axillary Pouch				Sternothyroid			
Serratus Axillary								Sternohyoid			
Pectoralis Major, Abd/Ribs								Omohyoid			
Pectoralis Major, Sternum				Costotransverse Ligaments				Stylohyoid			
Pectoralis Major, Clavicular				Levatores Costarum				Stylomandibular Ligament			
Pectoralis Minor				Rhomboid Major				Stylopharyngeal Ligament			
Subclavius				Rhomboid Minor				Sphenomandibular Ligament			
				Supraspinatus				Genioglossus			
Brachialis				Subspinous				Mylohyoid			
Brachioradialis				Infraspinatus				Hyoglossus			
Teres Minor				Teres Major				Digastricus			
Subscapularis				Triceps, Long Head				Rectus Capitus Anterior			
Infraspinatus				Triceps, Medial Head				Rectus Capitus Lateralis			
Rotator cuff				Triceps, Lateral Head							
Triceps Extensor				Glenohumeral Ligament, Posterior							
Anconeus				Shoulder Capsule, Posterior				Splenius Cervicus			
								Splenius Capitus			
Ulnar Collateral Ligament								Semispinalis Cervicus			
Radial Annular Ligament								Semispinalis Capitus			
Radial Collateral Ligament								Longissimus Cervicus			
Quadrante Ligament								Longissimus Capitus			
Supinator								Iliocostalis Cervicus			
Pronator Teres								Levator Scapula			
Pronator Quadratus								Rectus Capitus Posterior Minor			
Flexor Retinaculum								Rectus Capitus Posterior Major			
Radial-Ulnar Membrane								Obliquus Capitus, Superior			
								Obliquus Capitus, Inferior			
Extensor Carpi Radialis Longus								Cervical Rotatores			
Extensor Carpi Radialis Brevis				Serratus Posterior, Superior				Cervical Intertransversarii			
Extensor Indices				Serratus Posterior, Inferior				Occipitalis			
Extensor Digitorum				Trapezius, Ascending							
Extensor Pollicus Longus				Trapezius, Horizontal							
Extensor Pollicus Brevis				Trapezius, Supraspinous							
Extensor Carpi Ulnaris				Trapezius, Scapular Enthesis				Temporalis			
Radial Capitate Ligament								Temporoparietalis			
Radial-Triquetral Ligament								Anterior Auricular			
Flexor Carpi Radialis				Lattissimus Dorsi/Lumbar Fascia				Superior Auricular			
Flexor Palmaris Longus				Longissimus Thoracis, Superior				Posterior Auricular			
Flexor Carpi Ulnaris				Spinalis Thoracis				Occipitofrontalis			
Flexor Digiti Minimi				Iliocostalis Thoracis				Frontalis			
Opponens Digiti Minimi								Occipitalis			
Palmar Flexor Tendons											
Interosseous Palmar											
Interosseous Dorsal											
Opponens Pollicis											
Pollicus Muscles 1 - 8											
Pollicus Ligaments											

Page two of the neuromuscular bitmap form. The left column lists the upper limb from the shoulder down the arm to the wrists and hands. The middle column shows the shoulder ligaments and posterior torso muscles. The right column lists the cervical muscles supine and prone; beneath are cranial muscles.

Introduction

While there is no singular explanation of why we hurt, there are fundamental principles that underlie our everyday function and its failure. It is the intention of this work to suggest a lens, a logical framework through which we can understand the phenomenon of physical pain and degeneration in a concise, organized way. There is always a dynamic at play, a consequence of circumstances and events that have led to the current state. Understanding the dynamic is essential for understanding the outcome.

Underlying many common cases of chronic musculoskeletal pain and degeneration is a failure to stabilize, an inability to respond adequately in the face of innumerable events and demands over the course of a life, some of them beyond recall. There is a direct relationship between the failure to stabilize and pain and arthritic deterioration.

An understanding of how the organism stabilizes itself provides a basis for understanding how stabilization fails, and the relationship of this failure to many musculoskeletal complaints, both acute and chronic. The details of failure are the mirror of those of stabilization.

The loss of stabilization can arise from several factors. With the exception of anatomical anomaly, it is commonly due to a history of trauma, including physical injury and microtrauma, and the subsequent process of adaptation, in which we reorganize our neuromuscular configuration in order to solve the problem of continuing to maintain function in the face of adversity to that function. This is also true in the presence of anatomical anomaly.

Adaptations operate imperceptibly, serving our will in the moment, unreflective in the same way that the eye cannot see itself. They are behaviors that become woven into the operating system, in time becoming the operating system.

The adaptive process is cumulative, and over time can come to resemble a tangle of knots, a hierarchical layering of behavioral strategies that we've acquired in response to the incidents and demands encountered over the course of a lifetime. Eventually the adaptations themselves can become part of the problem.

I've not found an adequate universal model of stabilization in the medical literature. It was striking when I first went into practice that despite our long hours studying anatomy and neurologic function in intimate detail, when we arrived at clinical training and practice the information was, for the most part, not referred to much at all. This seems to be true of much medical practice.

We have to be able to hold ourselves together, mass times impulse (motion) under load, and when we can't do this, there is collapse. Collapse can seem sudden, but it is often incremental until a final breakdown. Before considering the myriad aspects of this simple dilemma, it's helpful to define some basic physiologic principles.

There are three primary provisions of stabilization of the physical body in space, in motion and under load. The first is anatomical integrity - the absence of congenital or acquired anomaly. Ideally the skeleton will be intact and symmetrical, each joint fully allowing specific motions while at the same time restricting certain motions. All of the non-osseous support structures need to be present, intact, and properly poised. Structural anomaly can present a lifetime challenge with some degree of permanent impediment. In these cases it is nonetheless beneficial to provide optimal functional efficiency to whatever degree is possible.

The second and third provisions of stabilization are the stabilizing (antagonist) function of muscles, and that of the elastic tissues, especially ligaments, fasciae and other fibroelastic tissues such as joint capsules.

The neuromuscular stabilization of the organism is a dynamic, selective, behavioral process, mediated by proprioceptive feedback mechanisms, and expressing itself through a binary configuration of facilitation and inhibition in the assignment of the reciprocal functions of agonist and antagonist behavior.

Muscles are the most active component of stabilization and have the distinct function of providing both mobility and stability from the same structures. They do this by role playing, utilizing the same physical tissue to provide both mobilization and stabilization as needed.

Mobilization and stabilization correspond to motor and sensory circuits (proprioception), each phase of function utilizing distinct neural pathways. The basis of neuromuscular stabilization - antagonist function – is dependent on the integrity of each proprioceptive-gamma (γ) motor loop.

While there is an obvious relationship between the motor and sensory functions, it is difficult to optimally adjust the behavior of the proprioceptive circuits by motor activities directed at improving strength and stamina because in many cases the primary failure is not a failure of strength but of neurologic poise and timing.

The issue is neither one of weakness or hypertonicity but is rather a complication of a neurologic behavioral phenomenon — the ability to reassign antagonist function based on the organism's perception of need and availability in the moment. Adaptations are a kind of neurologic loan, and like compounded interest on a loan, the burden tends to increase in magnitude as time goes on.

In both acute and chronic situations, the primary problem of failure often lies in proprioceptive function - the precise neurologic awareness of the body in space. If we can't accurately locate a structure, we won't be able to utilize it efficiently, especially as a stabilizer. Stabilization is acuity-dependent.

In the absence of anomaly or frank pathology the natural first order of inquiry is to examine the integrity of each specific stabilizing component, including the joints, and especially of the neural feedback mechanisms of the muscles, ligaments, and fasciae, observing their dynamic relationships in the strategizing behavior of the organism.

By examining the functional status of each joint, and the neurofunctional status of each muscle, ligament, and fascia, it is possible to ascertain the dysfunction underlying many complaints of musculoskeletal pain and degeneration. Contemporary medical protocol has largely replaced skilled physical examination with tests. An image, a blood test or a nerve-conduction study might assist in the determination of pathological changes, but they reveal little of the relationship of function and dysfunction, and rarely indicate a resolute, individualized course of action.

Competent anatomic examination can provide a wealth of useful data, which if regarded in the right way will often indicate the underlying cause not only of the symptomatology before us, but also something of the symptomatology to come. It is a most efficient as well as economical portal. The exam seeks to determine two fundamental facts: first, are there muscles, ligaments, fasciae or other connective tissue components that are failing to provide adequate stabilization to a joint, and secondly, how can these stabilizing structures be restored to their normal function?

There are multiple contributions to the failure of stabilization, and they invariably behave according to principles. Each anatomical structure needs to be able to hold its place. If it can't hold its place, it is a weak link and a site of potential failure. This work proposes the application of common sense to common syndromes.

The concepts presented here comprise a theoretical model derived from empirical observation in clinical practice as well as the evaluation of objective and subjective data culled from examination-based treatment of several thousand patients. Their application requires a never-ending and ever-detailed study of anatomy, and an ongoing curiosity about the logic of what is going on. In the clinical setting these principles have proven to be reliable, reproducible, and effective. Clinical practice is an ideal laboratory as each patient arrives at their complaint by a unique, individual path.

In summation

1. Underlying most common musculoskeletal pain and degeneration is a failure to stabilize the body.
2. In the absence of morphological anomaly, the primary stabilization of the body is provided by the stabilizing (antagonist) function of muscles, fasciae, ligaments and associated elastic tissues, which is distinct from mobilizing (agonist) function. In their antagonist function muscles utilize discreet neurologic pathways and exhibit distinct contractile functions, specifically by a combination of locking and eccentric contraction in response to motion and loading.
3. Structural adaptation is strategic neurologic behavior that by its nature can obscure the relationship between cause and effect and tends to favor short-term (proximate) benefit at the expense of long-term (ultimate) function.
4. Changes in stabilization behavior occur strategically in response to the need of the organism to adapt to ongoing daily use of the body in the face of adversities large and small. Adaptive behavior can be automated as stored patterns that are frequently long-lasting and, when integrated into the baseline norm, can represent decreased efficiency and increased vulnerability.
5. The strategic neurologic behavior of the adapting organism can be observed by careful examination of the behavior of the stabilizing structures – especially muscles, ligaments, fasciae and their associated structures.
6. Therefore the preferred gateway for the evaluation of musculoskeletal injury, chronic pain and degeneration is a detailed physical examination of each stabilizing anatomic component in order to ascertain its ability to hold its place, demonstrated by its ability to lock at will. In addition, a competent examination can reveal the dynamic interactions that these innervated structures have evolved over the life experience of an individual in their role of simultaneously providing both mobility and stability.

An important consideration in the approach to solving any problem is vantage, point of view, the perspective from which we view the situation and attempt to make sense of it. In order to effectively address the origin and resolution of common musculoskeletal pain and degeneration, it's necessary to have a clear, logical and realistic model of function.

The model proposed here is an examination of the relationship between the mechanical and the behavioral, a theoretical construct derived from more than forty years of clinical observation and study. At its core is the principle that the fundamental basis of vulnerability, chronic pain and degeneration is the loss of optimal neurologic connection with the self, in this context with the proprioceptive-gamma motor loop that governs the balance of the dual functions of mobilization and stabilization.

It's not too far a leap to see the disconnect from efficient self as the basis of many disorders, including emotional and behavioral disorders and even of cancer, in which the disconnect is within the cellular function. The role of the healer is to facilitate a reconnection of the patient with the self, because healing is a function of the organism and not of the healer.

Note: Dynamic models

Included in sidebars throughout the text are models of dynamic systems that illustrate in various ways the cascade of events that can lead to an eventuality. All of the models are relevant in some way to the dynamics in play in the organism. Each of the dynamic systems described is logical and mundane; the point of each is that things often are not as they seem at first glance.



A man trudges down a road, a large, heavy sack across his back, filled with his accumulated possessions. As he shambles along, the weight on his back becomes increasingly burdensome and he has to periodically shift his weight to redistribute the load, as first his shoulder and then his low back begin to ache. Shifting the load relieves the aches for a while, but after some time another ache develops, this time his knee, and he has to shift again. As the contents of the bag shift rhythmically back and forth over time, the handle of a pan, pulling the fabric tight, rubs against the cloth, finally wearing a hole through the bag and poking out. His hip starts to hurt.

As he waddles along, the tear in the bag begins to enlarge, and in order to keep the pot and other belongings from falling out, the man bends farther forward. As he shifts to relieve the aches he is acutely aware of the need to keep the hole in the bag facing upright so that the contents don't spill out. He begins to reach back with one arm, tugging at the bag to hold the tear tight. At some point during the walk his pants begin to slip down and he has to take the hand and pull his waist up while continuing to shuffle along, constantly shifting his load to avoid physical discomfort and trying to keep the contents in the bag.

—Illustration by Sonya Sombrueil

Chapter 1: The Cycle of Trauma and Adaptation

“Everything should be made as simple as possible, but not simpler.”

—Albert Einstein

The organism

The organism - the living, moving, behaving, vital and responsive flame that animates the body, the organizing principal of the body, is defined by activity. Breathing, pumping, metabolizing, filtering, generating an electromagnetic field. The organism heals wounds, processes food into ATP, secretes and excretes, balances the function of glands and regulates homeostasis, based on its best perception of what is going on and doing its best to provide an optimal response. The organism functions independent of conscious awareness and ceases at death, leaving the uninhabited corpus.

The organism encompasses and manages the mutually dependent systems and functions that cooperate to sustain and organize the individual: the physical body, the life processes, and the strategizing intelligence for these. The organism strategizes as best it can in response to the natural challenges of entropy, even for the most basic task of organizing oneself to raise and maintain the body upright in defiance of gravity.

An individual organism's efficiency of organization reflects its ability to thrive in its niche. An organism that is heavily burdened by adaptive concerns or is neurologically disordered will tend to be at a disadvantage in its endeavor to survive and thrive, as an increased degree of its neurologic focus is distracted from the pressing reality of the outer world in favor of the increased necessity of maintaining the inner.

The somatic mind and homeostasis

In its primary function of maintaining homeostasis, the somatic nervous system continually seeks strategy in response to the complex and ongoing physical challenges of daily life. The somatonic mind*, often regarded as robotic, is in fact spirited, decisive, and highly intelligent; as aware, intelligent and intentional in its own way as the “conscious” and “subconscious” mind. The uniformity of neurologic intelligence is independent of intellect; an individual with severe mental impairment can possess the same level of neurologic intelligence as the most esteemed genius.

The somatic mind, however, is handicapped by a limited perspective: it is restricted to a view of the immediate present, unable to discern the past and the future. It lives solely in the now.

* The term autonomic can mean “acting independently of volition” (Webster's Third New International Dictionary, Unabridged), but it usually refers specifically to the autonomic nervous system (ANS), which regulates visceral and smooth muscle functions, in contrast to the somatic nervous system, which regulates the “voluntary” function of the musculoskeletal system. For the purpose of clarity, in reference to the autonomic, or non-conscious function of the somatic nervous system, I will sometimes use the term “somatonic” interchangeably with the term “autonomic.”

The teleologic view

Teleology is the doctrine of purposeful behavior; the study of the relationship of design, purpose, and utility in nature. Often viewed as folly when invoked in discussions of sociology and politics, it is primary to understanding biology.

Normal neurologic behavior is intentional, intelligent and logical. The concept that neurologic behavior is purposeful stands in contrast to the not uncommon belief in our culture, including our medical culture, that the universe is the product of random or aimless phenomena. While there is no denying that we are subject to encounters with random stressors, the organism's response to these events is always intentional and organized to the best of its ability.

It is especially appropriate to regard neurologic behavior as being purposeful. Hans Selye, in his classic textbook *The Stress of Life*, says:

"...the sensations of causality with purpose are inherent in the structure of the human brain." [p 355, ch 16]

The universal equation: the classic stress dilemma

In seeking strategy, the primary motivation of the somatic mind, underlying all adaptive behavior, is the will to continue functioning. Hans Selye states that: "stress is the common denominator of all adaptive reactions in the body". [Selye, Hans, *The Stress of Life*, p. 64.] Thus we can relate adaptive strategy to stress, which Selye described as simply the neutral demand for a response, requiring the expenditure of energy beyond the minimal metabolic requirement.

We commonly use the term "stress" to mean "distress". Selye says: "It may be said without hesitation that for man the most important stressors are emotional, especially those causing distress." (Ibid., p. 370) There is also eustress, or stress that we are enjoying. A fun vacation road trip consumes fuel and wears the tires identically to a demanding business trip.

Selye was predominantly concerned with the biochemical, especially hormonal, aspects of stress adaptation. This book will examine the neurologic, especially neuromuscular, aspects of adaptation, utilizing the concept of "adversity", or that which challenges or compromises our ability to provide optimal, normal function.

The equation of stress

The equation of stress is a universal law of adaptive behavior. It is applicable to both emotional and mechanical stress:

$$W + A = S$$

Will to function + Adversity = Adaptation strategy

In emotional terms, if someone learns at an early age that those who love them are also those who hurt them, they might learn to be wary of intimacy but unable to recognize or evaluate the dimension of their avoidance because their response is not based in thought but is rather a reflex reaction to physical or emotional proximity. Their response has been programmed.

The same principle is at play in the mechanical body. If, due to injury, a person can't walk (adversity) but is going to walk anyway (will to function), the organism will, to the best of its ability, configure a new way of walking; they will limp away, strategizing a new gait that allows a continuity of function in an altered, compromised configuration. This will also require a new stabilization strategy to accompany the new gait. As the new motor and sensory behavior accommodates to the requirements of daily tasks, the strategies become automated, programmed, with advantages and disadvantages discussed below.

The response to stress

There are two possible responses to stress:

1. Change the circumstance or behavior in order to avoid stress
2. Learn to tolerate the stress (accommodation)

Selye called this “overpower or coexist” and “attack, passive tolerance, or retreat”. [Selye, Hans, *The Stress of Life*, p. 115] Common vernacular refers to this, somewhat awkwardly, as “fight or flight”.

The need to strategize

Adaptation is purposeful and intentional behavior that aims to provide the maximum possible function while avoiding further injury as much as possible. The somatonomic function quietly serves the conscious will, making crucial decisions which allow continued short-term success, but might lead to compromised efficiency later on as these behaviors are maintained inappropriately into the long term.

Four phases of adaptation

The response subsequent to trauma follows a typical sequence of injury, adaptation, accommodation and automation.

Injury can be traumatic, microtraumatic, degenerative or congenital (anatomic anomaly). Microtrauma, or repetitive use, is similar to, and is commonly integrated with, the response patterns of acute trauma.

Adaptation as used here refers to the initial response to the injury/adversity. It is the limp that is configured immediately after a knee injury that allows the injured person to get up and hobble away.

Accommodation is the continually evolving habituation of strategic adaptive configurations in response to the demands of daily life. It is the ongoing process of adaptation to our adaptations. As we engage in activity, the organism must adjust to the myriad requirements of physical tasks while simultaneously coordinating its ongoing negotiation with the needs of prior adaptive arrangements. There might be secondary injuries, setbacks that initiate further compromise.

Automation is a process of habituation, in which we automate an adaptation for the convenience of efficiency. By configuring and storing a programmed behavior, we can draw on the adaptation without having to reconfigure it each time we get up onto our feet, therefore minimizing the distraction that the injury presents to the task of the moment.

Accommodation is the most complex phase of the adaptive process and proceeds for life. Over time our adaptations become interrelated and interdependent, and the process of ongoing accommodation can lead to an overwhelming entanglement.

A further aspect of accommodation is normalization, or neurologic muting, the ongoing resetting of baseline normal, discussed below.

“Stress, in addition to being itself, is the both the cause of itself and the result of itself.”

—Hans Selye

Proximate and ultimate: the conflict between short-term and long-term strategy

The somatonic mind functions outside of conscious awareness but is organized from the conscious perspective, the “end-user’s” point of view, which is goal oriented. Adopting a proximate (short-term) strategy and utilizing it as a new basis for function, the organism will often integrate a new strategy into the ultimate (long-term) system. There are several factors that contribute to the integration of short-term strategies into the long-term.

Among them are:

1. If an unconscious function intrudes into conscious awareness, it can be perceived as pain or discomfort. A typical response is an urge to repress the discomfort, to drive it back down into autonomic or somatonic function so that we can avoid pain and proceed with our goal-oriented behavior. The somatic system is a servant to our will; therefore it will adopt a strategy to the best of its ability, dutifully melding into the background so that we can apply ourselves to the task at hand. It is, after all, normal to take unconscious function for granted. For example, if we sprain an ankle, we don’t want to think about the adaptation strategy (the limp), preferring instead to focus on the task at hand. The baby is crying, and we need to walk across the room and pick her up while talking on the phone. We therefore relegate the limp back to somatonic status as soon as possible (Automation).
2. Adaptive behavior is typically in response to injury or insult that can have a specific, often urgent moment of onset at which the adaptation is required. However, there is normally a relatively slow progress toward healing, and there is therefore no specific moment at which the adaptation is no longer needed. As the injury to the ankle heals, we gradually allow our weight to settle onto the altered, limping leg, causing the neurologic configuration of limping to lock in and persist even though the ankle is healed. Time, after all, moves forward and not backward; we don’t have the moment prior to injury bookmarked and we don’t go back and review the past changes, we simply go on.
3. A proximate strategy is more likely to become ultimate if it concerns a function that is used frequently, or over a long period of time, or has a role that influences other functions. For example, the badly sprained ankle is likely to be walked on for a sustained period of time and the adaptation may therefore become ultimate. On the other hand, a sprained left wrist in a right-handed person is more likely to be rested during the period of recuperation, in which case the adaptation might be less likely to be integrated into ultimate behavior.

The automation of adaptive behavior

Previous injuries persist in the form of altered adaptive configurations of body utilization, a kind of behavioral scar. The accumulation of adaptive changes alters the baseline function, often imperceptibly. We carry our vulnerabilities always, and encounter them randomly.

Adaptive behavior in response to ongoing proximate need can be automated and stored, similar to a computer macro script, lending short-term efficiency of focus and energy: we don't need to distract our focus and recreate the adaptation each time it's needed; the adaptive pattern is available to be recalled instantly upon need. In this way an adaptation can become ultimate and might exist for a lifetime, altering the functional habitus with possible future consequences.

For example, an altered gait – a limp - subsequent to an ankle sprain, when no longer needed in the short term, can persist as a subtle but impactful alteration of gait, a behavioral remnant which alters the vector relationship between weight and impact, delivering a repetitive shock to the hip joint, leading to degenerative arthritis and possible hip replacement forty years later.

The hip has degenerated for the simplest of reasons: it has been absorbing impact with each step, millions of steps a year for decades. In this way an old ankle injury can contribute to a serious situation decades in the future. This is discussed further in Chapter 5.

The somatonic automation of adaptive patterns is similar to the intentional process of training muscle memory when learning an athletic skill or a musical instrument. Practice and repetition encourage the programming of patterned behaviors that can be recalled spontaneously in the course of an activity.

The consequences of adaptive behavior

Being pragmatic by nature, the homeostatic self tends to demonstrate a short-term goal orientation. It lives in the present and is concerned with accommodating the moment.

We might or might not resolve an adaptive strategy and reconfigure the function as it was before, depending on the circumstances. If we are able to successfully restore our prior status, we will be unlikely to suffer any long-term consequence from our adaptation. Those who seek care are likely on examination to demonstrate the remnants of multiple short-term adaptations that have been retained and carried into the long-term.

There is often a specific moment of injury and a specific moment in which an adaptation is needed, but there is not a specific moment of healing. In addition, we don't have a bookmarked snapshot of our function just prior to injury.

The function of an adaptation such as a limp is to provide as near-to-normal function as possible while avoiding further insult as much as possible. A classic acute limp might consist of heel-walking with the toes lifted and averted, a temporarily elimination of the phases of normal gait (heel strike, mid-stance and toe-off), and a shortening of the stride time on the injured leg, and transferring the burden of weight to the opposite leg, thereby pulling that leg and pelvis into the pattern of altered gait and weight bearing as well.

As time proceeds and activity increases, weight is restored incrementally onto the injured leg with increasing confidence, necessitating an incremental realignment of the gait adaptation.

Eventually the physical injury heals and might no longer be actively perceptible; in many cases the remnant neurologic behavior of the limp remains as a subtle alteration of gait, not only in the injured leg but also in the opposite leg as well as the entire postural habitus.

There might be an unconscious and permanent change in the relationship between the weight vector and the impact vector. Instead of dispersing the impact via an ideal ordered pathway, from this time on the absorption of the impact into the joints might be increased. Over time a site of repetitive impact can tend to degenerate, leading to osteoarthritis.

While adaptation allows the proximate continuation of activity with reduced discomfort, the relative quietude of adaptive function also encourages further adaptation, which over time can accumulate in a complex of behavioral changes. Adaptive relationships between distal regions and functions can develop that might not be easily perceived.

Teleologic unity

In *The Stress of Life*, Selye discusses the teleologic center, the biologic unit of organizational perspective, which engages in “purposeful activity ‘for its own good’”, and about which he says:

“Of course, one center of homeostasis can exist within another and then their interests can no longer be identical in every respect. ...Consequently, every cell, even every reacton* within the body represents a teleologic center, whose purposeful reactions must be analyzed in relation to all other centers. Indeed, the terms teleology and purpose can be meaningful only in relation to an identifiable center. ‘It is advantageous’ means nothing unless we say for whom or for what.” [Ibid. p 358-359]

Each individual is, of course, a teleologic center, as is each organ, each cell, and each mitochondrion. Ideally, these centers should be arranged concentrically, with a single unified purpose. This is teleologic unity and represents biologic harmony. Selye also refers to “collective-” or “intercellular altruism”, in which the cells or body components share a community of interests (First Ed p. 282). If the centers of interest in an individual diverge, working at cross purpose to one another, there will be biological conflict.

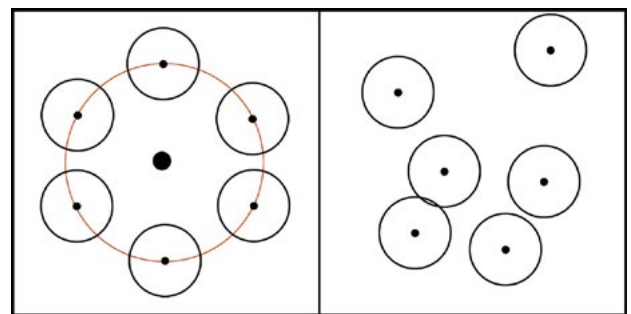


Illustration: concentric and parallel centers

Conflicting teleologic centers can exist in an individual in several ways. There can be a microbial infection or parasitic infestation, in which case the invader and host will each utilize the same biologic system from their own points of view. Cancer is a similar example of multiple teleologic centers in one organism. Adaptive behavior can also create disharmonious or conflicting points of view within an individual, because it is possible to adopt multiple strategies that have been configured at different times, in response to different experiences, each with its own agenda. For example, there might be an adaptive impulse to rotate the pelvis clockwise – perhaps to avoid pain at the same time there is a conflicting impulse to have the same pelvis rotating counterclockwise in order to reach the gas pedal while driving.

Adaptive liability

The energetic and organizational consequences of carrying proximate adaptations into the long term include the diversion of energy from the autonomic reserves (**adaptation energy**) and the distraction of neurologic focus (**adaptive conflict**).

* Reacton: the functional unit of life, the primary subcellular life unit; the smallest life unit which is capable of reacting selectively to stimulation.

Neurologic focus (Unity)

The ability of the nervous system to focus determines its proficiency in adapting optimally to the demands of daily life, favoring an organized response to the relentless forces of entropy.

The interplay between proximate and ultimate strategies can lead to adaptive conflict as the teleologic center of the organism is fragmented into multiple centers. The consequences of multiple and conflicting agendas on neurologic focus can manifest as the variety of symptoms, afflictions and complaints that compel patients to seek help.

Adaptation energy is energy siphoned from the organism's vital reserves to configure and maintain adaptation patterns, apart from the caloric requirements of normal metabolism (Ibid. p. 307). The energy required to maintain a lifetime's accumulation of adaptation patterns can be substantial, leading to fatigue.

When adaptation patterns are eliminated, the resulting free energy can be experienced in a variety of ways. The person might tend to feel increased vitality or stamina and may even find that without the burden of physical adaptations, she doesn't feel as overwhelmed by the general responsibilities of her life and now has more energy to devote to managing her emotional life.

Adaptive conflict is the loss of central neurologic focus (unity) due to the competition of multiple adaptive concerns. This division of the teleologic center into multiple centers, each with its potential point of view and its own set of interests, can represent a challenge to the unity of the organism.

Adaptive priorities

The adaptive response is almost always an interplay between two neurologic intentions: to provide as near to optimal function as possible, while avoiding further insult as much as possible. The greater the magnitude of the wound, the more compromised is the approximation of normal function. In addition, consistent with the present-tense task orientation of neurologic function, it is to the advantage of the organism to provide the adaptive behavior with as little intrusion into the conscious awareness as possible, a short-term advantage that often leads to long-term consequences. The organism prioritizes activities in the moment, and activities that are more common and more crucial.

Normalization or neurologic muting: the nature of self-blinding

Adaptation occurs in the autonomic and somatonic self; therefore we are often unaware, or not completely aware, of it. There is also a tendency to render invisible (mute) any annoying discomfort so as to eliminate distractions to present-time goal orientation. The advantage of neurologic **muting**, or **normalizing**, is that it relegates typically somatonic concerns (such as walking on an injured ankle or the processing of a "bad habit" such as smoking) from "conscious" consideration, where they are distractions, to the somatonic system, where they rightfully belong, thereby decreasing stress in the immediate term and allowing us to proceed with our daily tasks and goals.

The healthy organism achieves this by continually resetting its baseline. One clue to this behavior is the patient who states that he's not hurting and only feels "the normal pain."

Traumatic and microtraumatic stress

Microtraumatic stress refers to those forces that are so minute that the effects of any single event are too subtle to be perceived, but which when repeated chronically have a cumulative effect which is traumatic. Microtrauma weakens resistance to trauma, and microtrauma can become trauma. (Trauma, in addition to being itself, can be both the cause of itself and the result of itself.)

Microtrauma can be physical, chemical, nutritional, invasive, mental, or emotional. An example of physical microtrauma is repetitive stress: walking, sitting, and repetitive job tasks, including computer and phone use, that are also affected by adaptive complications. Microtraumatic stress often leads to degenerative changes. The subject of physical microtrauma is discussed in further detail in Chapter 5: Degeneration, Osteoarthritis and Disc Syndromes.

Acute and chronic

The need to tolerate adaptive behavior allows the continuance of short-term adaptation strategies into the long-term, where they can become microtraumatic. A disadvantage is that the very aspect that allows successful short-term adaptation can also account for chronicity of dysfunction and an ultimate failure of homeostasis.

Chronic adaptation can become a future impediment to function. For this reason, the cessation of pain is not a reliable indication that the problem is resolved; it is preferable to make this determination based on an assessment of function by examination. There are two concerns: pain and disability in the present; and degeneration, which means pain and disability in the future.

The need to adapt usually has a specific onset, but the adaptation pattern typically has no specific moment of irrelevancy as the somatonic self slowly allows the body to relax back towards a semblance of normalcy that might, however, be altered from the pre-injury state.

“Life can only be understood backwards, but it must be lived forwards”.

—Soren Kierkegaard

The immediacy of the nervous system

A major factor in the accumulation of adaptive stress patterns is that the nervous system has no sense of time; neurologically we live completely in the present. If we live for even a relatively short time in an adapted state (e.g. a limp), there is the possibility that the adaptation will persist permanently. The organism doesn't go back; it remains in the present, facing forward.

When, after suffering an injury, we make our first attempt at walking, we are painfully aware of each awkward step. As time goes by and we limp along, we are increasingly unaware that we are limping. It begins to become second nature. This is a form of neurologic muting, which allows us to focus as soon as possible on the task at hand, whatever it may be. The baby is crying, the phone is ringing, we need a file across the room, or in the case of an athletic endeavor, we keep on. We are eventually able to assign the adaptation to the background. After several days, we might not think of the limp at all after the first few awkward steps of the morning. And yet we are noticeably gimpy.

As we gradually heal and slowly begin to gain confidence in returning some of our weight to the injured leg, we will drop our body weight onto an altered gait, locking in the limp. Two months later we might think that we are completely healed and no longer limping, but in fact there is a remnant of alteration in the gait, possibly with significant long-term consequences.

A simple visual survey of people walking on a crowded street will confirm this phenomenon. Rare is the person who is not observably, albeit subtly, limping.

The Stress Cycle

Stress, neutral demand on the organism, can create a feedback loop that tends to increase its burden on the organism and diminish its capacity. Tasks, such as increasing load, require further adaptation. This is the law of increasing vulnerability: a system that is overloaded with past concerns has less ability to deal with the concerns of the present moment. As the organism becomes more loaded, as it is required to attend to more details, it becomes thinly spread, and there is less reserve capability to deal with new, ongoing concerns. We are all familiar with this phenomenon of overload in our emotional lives.

A car with perfect alignment is most able to handle a rough road. If the car hits a pothole which degrades the wheel alignment, the car will tend to be more vulnerable to the next bump in the road. In a similar way, both injury and adaptive behavior increase the body's vulnerability to further challenge.

Accommodation

Subsequent to the original moment of adaptation, the organism will continue to accommodate in response to ongoing demands, including the details of daily tasks, complicated by the requirements of pre-existing and newly acquired adaptive behaviors. New adaptations are configured as we go along, adding to the complexity of the adaptive tangle.

The interaction of adaptations: stacking

Stress is cumulative; from an adaptive vantage we further adapt. Every individual carries the remnants of past adaptive strategies; each new adaptation is predicated upon the adaptations present at the time that it is adopted, and the new adaptation will utilize pre-existing adaptations in configuring its pattern.

Existing adaptations serve as the infrastructure of subsequent adaptations; a new adaptation is integrated into the ground of retained prior strategies. In this way, enmeshed adaptations form a matrix of layered, hierarchically organized, archived strategies (stacking) by which we function, and which might serve us, unperceived, for years and decades as our baseline state.

Adaptive complexes

Adaptive behavior is a neural circuit phenomenon that can affect the facilitation and inhibition of specific musculoskeletal structures in specific situations. In the clinical setting, adaptive patterns can present in hierarchical subsets that have been woven into the behavioral fabric. These behavioral patterns can be revealed by examination, and resolved in sequential layers. Like untangling a complex knot, as one sequence is resolved a subsequent layer can be revealed and, in turn, resolved.

The hierarchy of the adaptive tangle

Just as a rope can develop a tangle of knots, so does a life become entangled, event by mundane event. Each event, each adaptation presents the possibility of another stacked layer of complexity. The **adaptive tangle** represents a lifetime of responses to the adversities we encounter and our drive to keep going.

Just as in a tangle there is likely to be a knot under each knot, in the clinical setting we are likely to find beneath every adaptation another adaptation. It is important to unravel a tangle in the correct order. We can't untie the third knot first; even though we might be correct in perceiving that it is there, it will simply not work. The first thing is to find the free ends and untie the top knot, and then the next knot is revealed as the new top knot. There is a specific hierarchy of organization to each individual's adaptive tangle.

This might seem daunting unless we are able to sufficiently comprehend the long-term nature of the situation and maintain an overview perspective. A competent examination can reveal the details of hierarchical adaptation.

Three factors that determine hierarchy in an adaptive tangle are the length of time that we live with an adaptation, the degree to which we push against it, and especially the priority with which the organism relies on that function.

For example, a runner steps into a hole while running and turns her knee. She takes a night off from work, but the next night she needs to earn her living, so she wraps the knee and goes back to work.

Her job as a waiter requires that she walk across the room numerous times, carrying and balancing trays of food and dishes, and swiveling her body while doing so in order to deliver these items. She might have to load a tray of plates from a counter at shoulder height, or simply balance the plates artfully on her forearm, travel across the room, perhaps even up and down some stairs, and swivel to place the tray on a stand at waist-height, or else remove each plate from her forearm and deliver it in place. On her way across the room she might have to pause and sway to avoid patrons moving through the room, or other waiters. All night she continues back and forth, up and down, swiveling and balancing, and the whole time she is limping. She subtly shifts her pelvis to accommodate the limp, and by the end of the night she might find that her hip is aching as well. The next night she repeats this exercise, and the night after that as well. Her body assists her again by subtly rotating her pelvis and torso to avoid adding force to the knee, especially as she transfers the weight of a tray from shoulder height, swiveling to the tray stand at waist height. In a short while the pattern becomes ingrained, and we might observe that from that point on, possibly for the rest of her life, whenever she swivels to deliver a tray of food to a table, her pelvis and torso shift subtly in their learned behavior. A year later her hip is aching to the point where it becomes a problem and she seeks professional help.

The waiter has integrated a set of adaptive behaviors that are unique to the demands of her job. If she did not experience these demands, she might have developed a completely different response to her knee injury. It might not be possible to determine the specific narrative of her unique adaptive dilemma, but it is possible, with proficient examination skills, to observe the interaction of neuromuscular factors at work.

We might find that the key to her pelvic rotation is in the behavior of the upper limb in its relationship to the lower body. This relationship could not be deduced from her symptomatic complaint and is far from obvious from casual or regional observation. And yet we find, upon examination, undeniable evidence that the origin of her hip problem is the knee injury of the previous year, and the solution first requires attention to the upper limb. It's possible that on subsequent visits we will be dealing with the function of the ankle as well as with that of her knee, hip and pelvis.

Our patient wonders how it can be that we have decided to address her triceps in the course of relieving her hip pain. If we have a clear understanding of the nature of musculoskeletal adaptation, we will be able to demonstrate to her the appropriateness of our conclusion.

She had to go to work, and this required that she adopt specific adaptive changes. She has by necessity carried the proximate into the ultimate. It is complex and yet very simple.

Homeostasis can sometimes mean the maintenance of status quo, as reliance on a crutch can prolong our handicap.

Emerging adaptations

Myriad somatonic management strategies accumulate over a lifetime of proximate behavior, registering the history of the individual experience, “stacked” in layers. In the process of resolving these layers of strategic behaviors, patterns can emerge which were not apparent during the initial examination. Some adaptations operate covertly and permanently unless and until they are specifically brought to the surface. In this case, when one pattern is eliminated, another might appear. This “new” pattern was not created by the clearing of the subsequent pattern; it was there all along and only surfaced when it was freed from its involvement in concurrent linked behaviors.

A tangle of adaptive strategies is undone one knot at a time, in a specific sequence. Because adaptation represents the strategy by which one maintains function, it is possible to remove a layer of strategy that leaves the patient feeling temporarily vulnerable, experiencing transient discomfort as he no longer has the adaptation and does not yet have the benefit of fully restored function. When untangling a lifetime of accumulated adaptive strategies, it helps to anticipate the emergence of the underlying knot, thereby avoiding unnecessary discouragement. In most cases there will be a final, simplified core pattern and long-term improvement.

The holographic nature of adaptation

It is helpful to understand that the initial cause of the injury and the reason that the patient has not fully recovered might be two different subjects. Full recovery from an injury can also be complicated by the activity of past adaptations.

Because the configuration of a neurologic adaptation strategy is predicated on the adaptations that were present at the time that it is adopted and incorporates the prior patterns into its architecture, the new adaptation can require the previous pattern as it is part of its pathway. In this way a seemingly unrelated adaptation can cause a pattern that seems to have been resolved to persist. This is **holographic memory**: any portion of the adaptation pattern has the potential to recall the entire pattern. This is discussed further in Chapter 5. To comprehend the interrelated nature of the adaptive hologram is to grasp the full meaning of holism.

The impact of past adaptations on recovery

The reason we are injured and the reason we are not recovering can be two different subjects. Adaptive reconfiguration to a past injury can prevail in the long term, a persistent remnant of events long passed, a kind of behavioral scar. Traumatic and microtraumatic forces that might normally be tolerated can be amplified by the heightened vulnerability of a previously injured or adapted structure. The organism, living in the present moment, tends to choose a proximate adaptive response as its best option, therefore the key to healing in the shoulder might reside in a distal, seemingly unrelated structure.

The tenacity of adaptive patterns

There are several factors to consider in estimating the prognosis of a case. Generally, the more complex the adaptation, the more tenacious it will prove to be. Factors influencing the complexity/tenacity of adaptive patterns include:

1. How strong was the adversity? How serious was the insult and what functions were affected?
2. How determined was the will to continue? Athletes are especially motivated to push through adversity and may therefore adopt more complex configurations than someone who rested the injury in the acute phase. The harder one has pushed against his adversities, the more entrenched and complex the adaptations will likely be. Because of this, even necessary and appropriate rehabilitative exercises can be accompanied by complication.
3. How long has the organism been functioning in the adapted state? An old adaptation has had a lot of time to accumulate potential stacks of adaptations around it.
4. What is the nature of subsequent adaptation layers? An adaptation that was configured subsequent to a previously existing pattern may be utilizing the old pattern as part of its pathway. Therefore it might be necessary to address other, seemingly unrelated patterns to satisfactorily resolve it.
5. What was the emotional status of the subject before, during, and immediately after the adoption of the adaptation? This is a more difficult assessment than the others and may prove to be a related factor.

The response of adaptation patterns to treatment

Adaptation is pragmatic (teleologic) behavior with the purpose of maintaining a modicum of equilibrium. This equilibrium might be delicately balanced. To alter an adaptation is to deny the homeostatic self its strategy and may therefore be disadvantageous to the patient unless we address the nature of the real and mundane stresses that her system is encountering. The pelvis that always returns to a rotated distortion might be doing so because it is better off that way, given the nature of the circumstance. For example, pelvic rotation might be an attempt to minimize a persistent impact to the hip due to an alteration in gait. If we ask it to stop rotating, we will first need to address the circumstances that make the organism decide that it is advantageous to rotate.

Also, because of the logical interaction of adaptations, once we introduce a change into the nervous system, we are likely to set off a chain of events that can potentially disturb a delicate equilibrium and create short-term discomfort. A patient might experience a shift or a temporary exacerbation of symptomatology. If the function is objectively improved, we can in most cases assume that the exacerbation is temporary and that a more ultimate equilibrium will be the eventual result. It is of course necessary to recognize and appropriately respond to any true exacerbation.

Healing vs. adaptation

Whenever an injury is self-limiting, there are two possibilities: we can heal, or we can adapt. We often don't know which of these alternatives occurs, as they can seem to be the same thing. We just want to get on with what we want to do. But there is a significant difference.

Healing implies a simplification of function accompanied by an inherent efficiency, while adapting implies a complication of function and a loss of efficiency. This loss might be imperceptible, and yet it might have significant impact on our life. There can be a siphoning of energetic economy as a portion of our focus and expenditure is allocated to maintaining what is essentially detoured function. We can end up spending more energetic capital to achieve what we were previously accomplishing with less effort. And there might be a future consequence, an increased vulnerability to subsequent injury, and more perniciously, to degeneration. Typically, we won't know about the degeneration until it has already developed and is more difficult to deal with.

Proximate and ultimate etiology

In determining the origin of a symptom, there might be both an immediate cause (proximate) as well as a predisposition (ultimate), a pre-existing vulnerability that might stem from a previous injury and adaptation. For example, many patients report that once they have sprained an ankle, their ankle has been, from that time on, prone to random or spontaneous re-injury. The immediate cause of a recent injury — “I was running and my ankle just seemed to give way” — might very well have its origin in an archived adaptation that was configured years ago.

Less obvious, and just as common, is the relationship between an old adaptation and a symptom in a seemingly unrelated location. As previously stated, the reason that we injure ourselves and the reason we don't heal might be two different subjects.

Chapter 2: The Neurologic Stabilization of the Musculoskeletal System

“Life is the expression of tone.”

- D.D. Palmer, *The Chiropractor's Adjuster*

The primary, ongoing concern in the management of structural homeostasis is the ability to adequately stabilize the body in space in circumstances of thrust, impact, cantilever and load, staying fully upright in defiance of gravity and competent in the four dimensions.*

Underlying most complaints of musculoskeletal pain, inflammation, degeneration and the limitations that they impose is an inability to adequately stabilize the structure. Comprehending the specific, unique nature of this failure is a critical factor in understanding the cause and therefore the approach to persistent, non-pathologic musculoskeletal pain and degeneration in an individual.

The antagonist system

The neurostructural antagonist system serves as a counter-balance to the agonist system, which creates motion. The antagonist system receives motion in the form of thrust and impact.

The antagonist system is both active and passive, consisting of two interlinked systems: the “actively passive” function of contractile tissue - striated muscle - and the “passively active” elastic tissue - ligaments, fascia, and joint capsules. Integrated into the neurostructural system is an even more passive system of shock-cushioning tissues: discs, joint cartilage, fluid capsules, bursae.

The integrated antagonist system forms a complex tensile net, acting as a unified whole while absorbing impact locally. Muscles, ligaments and fascia are integrally linked, inseparable; to address one intrinsically addresses the other. Fascia physically extends the reach of muscles and ligaments into other structures, and fascial restriction can impede muscle response. There are no essential structures that are not invested in some form of fascial tissue.

Antagonist muscles are the active and most significant component of stabilization, especially critical when motion is forceful. Antagonist stabilization depends less on strength and more on the acuity of proprioception and the timing of the proprioceptive-motor loop.

While for reasons of simplicity this text frequently refers to muscle tone, most of the principles applicable to muscles also apply to ligaments, joint capsules and extra-muscular fascia. The failure to stabilize can originate in any structural component, and frequently in more than one. Any anatomical factor that is failing to provide stabilization needs to be addressed. When considering the integrity of any system, the most important factor is its weakest point.

In order to maintain tensile balance in motion and under conditions of weight bearing, load bearing, impact and torsion, antagonist muscle function must closely monitor and track the behavior of agonist muscles in order to maintain constant and varying counter-tension against a potential distortion of the joints. This is achieved by a

*The fourth dimension refers to the first three dimensions through the dimension of time, or motion

combination of active muscle behavior, as in the tensing of the shoulder joint by the rotator cuff muscles during abduction of the arm, and the more subtle but significant function of muscle, fascia and ligament locking and eccentric contraction. Failure of any one stabilizing function can lead to a destabilizing vulnerability in both local and distal structures, resulting in injury. The stabilizers must be simultaneously taut and yielding, strong and flexible, adaptive and cohesive, and most importantly they must be proprioceptively calibrated.

In the absence of anomaly, the chronic loss of stabilization in a person is largely the consequence of adaptive changes made incrementally over the course of a life in response to traumatic, microtraumatic and repetitive events. Understanding how an individual's stabilization has been compromised requires an understanding of how the organism normally stabilizes itself. The loss of tensegrity is not random, but is frequently the result of intentional, logical behavior that was configured for advantage in the short term.

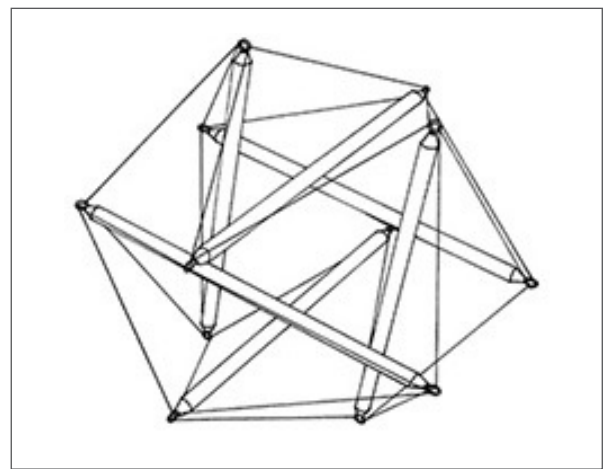
Tensegrity

The body's myofascial net is similar to a tensegrity system except for two significant distinctions: in the body, the struts - the bones - intersect, and because of this difference the distortions in the tensile net can result in grinding and compression at the points of intersection, the joints.

Secondly, the "cables" of the body are living tissue, both elastic and contractile. Muscle and ligament can lose, and also recover, their optimal tone. The imbalance of proprioceptive calibration (poise) can create tension gradients that affect other support tissues while simultaneously introducing torsional compression at the joints.

The somatic brain image

The body is represented in the nervous system at many levels. The integration and evaluation of the information supplied by the proprioceptive afferents occurs at the segmental levels of the spinal cord, in the dorsal nuclei of the brain stem, in the reticular formation, in localized subcortical regions, and over wide areas of the cerebral and cerebellar cortices (Logic of the Living Brain, p. 117). The assembled image of the body culminates in the somatosensory and parietal cortices and provides a spatial baseline for both the maintenance of stabilizing muscle tone and motor function. It is clinically significant if the somatic brain image - that is, our perception of our physical self in the world - and the actuality of the body in space and time are not the same. In this case, there will be a decreased ability to stabilize the musculoskeletal system, which relies on the acuity of neurologic tone in the muscles.



Tensegrity* model

Line drawing by Bob Burkhardt - Licensed under the Creative Commons Attribution 2.5 Generic.

* Tensegrity, a term conceived by Buckminster Fuller in the 1960s, refers to a reciprocal tension system in which rigid struts are suspended in a matrix of tensioned cables. In a tensegrity structure, the struts do not intersect, providing resiliency by directing compressive forces to be absorbed and distributed throughout the structure in a way that minimizes compression of the struts.]

Neuromuscular contraction

Three types of muscle contraction are usually recognized:

1. Concentric contraction, in which the muscle length shortens as the fibers contract. Concentrically contracting muscles pull on the skeletal levers to move the body. Exercises such as calisthenics and weightlifting develop this function.
2. Isometric contraction in which the muscle contracts with no movement.
3. Eccentric contraction, in which the muscle lengthens as the fibers contract, is a critical phase of stabilization, proceeding from the lock. As the agonist muscle pulls the body through its motion, the antagonist proceeds from its initial locking point, holding taut while letting out like fishing line.

In addition, consider a further aspect of muscle contraction:

4. Locking, a passive form of isometric contraction, is an indicator of proprioceptive acuity in a muscle. By conducting a manual resistance test, the fibers of an isolated muscle are challenged to lock on command, a contraction that produces no movement. Locking is passive, requires little exertion, and functions independent of strength. It is a binary response - a muscle or ligament when challenged to lock in place will have only two possibilities: it will either lock in conjunction with the subject's will to lock, or it will fail to lock. Locking is closely integrated with eccentric contraction. Like fishing line; the reel first locks and then begins to ease out, holding the lock as its point of reference. The buck stops here.

Fusimotor neurons

Muscle spindles are the only sensory receptors to have a dedicated motor supply. The striated intrafusal fibers are innervated by gamma motor neurons, also called fusimotor neurons, which receive input from descending pathways such as vestibulospinal and reticulospinal pathways. The intrafusal fibers do not participate in moving the joints but instead regulate the sensitivity of the muscle as it stretches by adjusting their tension. As a muscle contracts and the spindles shorten, the gamma motor neurons shorten the intrafusal fibers to keep the spindle taut; in other words, to keep the spindles calibrated to the muscle.^{1, 2, 3.}

When proprioception in a muscle is not properly calibrated, the muscle will not lock on command. The recalibration of intrafusal fibers is a primary focus of this work, and can usually be achieved by manual means.

The afferent basis of efferent function: the proprioceptive-γmotor loop

Human life is a sensory-motor phenomenon; we perceive our situation, evaluate the data, and respond accordingly. The musculoskeletal system works according to a proprioceptive-motor loop in which the input data is perceived by the proprioceptive organs. A properly functioning logical system will fail to produce the optimal result if the input data is flawed. "Garbage in, garbage out". We rely intrinsically on the proprioceptive function as the basis of our efferent function.

Ongoing stabilization of the musculoskeletal system during activity is largely maintained through the modulation of neurologic muscle tone which enables the antagonist function to efficiently monitor and track agonist behavior. A muscle in its antagonist function refers continually to its reference point, or poise, as it tracks the opposing motion as well as its position in relationship to the environment. A muscle or ligament that cannot lock at will is indicating that the proprioceptive representation of the muscle in the brain is inaccurate. The resulting response, based on imprecise feedback, will thereby be imprecise, resulting in an insufficient provision of stabilizing tone and increased vulnerability.

Neuromuscular calibration: poise

Poise refers to the normal state of a muscle in neutral position, a calibration point for the muscle, similar to the calibration of a scale to zero. A scale that reads minus two pounds at rest will read 98 pounds when 100 pounds is placed on it. The scale is actually working perfectly, but it is not properly calibrated.

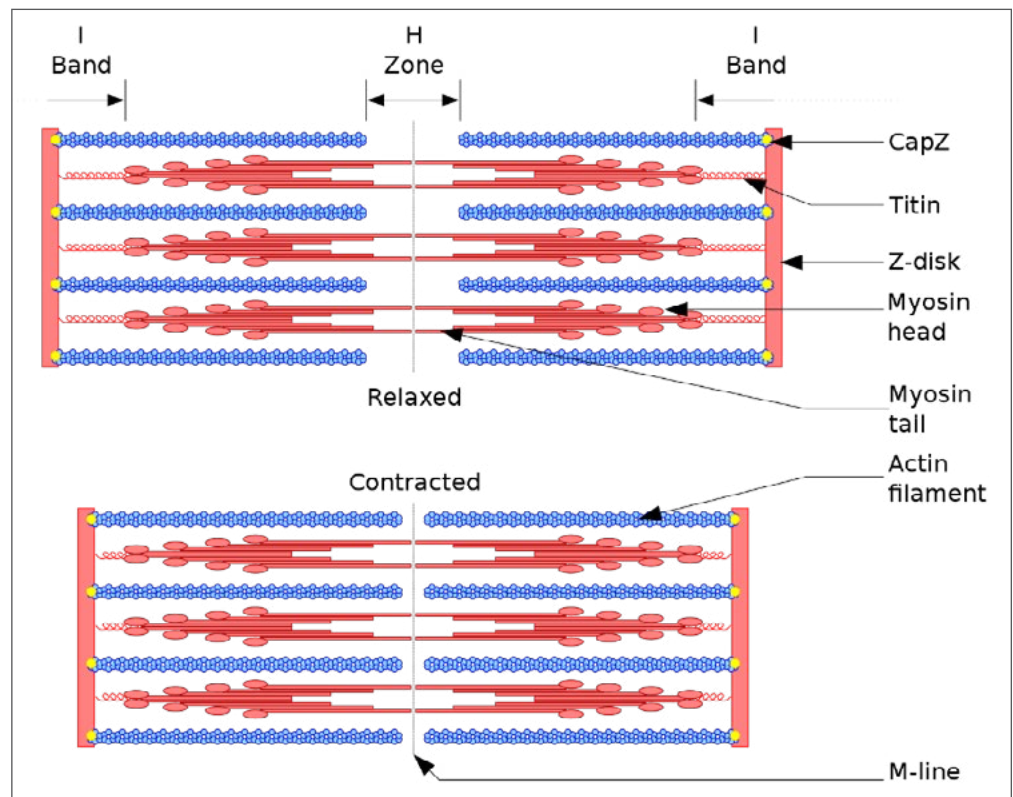
A muscle at rest is not fully relaxed; it rests at a point of neurologic poise, a state of tonal readiness that a muscle maintains when not active and not asleep. Poise represents a baseline that is fundamental to the stabilization of the body, a state of relaxed readiness from which a muscle can stretch, contract or lock as needed. When a muscle is properly calibrated, it will lock at will when challenged with a manual muscle test.

The antagonistic locking of a muscle is a function related to poise; locking requires an accurate proprioceptive read of the muscle at rest, in the same way that the scale must be calibrated to zero in order to give an accurate reading. Failure to lock a muscle can indicate a failure to pinpoint the perception of the muscle in space.

Poise and timing are intimately related. Locking is an expression not only of the acuity of three-dimensional perception, but also of the fourth dimension, timing. The timing of antagonist muscle response is as crucial as the strength and position of the muscle, in the same way that two balls traveling through the same space but not at the same precise moment will not collide. If the proprioceptive input from a muscle is not properly calibrated, the muscle will fail to lock at will, and might also fail at stabilization.

Antagonist function is acuity dependent. In the same way that a scale not properly calibrated to zero at rest will not give an accurate reading, a muscle set to improper resting tone might not be able to accurately track the agonist motion and therefore will not be able to stabilize against the motion; its base perception of the muscle in space lacks pinpoint accuracy. Similarly, it could be at a disadvantage at managing the response to a sudden impact.

The failure to lock at will any aspect of any joint can indicate a possible vulnerability to injury and degeneration.



Sliding filament*/Proprioception model

Richfield, David (2014). "Medical gallery of David Richfield". WikiJournal of Medicine 1 (2). DOI:10.15347/wjm/2014.009. ISSN

* The Sliding filament theory is the predominant understanding of myofibril action: Actin & Myosin fibers slide by each other as the muscle contracts and relaxes.

Poise as calibration

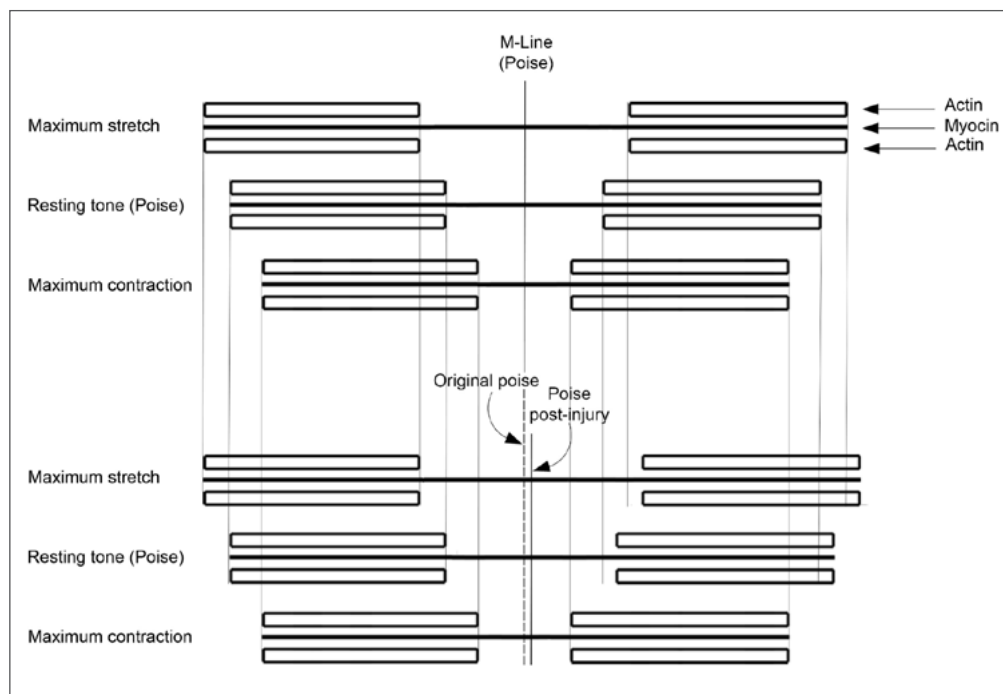
The diagram below is a schematic based on the sliding filament theory, suggesting the range of normal muscle tissue, including contraction, stretch, and poise. A working model deduced from clinical observation and study.

Maximum contraction is point A and maximum stretch is point C. Point B is the poise, or resting tone of the muscle, which represents the proprioceptive point of reference, indicated by the black lines. Both stretch and contraction read as stretch of a proprioceptor, each in opposite directions. If point B, the poise, is altered, then the calibration of both A and C is affected, similar to the calibration of a scale. The reading on the scale is low by two pounds, but the scale is working perfectly; it is simply not calibrated.

If a muscle is traumatically stretched beyond its normal tolerance (muscle strain), the resting point has been disrupted. When the tissue damage heals, the disruption to the muscle poise might not return to its previous point.

From this time on, the range of motion of the muscle, and specifically the resting tone, might be slightly altered. A muscle in this condition will typically not be able to lock at will.

The diagram to the left proposes a model for understanding the calibration of muscle proprioception. The first illustration shows the normal range of motion of a muscle fiber: maximum stretch, maximum contraction and poise, or resting tone. The second illustration suggests the altered range of motion of a fiber that has been previously injured.



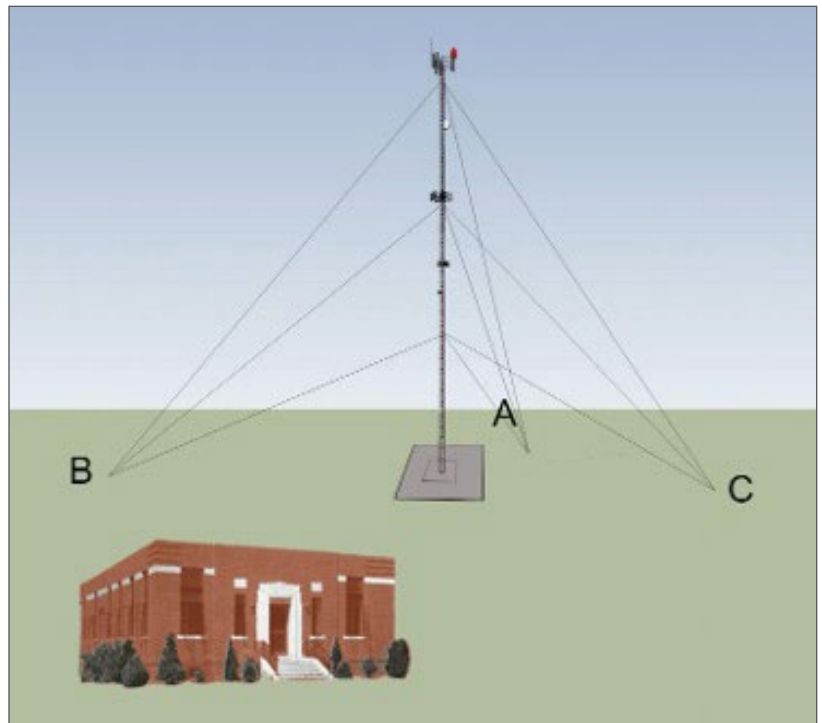
Maximum stretch is slightly increased (R) and the poise of the muscle is altered (R), indicating a state of mild flaccidity at rest. There are possibly several configurations of altered poise.

The nature of reciprocal tension systems

A classic example of a reciprocal tension system is the stabilization of a radio tower with cables. The tower is bolted to the ground; the bolts are local to the junction of the tower with the ground and cannot effectively stabilize the levered length of the tower. Even a moderate wind, amplified by the lever (the length of the tower), can shear the bolts. Similarly, most ligaments are local to the immediate joint. They hold the lever ends of the bones together and are not situated to stabilize the lever forces of long bones. In the diagram of a radio tower below, three cables extend along the length of the tower and are anchored to the ground. The cables, like muscles, travel along the length of the lever, and are pulled to tension (tone). We can make several observations about the cables:

1. Each tensioned cable would individually be a destabilizing force and would, if applied singularly, pull the tower over.

2. The sum of all the potentially destabilizing forces (the cables) stabilize the tower through their relationship. This is **reciprocal tension**. The tensile relationships between position and relative tone are worked out so that the forces balance one another.
3. If one cable is disrupted, the existing cables will lose the balance of their reciprocal tension relationships and the result will be that their inherent tone will be exaggerated into **spasm**. Similarly, a common cause of muscle spasm is normal tone unreciprocated by opposing tension. It is not a pathologic state, but rather an unbalanced exaggeration of a purposeful state.
4. As they go into spasm, the intact cables will pull the tower over, severing the bolts that anchor it to the base. As the loss of one cable (c) causes the other two (a&b) to go into spasm, the tower falls - not along either trajectory but directly between them, falling on the building. The damage - the main complaint - is on one side of the field and the problem is on the other side of the field. In a **reciprocal tension field**, the main complaint and the **functional cause** are not necessarily at the same location or even proximal to one another. In evaluating the situation it is necessary to have an overview of how the entire system is stabilized in order to permanently restore stability to the system. If we only work at the site of pain, we will in many cases miss the opportunity to achieve long-term improvement.



Of course, the body differs significantly from the above model in that the body, unlike a radio tower, consists of a series of hinged and geared levers, each dependent on the other levers, and each lever attached not to the stable ground, but to another mobile lever. In addition, the stabilization strategy must also allow for a wide diversity of motion and load. In addition, the organism is capable of a wide range of adaptive strategies which can complicate the presentation.

Dynamic vectors

A **dynamic vector** is formed by the dynamic alignment of structures, both mobilizing and stabilizing, in the body at rest or in motion.

Some dynamic vectors are related anatomically in an obvious way. The line of biceps femoris continues on directly as the sacrotuberous ligament, creating a linear relationship between the fibula, the ischium and the sacrum. The external oblique abdominals anchor to the ribs and their action continues on as serratus anterior. Superior gemellus continues on as coccygeus.

Dynamic vectors can apply to both agonist and antagonist modes. Dynamic vectors as a motor function are commonly referred to as forming kinetic chains. A similar understanding of dynamic vectors is discussed as anatomy trains. Dynamic vectors are especially relevant when evaluating stabilization. They can share the same pathways as motor function, in reverse.

Countless dynamic vectors are created as we move from posture to position. Dynamic vectors are ever-changing as we move and different structures line up. Dynamic stabilization vectors relate each structure to sequential structures as chains that can continue on in surprising ways.

Anchoring and Stabilization Chains

Unlike agonist function, which relies heavily on strength, antagonist function relies on a unique balance of locking and eccentric contraction. The antagonist muscles lock down the joint against the pull of the agonist muscle. In this way they anchor against the forces of motion, thrust, loading and impact.

A successful lock is required not only at the local joint, but along the entire chain of the dynamic vector of a motion. Each structure anchors to its adjacent structure as the organism encounters a force - a thrust, a push, a pull, an impact - and that force needs to be stabilized throughout the body from structure to structure.

A change of position is a change of neuromuscular configuration. A failure of any point along the path of a force or momentum can result in vulnerability and possible injury at another point along the path, or in relation to the path, depending on the nature of the forces and the specific vulnerability of the body. An unstable fourth costotransverse ligament can cause persistent pain and weakness in the right arm and wrist. In this simple example, the primary source of arm pain is not in the arm or shoulder.

Antagonist instability is transferred along the bones to the joints. Bones are levers capable of delivering enhanced forces, including rotatory force, along their lever arm to other levers.

Basis refers to the anchoring function of antagonistic structures along an extended path of a dynamic vector. A lack of stabilization in one structure can result in a lack of basis in a seemingly unrelated distal structure up the line. Stabilizing a medial quadratus plantae can improve cervical range of motion.

As we bend, twist, reach and lift, the stabilizing structures - muscles, ligaments, fascia and joint capsules - come into alignment, sometimes momentarily, sometimes for extended times. If there is a failure at any place along the dynamic pathway there is the possibility that an injury or adaptation can occur at any location along the pathway.

In addition, loss of basis can be a function of missed timing. A microsecond of ineffective timing in a sequence of locking behaviors can result in failure to stabilize. Proprioceptive read failure, timing failure and locking failure are all aspects of the same malfunction, inadequate poise.

“The foot bone connected to the leg bone.
The leg bone connected to the knee bone.
The knee bone connected to the thigh bone.
The thigh bone connected to the backbone.
The backbone connected to the neck bone.
The neck bone connected to the head bone.
Oh, hear the Word of the Lord!”

—*The Delta Rhythm Boys, “Dry Bones” 1941*

Balancing load

Load is the downward force vector that represents the body (or body part) weight, plus extrinsic weight being carried. Load is increased by leverage, velocity and duration.

The stabilization system is tasked with balancing leveraged load in space while in motion. This assignment can be ongoing and relentless, and failure of stabilization creates disruptive force vectors that further tax the stabilizing function. These disruptive forces frequently involve torsional components in all possible directions, added to the load of mass in the gravity field. Load is further complicated by motion, by momentum, by angulation, by duration.

Factors of musculoskeletal stabilization

Three primary factors of musculoskeletal stabilization are [1] anatomical integrity, [2] the antagonist function of muscles, and [3] the relatively passive support of elastic connective tissues.

1. Anatomical anomaly, congenital or acquired, can include aberrations of skeletal and joint morphology, soft tissue deformities, and surgical and traumatic scars. Although anatomical anomaly can limit the possibility of full recovery, significant improvement can often be attained.
2. The active, strategic relationships of antagonist muscle tone, which provides basis when properly calibrated.
3. The relatively passive force of ligaments and other elastic connective tissue, including joint capsules, and fascia. There is also a complex system of internal membranes including the diaphragm, compartmental structures, and mesentery.

Skeletal and joint morphology

Each joint by its design allows certain motions and restricts certain motions. If structures are not symmetrical, if the joints are anomalous or if the ligaments are not intact, the stabilization will be difficult to fully improve and might only be managed at best, with a reduced expectation of a complete and satisfactory resolution. Spinal scoliosis is a frequently encountered anomaly.

Examples of acquired anomaly include advanced degenerative arthritis, surgical scars, a history of fracture or dislocation resulting in limb length difference or joint distortion, and severed ligaments. Physical anomaly, whether congenital or acquired, can create an intrinsically unstable system; for example, if one leg is anatomically shorter than the other, it will be more difficult to achieve optimal balance and function than if they are the same length.

Muscles

The musculoskeletal system, loaded and in motion, is largely stabilized by means of reciprocal tension. Each skeletal lever is secured by the relationship of antagonist muscles, ligaments and other elastic tissues which form a system of straps and cables, working together to achieve the dual functions of motion and stability.

Muscles are the most active component of the antagonist system. They have the dual responsibility of providing both mobility and stability. A muscle can function as a prime mover, prime antagonist, or synergist, depending on the demands of the situation at any given moment. The ability to switch efficiently from mobilization to stabilization function with proper timing and optimal neurologic tone is essential for effective stabilization.

The stabilizing function of a muscle relies on a different mode of contraction from that of mobilizing function. Stabilization arises from a combination of concentric, locking and eccentric behaviors that are dependent on proprioceptive feedback. In order to stabilize the leveraged motion, antagonistic muscles lock and then accommodate the movement by eccentric contraction in which the muscle lengthens while holding taut, similar to letting out fishing line.

In addition, the complex functions of stabilization utilize neurological pathways distinct from that of mobilization (dorsal column-medial lemniscus vs. spinothalamic) and are only partially responsive to strengthening exercises.

Ligaments

The majority of ligaments lie immediately adjacent to the joint capsules, binding the joint tightly together while at the same time allowing a slight degree of elastic mobility. Ligaments are elastic tissue with little contractile function, and can fail by becoming slightly lax, like a stretched-out rubber band, thereby allowing a slightly excessive degree of local motion. Ligaments have proprioceptors, and an overstretched ligament responds well to effective stimulation. It can often be induced to “spring back” into tone from a relatively flaccid, and therefore inefficient, state. A ligament if severed becomes an acquired anomaly; a joint with a severed ligament will typically displace in a consistent way and might only be recoverable by surgical intervention.

Other types of connective tissue are closely related to ligament and can be regarded clinically as identical. These include joint capsules, retinaculae, syndesmoses, and aponeuroses.

Fascia

Fascia is an elastic, membranous sheathing that encases virtually all structures and provides essential strapping support to the body. Fascia is both linear and concentric, and disruptions in the fascial membrane can reverberate through the entire system. Fascial tissue exhibits tonal poise which can become compromised, and like all proprioceptive tissue responds favorably to passive manual stretch. Fascial structures include myofascia, organ capsules, periosteum, perineurium, and dura mater.

Fascial restrictions can arise from multiple origins, including surgical and traumatic scars, adhesion due to organ inflammation and displacement, chronic inactivity such as long sitting and its attendant fluid pooling, compartmental pressure gradients, and secondary torsion resulting in structures being pushed or pulled against one other for extended periods of time. Fascial restrictions can represent a passive yet unrelenting force contributing to persistent body torque. They can exert reciprocal influence on the active neuromuscular function that is the primary topic of this book. The skillful release of fascial fixation requires consideration of multiple factors and can be essential for the restoration of normal function. Deep surgical adhesions, including surgical staples that have been left in place, can be especially difficult to resolve manually.

“The world is like an enormous spider web and if you touch it, however lightly, at any point, the vibration ripples to the remotest perimeter. It does not matter whether or not you meant to brush the web of things.”

—Willie Stark (Robert Penn Warren), *All The King's Men*.

The actions and limitations of muscles, ligaments, joint capsules and fascia are intimately interrelated; they all swim in the same sea.

Tendons

Tendons, frequently described as a tissue that connects muscle to bone, are actually the aggregation of concentric elastic muscle fiber sheaths (epimysium, perimysium, and endomysium) that extend through the entire length of the muscles from end to end. They continue beyond the blood-red contractile muscle tissue and therefore appear white. The tendons as such are an integral component of muscle structure.

Muscles vs. fascia and ligaments as joint stabilizers

White and Panjabi (Clinical Biomechanics of the Spine p 194) point out that “in polio patients with total paralysis of cervical muscles, there is no loss of clinical stability as long as the bony and ligamentous structures remain intact.” Therefore, they maintain that “The role of the muscles in clinical stability remains obscure.” However, in healthy people not suffering from paralysis, the bony and ligamentous structures will not provide sufficient stabilization to allow for normal structural continuity during robust activity. Most ligaments act as relatively passive and inflexible straps that reinforce the joint capsules, for the most part holding the levered ends of the bones in proximity to one another. Being local to the joints, most musculoskeletal ligaments have a less dynamic role in stabilizing the lever forces of the long bones in motion.

The muscles, which travel the length of the bones, tend to exhibit a more active role as indicated by their increased contractibility, their dual function as mobilizer and stabilizer, and their rich neurologic provision and feedback. Muscles exhibit both contractile and elastic properties. Ligaments, fascia and related connective tissues (tendon, retinaculum, capsule) primarily exhibit elastic properties.

Having primary responsibility in the stabilization of the long levers during activity, the effectiveness of muscle as a stabilizer is directly related to the poise, or neurologic resting tone of the muscle.

Despite the important role of muscles in dynamic stabilization, a ligament if not properly tensioned can be, and frequently is, a primary weak link in the system. It's important to find the vulnerability wherever it exists.

Together, the muscles, fascia and ligaments work in concert to provide integrity to the skeletal levers. As in the broadcast tower model presented previously, any component that performs ineffectively - cable or bolt - will destabilize the system and contribute to it becoming increasingly and degeneratively disordered.

Tracking

As the body moves, the antagonist muscles need to closely track the motion that they oppose in terms of location, direction, timing, and tensile counter-force. They must exactly meet the agendas of synergistic muscles. For this reason stabilization is acuity-dependent. Much of mobility function is less dependent on specific acuity of proprioception, With the obvious exception of fine-motor skills or high-performance athletics. It might be good enough to lift a foot a quarter-inch higher or lower when climbing a step, but that same quarter inch of missed stabilization can expose the joint to traumatic liability.

If a synergist cannot provide the required synergy, related muscles might extend their reach in an attempt to cover the inadequate function. A muscle in this situation cannot perform the task as effectively as the intended antagonist but might be able to cooperate with other related muscles in order to provide as near-normal stability as possible. A muscle contributing beyond its normal, easy function will therefore have its focus divided, compromising not only its ability to provide secondary support, but also its ability to perform its normal tasks.

Active stabilization

Just as muscles cooperate in mobility, either as prime mover or synergist, they also act in concert when actively stabilizing tasks involving complex movements. For example, when using a screwdriver, the triceps is activated isometrically as the biceps drives the force forward and the forearm intermittently pronates and supinates. This synergistic action checks the tendency of the biceps and pronator teres to flex the elbow beyond ninety degrees while allowing forward impulse of the arm. During these behaviors, there is a concomitant engagement of stabilizers throughout the body which stabilize the torso, pelvis and legs throughout the task. A breakdown in a distal agonist can result in injury to a seemingly unrelated location, which might not be apparent at the time.

Chronic inflammatory joint syndromes: symptoms of functional failure

The diagnoses of many acute and chronic inflammatory joint syndromes such as osteoarthritis, tendinitis, bursitis, and non-discogenic radiculitis are often applied locally, without reference to their functional etiology. It can seem as if these conditions just materialize without specific cause, frequently leading to a diagnosis of a “syndrome” in which the symptom is treated with anti-inflammatory drugs, physical therapy modalities, pain control methods, manipulation, or soft tissue techniques directed at suppressing inflammation at the site of the complaint.

In order to comprehend the anatomical basis of these symptoms, we need a realistic model of normal function and an understanding of how the individual patient has deviated from this function, and has therefore no longer able to provide optimal stabilization. Hans Selye says: “To understand a complex thing you must take it apart systematically”. (The Stress of Life, First Edition 1956, p. 48)

For example, a patient injures his shoulder throwing a ball. His doctor arrives at the diagnosis of bicipital tendinitis. Treatment is directed to the biceps tendon, the obvious site of injury. After a while the pain subsides, but when the patient next throws a ball from the outfield he reinjures his shoulder. The shoulder is never quite the same again, flaring up now and then. The patient wonders if he might have to quit playing softball at his age. In later years he develops chronic “tendinitis”, “bursitis”, “arthritis”, or “rotator cuff syndrome”.

This illustrates the difference between diagnosis and evaluation. Examining this injury anatomically, we are likely to find that the problem stems from a failure to stabilize the shoulder in motion, most likely from the posterior aspect — the muscles and ligaments that hold the head of the humerus against the glenoid fossa of the scapula, and the scapula to the rib cage. Without this posterior support, as the triceps and subscapularis muscles throw the ball, they also throw the humeral head. The biceps tendon happens to be in the line of fire of this motion. The diagnosis of bicipital tendinitis is correct but not really relevant to the ultimate solution. The problem might stem from any of the rotator cuff muscles, or the trapezius, the teres major, the serratus or other stabilizers of the shoulder as the ball is thrown forward. And these muscles in turn might be influenced by any number of distal factors—the way the pelvis rotates when the person takes a step and plants the foot as he throws the ball, or a psoas muscle that has been adaptively trained to pull the body counter-clockwise when the shoulder is lifted.

The patient is not necessarily getting too old to play, but there is a correlation between age and the degree of acquired adaptation in the body. The longer we live and the harder we push against our adversities, the more complex is our adaptive tangle. The problem is inherent to the situation but not necessarily intrinsic to the individual. In most cases, the diagnosis and the functional analysis are two distinct matters; related, but not one and the same.

It is not possible to discern all of the challenges that have contributed to a pattern of adaptive instability. It's like taking your dented fender to a body shop and asking the technician to tell you what you have hit. The technician can assume that the fender didn't come out of the showroom with the dent and that the dent is the logical consequence of impact. He can repair the damage, but he won't be able to tell you how the dent occurred.

The reciprocal tension field

Muscles, in providing both mobilization and stabilization, maintain a continual gradient of concentric agonist contraction and eccentric antagonist counter-tension as the situation requires from moment to moment. The antagonist function must track any motion in terms of location, strength and timing, balancing the agonist pull and the load in all directions and from each related anatomical anchor. It must be ready to adjust in order to maintain this balance on a moment's notice. If it fails to do so, the balance of the load on the lever is altered, leading to vulnerability.

As we move through an arc of motion, a limb, for example, is handed off to a series of muscles, each responsible for moving through its specific region of activity in sequence. The supraspinatus initiates lifting the arm and at a certain degree of abduction the deltoid (among others) takes over, and then as we reach out, the serratus anterior assumes responsibility for the motion. Simultaneously the antagonists are also handing off to the next appropriate muscle (or muscles) as the limb moves through space. As the supraspinatus begins to lift the arm, the latissimus dorsi and serratus anterior (among others) assume a role as stabilizers of the scapula and humerus. As the serratus initiates reaching forward, the supraspinatus and posterior deltoid (among others) shift from agonist function, becoming antagonists. After reaching, the triceps initiates the act of pulling the arm back and the biceps functions in antagonist mode (among others) while the serratus assists in stabilizing the scapula once again.

The provision of stabilization with antagonist function is acuity-dependent, in other words the muscles in their stabilization function rely acutely on the accuracy of the proprioceptive data that the muscles transmit to the sensorimotor cortex. The organism continually monitors all of the afferent data and efferent input as the basis for assigning the proper role to each stabilizing muscle. It is the balance of these relationships that allows for stabilization during mobility.

In addition, there is passive reciprocal tension from the contiguous membrane system, which includes the myofascial and serous membrane planes, organ investments, the envelopes of muscles, nerves and bone, and the cranio-spinal meningeal system.

In evaluating the adequacy of musculoskeletal stabilization, it is necessary to view the system as a whole and in vivo. The body in action relies on interlocking, modular stabilization strategies and is a brilliant and spontaneous improviser, capable of an impressive range of possible recruitment schemes when the primary systems are incapable of providing adequate support. It is therefore insufficient to limit examination to the immediate area of complaint. For example, the neck anchors to the scapulae, the thoracic cage, and the thoracic spine (both anteriorly and posteriorly). In a case of neck stiffness, it is not uncommon to find the neck relatively free of dysfunction and the primary lack of stabilization in a scapula or the rib cage. Treating the neck in such a case is likely to offer temporary relief at best.

A less obvious but just as real illustration is the case of a kitchen worker who has to lift a heavy pot of soup from a table and carry it to a stove top every day. One day when lifting the pot, she herniates a lumbar disc. Of course, the acute injury requires that immediate treatment be directed to the herniated disc, but a thorough examination also reveals a chronic failure in her left shoulder girdle, suffered in a skiing injury fourteen years prior. Because of the shoulder insufficiency, whenever she lifts the pot to the burner, she rotates her pelvis in order to bolster her lower body to make up for the inadequacy in her lifting arm. This adaptive behavior, subtle and somatonic, subjects the lower body to rotatory forces which complicate the weight bearing load and deliver the force directly into lower structures, including the lumbar disc which eventually gives out. In this case, after the acute injury is healed, correction of the shoulder adaptation can eliminate what has been a long-term vulnerability to recurring low back injury, eventual degeneration of the lumbar disc, life-long pain, and possible surgery down the road.

Discovering a mechanism of this nature is not difficult or particularly obscure; it is a matter of taking the time to fully examine each patient, understanding that there is an adaptive hologram in each of us.

Joint fixation

Joint fixation is dislocation within a joint as opposed to full dislocation in which a bone falls out of the joint. In ideal conditions, the articulating ends of bones should almost float in the joint space, suspended in the joint fluid and supported by the reciprocal tensegrity web. When its suspension system is disrupted, a bone drops within the socket, creating torque, limiting its mobility and increasing the joint's susceptibility to jarring impact. Joint fixation can be subtle but is nonetheless clinically significant.

The nature of biomechanical levers

Levers are classified according to the relationships of fulcrum, load and force. There are three types of fulcrums:

Class 1: the fulcrum is located between the applied force and the load, as in a crowbar.

Class 2: the load is situated between the fulcrum and the force, as in a wheelbarrow.

Class 3: the force is applied between the fulcrum and the load, as in the human arm. This is the most common type of lever in the body. Third class levers produce motion in the same direction as the effort.

The bones - skeletal or spinal - are levers and have no intrinsic ability to mobilize or stabilize themselves. This falls primarily to the muscles and ligaments. Muscles and fascia can also act as soft levers, transmitting forces along their length into adjacent structures and beyond.

The kinesiological consideration of levers in the body differs according to whether we are considering their application in the mobilization or stabilization of the body.

Levers by their nature increase force proportional to their length, which of course is why they are so useful in moving objects of great mass. In the body, the lever principle is an advantage when we utilize it to do work and a disadvantage when we are subject to it, in other words when it acts upon us. A force imposed on the body can be a source of distortion, as in torque or overbearing load. The lever can then deliver the distortion to an adjacent or distal region with even more impact than at the site of original failure. Multiple interrelating levers can transmit torsion and impact forces in multiple conformations, mimicking the behavior not only of levers but also of springs, hinges and gears.

We often encounter extrinsic fulcrums in our environment, such as when we reach over the car seat to grab something behind us, when we reach for something while holding a child, or when we use a computer mouse.

As a weight-bearing system of contiguous hinged and geared levers, the body structure is subject to reciprocal linear and rotatory vector forces. Any force exerted on one end of the lever is applied at the other end of the lever. If one end of a lever is unstable, the distal end is also unstable and subject to an increase of magnitude along its course.

Since the reciprocal end of any lever articulates with either the next lever or with the external environment, a force exerted upon any part of the body will be transmitted, directly or indirectly, through the entire structure. From a clinical perspective, the ankle is the knee is the hip and so on: an ankle problem can become magnified as a knee problem, a hip problem, and by extension, a shoulder problem. A shoulder problem can create or contribute to a hip problem. Everything is functionally related to everything else, and each individual presents a unique configuration.

Chapter 3: The Neurologic Management of the Organism in Space and Time

“Processes are always of the essence; things have significances as participants in processes, for better or worse.”

—Jane Jacobs

The nature of neurologic organization

Each bio-mechanical component must be able to hold its place; if it can't hold its place, other structures and postures will be reassigned to cover the vulnerable territory to the best of their ability. The organism does this relentlessly and without hesitation until it cannot. The focus of a newly reassigned component is now divided; it must perform its native task and is now also addressing a secondary concern from a handicapped vantage. It's possible that over time a muscle might be assigned multiple and sometimes contradictory functions that have been adopted scatter-shot in the course of daily living.

While musculoskeletal pain can arise from a range of sources, including referred pain from visceral dysfunction or pathology, fixation and torsion due to anatomical anomaly, deep scars due to trauma or surgery, and emotional disturbances, the mechanical failure to stabilize is a significant and dominant cause of pain and degeneration.

Two related factors contribute to mechanical dysfunction: injury, including microtraumatic injury, and, significantly, the complex of adaptive reconfigurations that have accumulated over time in response to these injuries and challenges, motivated by our need to maintain activity as best we can. These adaptive changes can continue long beyond the resolution of the acute injuries, and they entangle and distort as we progress through our lifetime.

The organism has the capability to configure new initial strategies, institute them as new patterns of function, integrate them with preexisting patterns, and then automate the new behavior.

The organism might manage the adaptation locally, for example extending the responsibility of the scapular and clavicular divisions of the deltoid muscle to cover an insufficiency of the acromial division. Or it might respond to a construction worker's elbow injury by rotating a leg, pelvis and torso to change the angle of his hammer blows, thereby minimizing the impact at the elbow but stressing the hip and knee.

In managing the myriad of concerns that confront the organism on a moment-to-moment basis - autonomic, somatonic, mental, emotional, and tasking - the organism prioritizes proximate over ultimate concerns; in other words, it favors achievement and well-being in the immediate present, strategizing to perform the present task if able to do so. When the baby is crying, our attention is hopefully on attending to the baby and not on the mechanics of walking across the room.

In the presence of an injury, the immediate adaptive motives are twofold:

1. To provide the maximum possible function, while
2. Avoiding further aggravation or re-injury as much as possible.

When these two priorities are satisfied, the third priority of the organism is to automate the strategic behavior in order to minimize, as much as possible, any distraction to performing the task that's before us.

When we first get up and limp away from an injury such as an ankle sprain, we are aware of each hobbled step. As time goes on, we might still be limping - for weeks or months - but we are not as acutely aware of each step. The limp has been progressively automated and normalized. Automation ensures the consistency of the adaptation and frees the organism from having to recreate the adaptation each time it is needed.

Computer model: Simultaneous layers of programming

The concurrent, hierarchical organization of the organism can be compared to that of a computer. Underlying the user interface of a software program is a programming language. The program or application itself is nested within an operating system with its own programming language, and beneath all of this is a primary language of binary code, simple in that it contains only on and off commands, and at the same time complex by the nature of the infinite number of ways that these binary signals can combine, negotiated by compilers and interpreters to evolve into sophisticated levels of function. A problem in a system can occur at any of these levels. In the clinical setting, the ability to evaluate the underlying binary status of the proprioceptive-motor system provides essential insight into the matrix of stabilization and its failure.

Redundancy

Musculoskeletal adaptation functions as a form of redundancy, a key feature of complex systems that serves to reinforce resilience. Wikipedia states:

“In engineering, **redundancy*** is the intentional duplication of critical components or functions of a system with the goal of increasing reliability of the system, usually in the form of a backup or fail-safe, or to improve actual system performance, such as in the case of GNSS receivers, or multi-threaded computer processing.”

Adaptive redundancy, necessary and vital, favors proximate advantage at the potential cost of ultimate consequence. Anatomic structures, reassigned to provide functions that are not native, might do so from a tactical disadvantage. In addition, with their workload now increased, their efficiency at their original function can be compromised. Scott D. Sagan states:

“Redundancy sometimes produces less, instead of greater reliability – it creates a more complex system which is prone to various issues, it may lead to higher production demands which by over stressing the system may make it less safe.”**

The Law of Parsimony

The Law of Parsimony¹, also known as Occam's Razor^{***}, is the principle that when confronted by competing theories or explanations, the simpler one is to be preferred. Applied to the musculoskeletal system, it is the principle that the organism tends to activate the fewest muscles or muscle fibers possible for the control of a given joint action. This principle, usually applied to motor function, surely applies to antagonist function as well. Simple function is efficient function, and as adaptive behaviors accumulate and interact, the efficiency of the organism economy can be diminished.

* [https://en.wikipedia.org/wiki/Redundancy_\(engineering\)](https://en.wikipedia.org/wiki/Redundancy_(engineering))

** Learning from Normal Accidents, Scott D. Sagan: Organization Environment 2004; 17; 15 DOI: 10.1177/1086026603262029

*** Donald A. Neumann: Kinesiology of the Musculoskeletal System, p204. Occam's Razor https://en.wikipedia.org/wiki/Occam%27s_razor

The Law of All-or-None

The Law of All-or-None states that the degree of response of a nerve or muscle fiber is independent of the strength of the stimulus. If the threshold of resistance in a nerve is met, the nerve will fire all the way down the axon each time. In other words, the nerve will either fire completely or not at all. It is a binary response. This applies to the neurologic assignment of muscle function.

Muscle locking can be regarded as a binary function. A muscle when tested for a lock point will either lock or not lock. It is not a matter of strength but of specificity, the ability to differentiate itself in space. It is more a matter of timing than of strength.

Sequential Binaries

When two binary switches interact on the same circuit the result is limited to a binary set; the first switch can only flip the second switch to its polar opposite and back again.

This can be observed in the function of a “three-way” switch in a lighting system, in which there are two switches in the same room operating one set of lights. If one switch is toggled, the second switch will be flipped to its opposite. If it was on, it will now be off, and if it was off it will now be on. The up position which represented “lights on” now represents “lights off.” Flip the first switch again and now up is once again “on” and down is once again “off.” These are the only possible outcomes when two binary switches interact.

Sequential Inhibition

Sequential inhibition is a neurologic behavior that can be observed with resistance testing. When a compromised and inhibited stabilizer - a primary dominant muscle - is engaged, it can cause a secondary muscle to flip to its polar opposite. If it was facilitated it will fail, if it was inhibited it will facilitate and seem to strengthen. When the primary is engaged again, the opposite state will once again manifest. This behavior is infinitely reproducible; no matter how many times the primary muscle is engaged, the second muscle will revert to its opposite state. Sequential inhibition is an indispensable and reliable examination procedure.

When a muscle which when engaged changes the polarity of other muscles, this is evidence that the reacting muscles are monitoring the inducing muscle to determine their assignment. They have been recruited from their primary responsibility to an adaptive responsibility according to the organism's priorities.

By observing the neurologic assignment of antagonist function it is possible to gain insight into the ways that an individual organism has managed the task of providing consistent stabilization through a range of varying situations both external and internal.

When a stabilizer cannot adequately perform its function, the organism will adapt by several means. It can recruit a nearby muscle or several muscles to fill in for the vulnerability. For example, the scapular and clavicular portions of a deltoid might extend their reach to cover the inadequacy of the acromioclavicular deltoid fibers. They might thus be able to reasonably substitute for an inadequate stabilization; however there will be some loss of efficiency since they will not be able to fully stabilize the shoulder from their vantage as effectively as the acromioclavicular deltoid would if it were functioning normally. In addition, because their region of responsibility has been extended, they might also be compromised in their ability to perform their normal task, as their focus has been divided. Secondary muscles can suppress the function of a muscle they are covering. It's as though they're saying, “We will cover your territory but then you can't jump up in our face.”

This inhibitory function can be long-standing and can be observed by engaging muscles and ligaments in sequence. For example, when the scapular deltoid is engaged on a resistance test, it might demonstrably inhibit the function of the acromioclavicular deltoid, demonstrating a primary dominance in relationship to the second muscle, and possibly to other structures as well, such as the acromioclavicular ligaments.

As time goes on, other, more distal functions can be recruited as the organism accommodates to various routine tasks. The pelvis might rotate in order to support an inadequate triceps, stressing the back, hip and leg while lifting. As this adaptive re-ordering of function becomes more complex, it can eventually be prone to failure resulting in a symptom far removed from the original injury in both time and location. These changes can be revealed by examining for sequential inhibition.

Neurologic unity

Anatomists describe the nervous system in terms of subsystems such as central and peripheral nervous system as a convenience of dialogue. There is but one neural organ, which includes the central nervous system and the peripheral nervous system, from cerebral cortex to dermal nerve endings.

In embryogenesis, the peripheral nerves, the blood supply and the muscles evolve in unison to create an innervated, vascularized tissue. Because the nervous system permeates the tissue ubiquitously and microscopically, it is not unreasonable to regard muscle as an aspect of brain, especially relevant when observing muscle behavior.

Neurologic focus

The ability of each anatomical component to function simply and without distraction favors efficiency and allows the organism to function with maximum economy. The processes of adaptation, while lending a proximate advantage, can introduce multiple agendas that increase the burden on the ultimate or long-term administrative management of the organism. Just as a society or a business becomes more complex as it grows, the organism as it adapts tends to become more complex and its focus more diffuse.

Efficiency of function

The more details the organism has to attend to, the more dissipated its focus becomes. As conscious, autonomic and somatonic function become overwhelmed, our ability to attend to all details effectively is compromised. Simplicity of function and focus is advantageous for optimal function and therefore for optimal resilience.

The advantages of physiologic focus: organizational tone

Singleness of purpose produces economic efficiency, allowing the organism to expend the least effort and conserving energy while achieving the most advantage. Simplicity of function enables organizational tone, a state of alertness without vigilance, which allows the organism to respond briskly, appropriately and efficiently to the demand of the moment. Optimal physiologic function allows the organism to pay close and quiet attention, neurologically, to the moment and respond with the most appropriate action. It is the same advantage that differentiates a good athlete or business executive.

Synchrony

Effectively stabilization of the active body requires each component along an entire stabilization chain to perform synchronously in terms of directionality, degree of counter-tension, and, importantly, timing. A failure of any of these aspects at any point along the chain can represent a potential vulnerability, leading to injury or further adaptation.

The practical advantages of neurologic focus in athletics

Simplicity of function, in which the organism is free of complex, multiple adaptive assignments, unburdened by overwhelm and distraction, optimizes neurologic focus.

There are at least three clear advantages of increased neurologic focus:

1. Reduced vulnerability to injury
2. Reduced vulnerability to degeneration
3. Acuity, agility, coordination and power in athletic performance

Complexity and vulnerability: “spaghetti”:

When a computer program is developed for a financial institution, a problem inevitably arises as the parameters of market strategies are always shifting. Institutions hire programmers to continually upgrade the ability of the program to meet the evolving demands of a constantly changing market by patching sequences of additional code onto the system. Michael Lewis, in his book *Flashboys*, describes a phenomenon in which investors hire programmers to write additional code onto their programs that allow it to accommodate the new parameters. At some point, the complexity of code which has been added creates an inefficiency of response in the program. The program, burdened by these added bits of code, called “spaghetti,” begins to be overwhelmed. It’s latency increases; it becomes sluggish, less responsive and is prone to freezes and errors, at which point the programmer is likely to suggest that the entire program be rewritten with the additional functions better integrated into the program instead of functioning as an afterthought. But frequently the investors, having a proximate point of view, decline to do this as they don’t want to make the required commitment of time and expense. They want what they want, now.

Adaptive patterning, a neurologic analogue of coding, can act in a similar manner, piling on and creating burdensome complexity and inefficiency to the organism, potentially with long-term negative consequences.

Pattern generators

Whenever we move our body, there is a complex interplay of neuromuscular functions that interact to achieve the motion and at the same time provide stabilization. Adaptation introduces new patterns that allow alternative routing of functions, providing proximate stability to a body which is unable to effectively hold together by utilizing normal mechanisms. These patterned behaviors, revealed by engaging stabilizing structures in sequence, suggest that patterns are memorized and stored like a computer macro – an automated set of instructions that can trigger a systemic pattern.

Vernon B. Brooks hints at this phenomenon in his book *The Neural Basis of Motor Control*:

For movements that have been experienced previously, the brain seems to expect levels of alpha-gamma co-activation that were appropriate in previous, successful trials. When this expectation is not fulfilled, decoding becomes faulty and illusory movements are perceived. “Information Processing” p 43.

Experiential history

Over the course of a lifetime, the cascade of real events, both mundane and dramatic, that the organism encounters over the course of its life create the complex of adaptive responses that accumulate in the neurologic matrix of an individual. These are layered behavioral patterns assigned as binary circuit configurations. As episodes and responses pile up, there is an gradual deterioration of focus and a relative randomization of concerns as the organizational tone loosens.

Linking

The process of adapting to acute injury begins spontaneously at the first effort of continuation, as when a person first rises from a fall to hobble away. The organism responds to the need to continue with a strategy that shifts the body habitus (see p. X) according to the two priorities inherent in all adaptation: to provide as near-normal function as possible while avoiding further aggravation as much as possible. This requires a simultaneous shifting of both mobilization and stabilization assignments (as well as posture) to create “detoured” function that will allow the injured person to resume her life behaviors.

As time and activity progress, adaptive patterns themselves accommodate (adapt) to the requirements of daily tasks. The acute adaptation becomes chronic, settling into a state of conditioned entanglement with other adaptations of acute and repetitive-use origin, both current and historical.

In creating new behavioral patterns, muscle functions link to one another and are therefore mutually dependent. The linking of muscles and ligaments, especially those that facilitate frequent and repetitive behaviors, can persist permanently and can become invested in subsequent adaptations that are removed from the original injury but are yet intimately involved with ongoing syndromes. Sometimes the reason one was injured and the reason the injury is not healing are not the same.

Stacking: The tangle of layered adaptations

From an adapted vantage we further adapt, accumulating adaptive strategies in functional layers as a life progresses through its course. Adaptive layering presents like a tangle of knots: just as a tangle is simply a knot over a knot over a knot, an adaptive tangle is an adaptation over an adaptation over an adaptation. When untangling a knot it is necessary to find the free ends and untangle the top knot first, revealing the knot underneath as the new top knot. The new knot was already there but could not be accessed until the knot above was undone. Similarly, it is necessary to find the primary adaptation, that is, the adaptation that exerts the most global influence on the entire organism. Attempting to resolve a local, less global pattern might reduce the likelihood of a satisfactory long-term result. It's possible that the resolution of a more global adaptation might in fact resolve a local dysfunction without attending to it directly.

Because many patients have taken years and decades to accumulate their unique adaptive tangle, resolving the entirety of an individual's lifetime accumulation is a process that necessitates the overview perspective of a detailed anatomical examination process.

The degree to which the resolution of an adaptive tangle must be achieved in order to provide a satisfactory result depends on the goal of treatment. Again we can refer to the model of a tangled rope. Untangling the first knot of a large tangle can seem like scant progress but it is indeed progress, and the only progress possible. A patient with an incomplete understanding of the mechanisms involved might feel discouraged. But as we proceed through the layers of knots the overall knot gets smaller and smaller. Ongoing physical examination and the informed encouragement of the doctor can help assure a patient that the outcome will be good.

The tangled rope and the untangled rope are of course the same rope, but the tangled rope is not available to use because it is fully occupied by the tangle. Similarly, an organism can be so committed to adaptation that the ability to utilize the body is reduced. The degree to which the rope must be untangled in order to use it depends on how we intend to use the rope. If we want to use it to tie down a tarp, it's possible that if enough length is freed up, the rope will suffice for the task despite still having a significant bunching in the middle. If we want to use the rope to belay ourself on a rock face, a single knot could be disastrous.

Having made sufficient progress in untangling an adaptive knot to satisfy the complaint that brought the patient to the appointment, he might decide at this point to end treatment based on his priorities, typically based on his assessment of the time and money required to continue. Despite solid evidence that there is more work to be done and that we are leaving him with confirmed vulnerability, we might only be able to continue to progress at another time, or not. In any case, the patient will likely be better off for whatever simplification has been achieved.

The adaptive hologram

The neuromuscular system maintains utilitarian patterns of individual muscles that fire in acquired sequences of facilitation and inhibition. If used repeatedly, these patterns form facilitated pathways, stored as configurations readily available for re-use, like a path that has been cut through bramble.

Adaptive sequences can present in hierarchical layers, acquired over time, their pathways interlinked by time and circumstance. A subsequent breakdown in one function can affect other adapted configurations related to it, creating an increasingly complex chain reaction as these behaviors rearrange themselves out of necessity.

In the clinical setting, an adaptation that seems to have been restored in treatment can have returned on the followup because another linked adaptation program requires it. The second adaptation might have been adopted when the first behavior was active and is utilizing it as part of its pathway.

This underscores the principle that a specific treatment should not be repeated. If a pattern returns that seemed to have been resolved, it does not indicate that the first treatment was the wrong one, but rather that there are more details to be discovered.

Chapter 4: Injury, adaptation and the rotatory consequences of structural instability

“You can’t fool water.”

—Charlie Lange

In the reciprocal tension system, any vulnerability can contribute to any symptom.

Acute injury can lead to lasting consequences long after the acute phase resolves. Conventional wisdom recognizes that a knee injury can result in arthritic changes years later. The mechanisms of this are wide-ranging, non-linear in time and location, and frequently below the threshold of perception. This chapter discusses the sequence of events that contribute to post-traumatic degeneration. Three foundational concepts are:

1. There are two common types of injury: traumatic and microtraumatic. Traumatic injury most commonly results from the absorption of impact coupled with torsion, and involves obvious pain, inflammation and limitation of normal function. Microtraumatic injury is wear and accommodation due to repetitive behaviors.
2. Adaptation to traumatic injury presents in two phases: the acute phase (at the time of first rising from the injury itself) and the chronic phase (ongoing accommodation to the injured state) with long-term post-traumatic consequences. The chronic phase of accommodation is an ongoing process of adaptation to the everyday circumstances subsequent to acute injury, involving both agonist (motor) and antagonist (stabilizing) functions.

Accommodating to an injury requires a strategic reconfiguring of body utilization that allows the injured person to continue with an approximation of normal function while recovering. This secondary accommodation can persist after the acute phase, a proximate behavior with ultimate consequences.

3. The reason we are injured and the reason that we don’t fully recover are often two distinct issues.

The cycle of trauma, adaptation and vulnerability

Injury and adaptation tend to encourage more injury and adaptation. Failure to stabilize results in a cascade of events, a cyclical constellation of complex relationships that contribute to further instability as the adaptive burden increases with time and activity.

These include both local joint instability as well as distal instability transmitted by torsional, lever, tensile and pressure-gradient relationships. A left foot problem can contribute to a right shoulder problem. A right triceps problem can create or prolong injury in the low back.

The need to continue on with the tasks of daily life leads to incremental, mundane behavioral shifts that build upon one another over time. The full significance of these events and their implications are often latent, obscured by the very nature of adaptation which can lengthen the time between cause and effect.

The adaptive process involves the substitution of structures that are less competent at the task than the ones they are replacing, and is therefore characterized by increased vulnerability, similar to how a vehicle that hits a pothole, compromising its alignment, will be more vulnerable to the next pothole. As the adaptive cycle compels a shift in

the regional responsibilities of muscles and ligaments from their original assignment to new and possibly multiple responsibilities, the efficiency of stabilization is diminished.

The structure distorts by torquing and counter-torquing, establishing multiple and potentially conflicting axes of rotation and counter-rotation which affect the interaction of opposing force vectors, most commonly, but not limited to, those of weight and impact.

The classic process of adaptation — trauma/microtrauma and the entangling accommodation to traumas and microtraumas – is an ongoing, lifelong process that continues, and magnifies, unceasingly throughout life.

Traumatic injury

Traumatic injury can initiate a cascade of events involving multiple structures, near and far; a dynamic process that can increase in complexity and consequence for years to come. In the same way that a minor auto accident can result in multiple pages of replacement parts, injury to the body often affects multiple structures and systems. A diagnosis such as Medial Collateral Ligament Sprain will also be likely to require attention to other ligaments, muscles, and retinacula both proximal and distal, some directly related to the trauma and some to the adaptive process.

Three components of injury:

1. The primary injury, usually obvious and painful.
2. Disruption, the secondary involvements; associated structures whose anatomy and function has been disrupted but might be less immediate, less obvious and less painful.
3. Accommodation, an adaptive response that allows continuing daily function during the period of acute injury. The adaptive response is frequently not obvious or painful and can continue indefinitely.

Secondary and adaptive dysfunctions frequently live on as vulnerability. They can linger for years after the acute injury has resolved and are best ascertained by detailed anatomic examination.

Microtraumatic injury

Microtraumatic injury is repetitive stress, often below the threshold of perception. Mechanical distortion can transform normal function such as walking into microtrauma by repeatedly delivering low-threshold impact and leverage into a joint over a prolonged time. Other common sources of microtrauma are sitting and the accommodation to templates.

Templates

Templates are consistently structured environments with which we engage repetitively. A template doesn't change to meet the specifics of our body, instead we are compelled to adjust our bodies to it. Even an ergonomically designed work environment, once established, represents a relatively immovable template (or templates) to which the user must accommodate habitually. The template is fixed but the body can variable on any given day.

There are countless templates in our collective life. Desk and keyboard, driver's seat and steering wheel. A dental hygienist who sits on a saddle chair for hours each day, leaning over the patient to her right as she performs her work, an auto mechanic bent over and reaching into engines every day, a carpenter wielding a framing hammer are examples of more dynamic templates. Sitting nightly on a poorly supportive couch. Any chronic use pattern can be considered a dynamic template.

A Termite Mound

An aardvark, roaming the Kenyan forest, ambles upon a termite mound, built several feet tall. She is especially hungry, and with her ferocious claws she breaks a hole in the side of the mound. Her whiplike tongue flickers into the termite tunnels, and when she has had her fill she rambles on. The loss of termites is minimal, but she has penetrated deep into the mound, exposing the queen's chamber.

Worker and soldier termites mobilize to repair and protect the queen and colony. Thousands of workers begin the daunting task of moving the massive queen while others frantically begin the task of building a new wall to enclose her.

Outside of the hive a soldier termite encounters an army ant that is scouting the territory. A gladiatorial battle ensues. If the termite is able to kill the army ant, there will be more time for the wall to be completed, but if the ant wins the battle, it will be able to go back to its nest and arouse an army. In the end, the ant is victorious and it scurries back to rouse its colony. Thousands of army ants invade the termite mound, overrun the termite soldiers and devour the queen. The queen is dead, and without her, the termite colony will eventually die as well.



A scene from the 1978 documentary film *Mysterious Castles of Clay*

Dynamic Adaptation

Following traumatic injury in which muscles, ligaments and joint capsules are disrupted, proprioceptive calibrations are also likely to be disturbed. Observation suggests that there is no reliable mechanism by which the organism fully reverts to its pre-injury state.

When the acute tissue damage has been repaired, elastic fibers and proprioceptors that have been overstretched or reassigned in many cases do not find their way back to the way they were. The muscle or ligament doesn't return to the prior state of neurologic poise but instead can be slightly lax, just enough to make a difference. Actinomyosin relationships have been altered; the proprioceptive reference point is not the same.

Adaptations arise not only due to injury itself but also as a consequence of the need to accommodate function during the period of recovery. It's not only the ligament sprain that persists, it's also the limp. The organism has reconfigured the gait according to an order of adaptive priorities.

An example: Carpal Tunnel Syndrome

For example, carpal tunnel syndrome might not fully originate in the forearm and wrist. Rotational distortion necessitates consideration of the entire conformational habitus.

While seated at a computer desk, the keyboard and mouse present a classic template. If the oblique abdominals, which wrap around to the posterior ribs, fail to provide equal tension as they lock the torso to the pelvis, torsion will result; the torso will slightly rotate, taking along the scapula as well. This classic pattern is often superimposed onto a slouching posture, a distortion occurring simultaneously in multiple planes.

The scapula often rides the rotation of the torso, altering the position of the glenoid fossae. As the arms are held out in front of the body with the hands pronated, the fingers and wrists flex. Simultaneously there will be small, frequent lateral and rotational motions as the fingers reach out repetitively to the different keys.

These motions occur well beyond the wrists and hands. The biceps, brachialis, supinator, upper trapezius are all engaged, subtly but persistently. The activity reverberates through the entire structure in ways that are barely perceived.

In order for both hands to match the keyboard - a classic template - equally, one or both arms might be rotated slightly and unevenly; one arm might have to reach slightly more in order for both hands to match the template. The template might have been ergonomically engineered but the body can be variable, even from day to day.

The motion of typing consists primarily of two-dimensional flexion and extension at the wrist. This creates a secondary task in the arms as they accommodate to the conflict between the two-dimensional motion of flexion and extension and the rotational distortion of the shoulder, humerus, forearms and wrists.

Two-dimensional motion does not easily tolerate three-dimensional distortion, repetitively stressing the wrists. The diagnosis of carpal tunnel syndrome is correct, and yet the cause of the syndrome is not only in the wrists or arms but also in the core imbalance.

A computer mouse or trackpad introduces a related but distinct template with further implications for the hand, arm, shoulder and beyond.

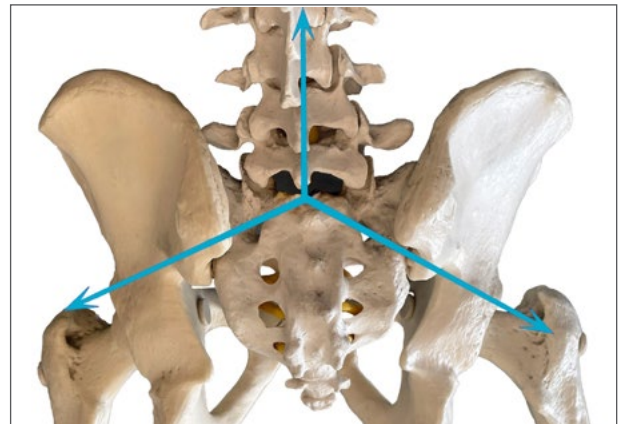
Other common templates include swiping the screen of a phone, the driver's seat with its pedals and steering wheel, as well as a variety of repetitive tasks specific to a person's daily work.

The ordered pathway: the reciprocity of weight and impact

The most common source of compressive force is the opposition of weight and impact. Weight, a descending vector, and impact, an ascending vector, travel through the body in opposite directions. Like two trains in a tunnel, each requires its own track or they will collide. One consequence of repetitive vector collision in a joint is osteoarthritis.

It is important that the body be able to efficiently distribute its weight. The spinal and pelvic mechanism delivers the vector of body weight to the triangular sacrum and divides the weight vector into two vectors, each perpendicular to the two sides of the sacrum, directing the weight to each leg and to the ground.

The same sacral mechanism acts in reverse, conjoining the individual impact vectors from each leg into a single force vector ascending from the sacral base, and up into the spinal spring.



The dispersion and absorption of impact

An impact vector can enter any part of the body from any direction and with any force, but shock in its most common form is an ascending microtraumatic vector that enters through the soles of the feet with each step and comes up through the legs to the sacral base (Phase 1) and then into the spinal column mechanism, which disperses the shock in an orderly manner (Phase 2).

The ordered pathway for the dispersion of vertical vector conflict, Phase 1:

A single weight vector (red) descends from the torso and is divided at the sacroiliac complex into right and left leg vectors. Impact vectors (blue) ascend from the feet through the hips to the sacroiliac complex where they are unified into a single torso vector and delivered from the sacral base into the spinal spring.

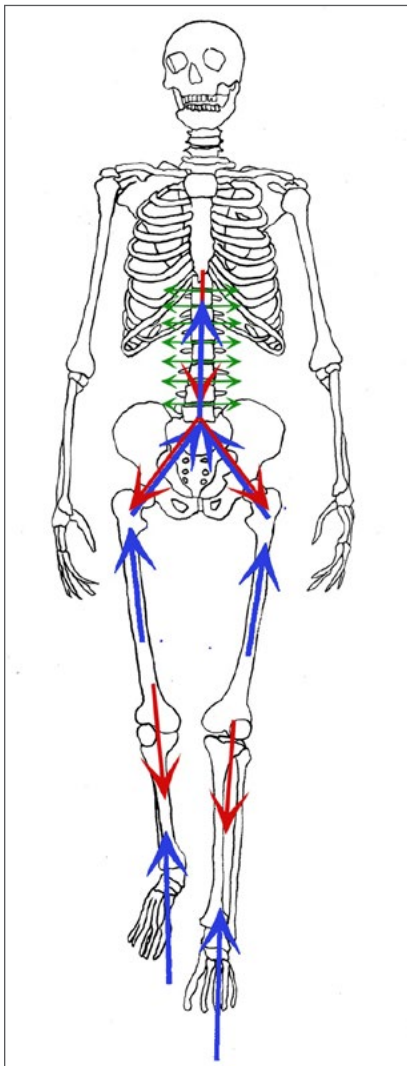


Illustration: The ordered pathway for shock dispersion.

Efficient shock absorption is actually shock dispersion. If the system actually absorbs the shock, the rate of degeneration will increase proportionally to the intensity and frequency of incoming shock absorption. Disruption of the ordered pathway tends to increase focal compression. The collision of weight-bearing and absorbed shock vectors is **pathologic absorption**.

The absorption of shock is degenerative to any structure, living or non-living; a major concern of mechanical engineering is ensure that any force entering a structure is redirected out of the structure as much as possible, and that any force that can't be dispersed is distributed evenly throughout the structure without a focal point. The absorption of forces at a single point tends toward deterioration. Impact vectors are often micro-traumatic, below the level of perception.

The impact vector is active even when standing still; this is what renders mass into weight. The average American takes well over a million steps in a year. Running, hiking, jumping, climbing up and down stairs and hills can increase both the number of steps and the force of each step by multiple factors.

Torsion of the body results in a random redistribution of weight and a concomitant redirection of impact vectors. Previously compromised joints are especially vulnerable to traumatic vectors; both trauma and micro-trauma tend to find the vulnerabilities. Weight becomes collapse.

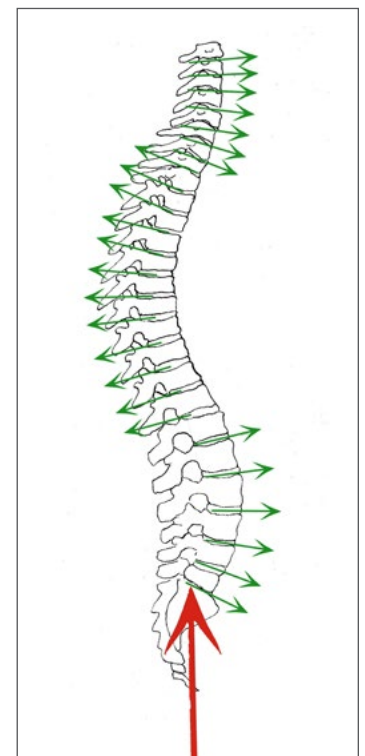


Illustration: The ordered pathway for shock dispersion, Phase 2: The spinal spring : translation of vertical impact vector (red) into multiple, smaller vectors (green) that are dispersed horizontally at the plane line of each disc. The spinal column is rhythmically compressed and released with each step.

Vector paths

Impact and torsional vectors course through adjacent and distal regions by multiple means. Forces travel along the bony levers into the joints. A person who falls off a horse onto their hip can suffer a compression fracture in a thoracic vertebra. Blunt-force impact such as falls, athletic collisions or vehicle accidents, and the slow, destructive distortion of chronically stretched ligaments due to years of slouching at a desk and on the couch are two examples of disruptive influence.

Simultaneously, fascia connects all anatomical components, including the viscera and meninges. The fascial net is both linear and concentric and is especially active in the distribution of torsion and pathologic stretch, including distortion arising from conflicting pressure gradients. Fascial fixations and scars can affect distal structures for years.

Compressive force, whether rapid or incremental, compresses the joint and organ spaces, gradually deteriorating both fluid capsules and cartilage. Bones remodel arthritically in response to articular compression. Compromised organ capsules and compressed or prolapsed organ spaces might compromise the efficiency of organ function.

Torsional force results in rotational distortion of the body, torquing the structures of joints and causing body segments to rotate and counter-rotate in response. Both traumatic and microtraumatic torsion can directly damage the tissues, creating tears and laxity.

Axial rotation coupled with lateral flexion, flexion, extension and translation create distortion in all planes. The effects on distal structures can be complicated in a way that obscures the relationship between local and distal structures, as well as between proximate and ultimate events. Linear relationships - superior and inferior, right and left, anterior and posterior - all become ambiguous.

All of these factors occur simultaneously, and can result in a long-term disruption of tissues in their normal orientation and poise.

Consider a classic gait vector due to a limp that ascends from the left foot and ankle to the knee and hip. The pelvis might rotate to the right in an attempt to minimize impact into the hip and sacroiliac. Chiropractors often adjust the pelvis for correction, only to find that the patient returns with the same pelvic rotation. The ascending vector might continue to spiral diagonally through the torso to the right ribs and scapula, impacting a clavicle compromised by a seat belt injury suffered long ago and forgotten, further destabilizing the scapula and creating conflict in the shoulder, arm and neck. Occupational and athletic motions are further sources of horizontal and rotational vector generation.

If this person is a carpenter, he might have a complicated history of hammering, screwing and driving a drill or saw forward, often from an awkward position. Hammering introduces powerful, repetitive horizontal force vectors. The drill applies its own back-torque into the arm. He begins to develop a right elbow pain, and this motivates a secondary rotation of his torso as he unconsciously rotates his pelvis to redistribute the clash of forces at the elbow joint, possibly in contradiction to his need to rotate the opposite way to accommodate the left leg and hip adaptation. Multiple vectors are created by the ascending impact vector, the configuration of bracing himself while using the drill, and the counter-torsion as he rotates to accommodate the elbow pain. The resulting conflict induces the creation of new adaptations and new distortion vectors. Afterwards he goes for a run, and in the evening he slouches into the couch, surfing his phone while watching TV. And so on.

Needing to complete his work tasks regardless of the pain, the pain eventually increases in the shoulder, spreading into the ribs, scapula, upper arm, shoulder and neck. The habituation of patterned behavior due to the demands of his daily life has linked the left ankle injury and the right arm injury, and the patient now reports that his elbow pain is exacerbated after walking for more than ten minutes. Attempts to relieve the right shoulder, arm and elbow pain locally result in only temporary relief. Only after attending to the old left ankle injury is it possible to finally begin to resolve the details of the right shoulder, arm and neck pain.

There is frequently more than one underlying contribution to a complaint, and it might be that the patient can barely recall the original injuries that occurred in the distant past. Only by detailed examination can his complex be untangled.

Vector paths are unique to each case, a reflection of anatomic, traumatic and accommodation factors which are fluid. Pathways can shift according to the shift in circumstances.

Local joint instability

Stabilization failure is both active and passive. The local stabilization of a joint relies on the contribution of multiple, simultaneous factors, including the structural integrity of anatomic/skeletal morphology as well as diverse functional factors, including the integrity of joint capsule and ligamentous tension, internal and external fluid and pressure dynamics, and importantly for the clinician, the efficacy of dynamic, antagonist muscle and ligament tension.

The stabilization function of antagonist muscles is acuity-dependent, as the antagonist must track the agonist function closely under conditions of simultaneous and rapidly changing motion, velocity, weight-loading, leverage and impact forces. Muscle stabilization provides an active component; as the antagonist muscle tracks the agonist motion it must adapt attentively to the changing status.

The failure of ligaments, fascia and other elastic tissues is relatively passive as they do not contain active contractile fibers; they nonetheless play a significant role in stabilization. They can become overstretched, and remain so, due to traumatic and microtraumatic forces. The loss of proprioceptive rigor can result in a persistent local laxity of the joint, exposing the articulation to injury and persistent micro-trauma that lead to further injury and degeneration. They might have little ability to recover ideal elastic poise on their own, but they respond favorably to skilled manual measures.

Dynamic lever instability

Bones function as levers, delivering forces into the joints and, by association, into the next joint and all joints. A lever by its nature amplifies force; an instability at one end of a lever can destabilize the distal end; this is especially true of long bones. As levers gear into distal joints, these forces can be amplified in multiple ways, increasing both impact and torsional forces. The bones and soft tissue have a reciprocal relationship, exerting both stabilizing and destabilizing forces on one another.

Complicating this is the adaptive response of the organism, which is always seeking homeostasis, in this case in the form of balance. Vitality compels us to seek uprightness and a midline orientation as we confront the various templates of our lives, and we continue to do so until we no longer can, at which point there is breakdown.

We accommodate, unconsciously tilting, counter torquing and shifting our bodies, adding layers of complexity to the adaptive tangle. And, of course, we shift our bodies to avoid pain. All of these challenges tax the efficiency of **dynamic stability**, the stability achieved while the joint is moving (Neumann, *Kinesiology of the Musculoskeletal System*, p144).

Each individual presents a unique version of this process which represents their individual experience: a combination of their anatomical basis, their life challenges and their responses and reactions to these challenges as they encounter the common and uncommon tasks of daily life.

An instability at the torso, pelvis or hip which causes a rotation of the femoral head can result in a rotatory distortion at the distal end of the bone, increasing vulnerability to impact to the foot and knee as well as the hip. The two-dimensional hinge function of the knee does not easily tolerate rotation of its members; there is stress on the joint as the knee flexes and extends because of the uneven distribution of contact and weight at the articulation of the femur with the tibia, leading to degradation of the articular cartilages and menisci as well as the elastic structures of the joint. Both the descending weight vector and the ascending impact vector are implicated in this dynamic.

In similar fashion, instability of the ankle or fibula can also result in conflict at the knee. These lever forces translate readily through the musculoskeletal system to secondary and distal joint relationships: rotation of the lumbar spine → rotation of pelvis → rotation of hip joint → conflict at knee, fibula and ankle; or wrist/arm/scapula/torso/sacrum/pelvis/hip/knee.

In this way, rotation of the pelvis can contribute strongly, even primarily, to a carpal tunnel syndrome (see above). This helps to explain why the reason we are injured and the reason we are not recovering can be two different subjects. There might very well be a local injury at the right wrist but it might not be able to normalize unless the shock vector due to the left leg limp is relieved first, similar to the way a deep knot in a tangle requires that the knots above it be untied before it can be addressed. The costotransverse ligaments might need to better anchor the ribs, and therefore the scapula, to the central pole of the vertebral column. There might be multiple intervening factors requiring resolution before the local dysfunction is available to be addressed.

Patient

A 71 year old outdoorsman in excellent condition. He injured his low back while lifting a heavy motor, something that he did commonly. The pain was significant and he came to his appointment using crutches. He stated that he not only needed the crutches to walk, but that he was unable to stand upright without them. Local attention to his back and pelvic structures provided only mild relief. On his return visit he had been able to trade the crutches for a walking stick but still could not fully bear his weight, nor bend tentatively forward more than twenty degrees.

Examination revealed a circuit relationship between his right lateral triceps and low back muscles. Restoring the right triceps resulted in immediate, dramatic improvement. Lumbar flexion was now eighty degrees with little hesitation and a couple of minutes after he left he returned to say that he had forgotten his walking stick in the treatment room.

It was apparent in retrospect that Ken's pre-existing triceps vulnerability had caused him to adaptively rotate his pelvis as he lifted the motor in order to shift the burden that the triceps was not able to handle to his legs. The angle of his body in relationship to the motor had lined up precisely with the vulnerability of the lateral triceps. There was a likely timing component.

His organism was seemingly unable to let go of the injury until the triceps was restored. It was notable that the triceps seemed to have no problem handling the crutches.

Conformational Habitus

Conformational habitus, or body habitus, refers to the form, the shape, the posture of the body as an expression of its neurologic configuration; the way the body holds itself and surrenders itself, the way it distorts from being fully upright and symmetrical, the rotations and shortening. It is the way the body occupies space; its baseline status, the perspective from which we live, view and strategize our body and its relationship to the world. Conformational habitus represents all of the patterning, behaviors and neurologic expectations of the physical organism. Distortions in conformational habitus represent vulnerability to vector conflict.

Because there is no symmetry in human bodies, visual observation of conformational habitus, while useful, is insufficient in the evaluation of function. Measures taken to restore symmetry, such as tissue work to soften a muscle or vertebral adjustment, work best when determined by neuromuscular examination. We live with our vulnerabilities all of the time and encounter them intermittently.

Vulnerability loops

Dysfunction in both living and non-living systems leads to vulnerability and eventual deterioration. A compromised structure, being less efficient, becomes vulnerable to further compromise, and therefore more vulnerable, as time and activity goes on, inviting more vulnerability and more dysfunction.

A poorly stabilized joint can be more vulnerable an impact vector during a run, or it can destabilize an adjacent joint or one involved in a common activity. For example, an unstable knee can interfere with the mechanics of a shoulder when swinging a golf club. An unstable rib cage can contribute to an elbow injury when throwing a ball.

The phenomenon of vector divergence (scatter)

The collision of shock and weight-bearing vectors has consequence systemically as well as locally. Impact vectors tend to scatter upon impact, splitting into multiple vectors that diverge in an unpredictable pattern and can be absorbed by other body structures where they have a disruptive, degenerative effect.

An simplified example of vector divergence (scatter). The pelvis is rotating to the left because of a subtle but persistent right limp due to past multiple right ankle and knee injuries which shortened the stride time of the right leg and shifted weight to the left to avoid impact while acute.

This causes the left foot to strike the ground with exaggerated force. The ascending impact vector (blue) is being absorbed by the left hip socket, encouraging the pelvis to rotate away from the left, attempting to avoid the shock. There is torsional conflict at the right hip as the leg and pelvis are being driven in contradicting directions.

Secondary vectors (red) diverge from the shock at the hip and are absorbed by distal joints, including rebound vectors that bounce back down into the left knee, ankle and foot. Previously injured or compromised regions are especially susceptible to scatter vectors.

The left arm, shoulder and torso are carried into left rotation by the pelvic rotation. The right arm is rotating externally due to frequent use of a computer mouse, stressing the right shoulder, clavicle, and scapula.

The right leg shows its local conflict, perhaps caused by one past event that sprained the right ankle, causing a persistent limp that pronates the foot, and another event that sprained the right knee, injuring the medial collateral ligament and causing a tendency for the right femur to rotate externally.

Vector conflict can create complex loops of reciprocal reactions that compile and entangle over time.

If a car hits a deep pothole, the jarring impact might throw off the wheel alignment. Once the wheel alignment is disturbed, the car is more vulnerable to the next shock because the car was best able to effectively deflect and distribute impact when the suspension was intact and well-balanced. A subsequent bump in the road that might have been easily distributed might now be absorbed, creating further misalignment, introducing increased impact into the entire suspension system and increasing wear. As the alignment becomes more compromised, the cycle of vulnerability and deterioration continues, and the area affected widens.



Patient

C was walking toward a parking lot when she was knocked down from behind by a 125 lb German Shepherd running at full pace. She fell with significant force onto her outstretched right arm, shattering her right wrist, and required surgery.

The fractured wrist, acutely painful and limiting, was the primary focus of the next two months; there was a protracted recuperation, including intensive physical therapy with a hand and wrist specialist. Eventually the wrist healed, and the most prominent lingering limitation was that she had to adjust her hand position when performing planks and push ups.

Eight months later C developed right thoracic, clavicular, interscapular and upper trapezius pain. There was a constant tension that stiffened her neck. She didn't associate this problem with the wrist injury as some time had passed and the pain was not in her wrist or forearm. The solution was found in the chain of right costotransverse ligaments, and subsequently in the third costotransverse ligament. On two year follow-up, the complaint remained resolved.

In retrospect, there was a direct connection between her acute injury and her subsequent thoracic symptoms. The impact of the fall had traveled up her arm, briefly jarring her right scapula away from her rib cage, and the ribs from the vertebral column, creating a vulnerability that was not immediately noticeable.

The relationship between injury, adaptation and accommodation frequently leads to distal syndromes, obscured by torsional dynamics and the passing of time, and therefore not obvious. Nonetheless many cases of pain and degeneration arise as a direct consequence of a previous adversity. An old knee injury and subsequent, subtle change in gait might be the key to relieving a neck tension on the opposite side. These relationships can be tracked with anatomical examination.

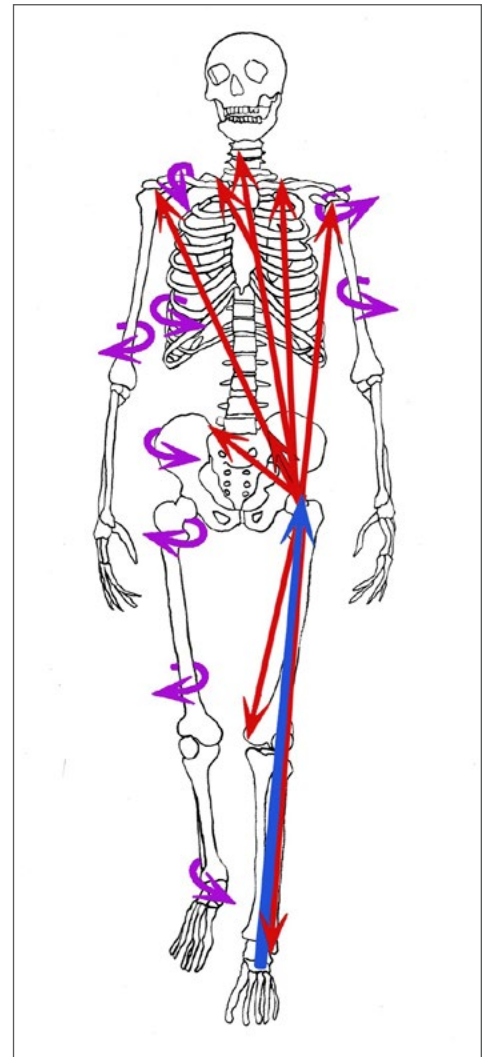


Illustration: Vector Divergence (Scatter)

The nature of springs: dispersion equity

The spinal spring function of the ordered pathway provides significant advantages in the dispersion of the compressive forces of shock and in weight-bearing, ideally absorbing impact as a unified system without a focal spot or fulcrum. This dispersion of impact functions according to three overlapping principles:

1. **Translation:** Translation refers to the transformation of force vectors through an ordered pathway into minimized and redirected forces in order to disperse them. This is ordered translation.

As the spinal spring absorbs and disperses shock its overall length decreases and increases as it compresses and decompresses. As the height of a curve increases and decreases, the radius of spinal curves increases and decreases as well. In a well-functioning spine, the impact of vertical shock is translated with each compression into multiple, smaller horizontal vectors that are redirected at each disc out of the curve through its convexity. In general, a force that translates through convexity will tend to be dispersed, a force that translates through concavity will tend to be absorbed.

2. **Dispersion equity:** The segmented spinal spring distributes each vertical shock vector into 31 lesser horizontals directed out of the body, one for each disc, anteriorward in the cervical and lumbar regions and posterior in the thoracic spine. The head and sacropelvis roll into flexion (fetal pose) and extension (curiosity and engagement).
3. **Rebound (decompression):** A spring by its nature recovers from distortion, providing functional elasticity. The integrity of spinal curves is crucial to this function.

Scatter, discussed above, can be considered a form of pathologic or random translation in which an impact or torsional vector can be passed on to both adjacent and distal structures, changing their direction with degenerative consequences.

The Ordered Pathway, Phase One: lower limb joint spring and play

The first phase of the ordered pathway requires the efficient delivery of shock vector through each of the lower limbs to the sacral base. Each lower joint: those of the feet, the ankle, the fibula, the knee and hip, should exhibit an almost buoyant flexion and extension, and where appropriate, natural rotation that by its nature disperses impact in a springing motion.

If the shock is not delivered efficiently and with bilateral proportion, it will tend to collide with the weight-bearing vector at the angle of the hip joint, causing the femur to rotate, the pelvis to counter-rotate in avoidance, and then break up into multiple diverging vectors (scatter) upward into the torso, shoulders, and neck, as well as ricochet back down the leg in the form of increased force of weight. Phase one shock failure is a significant factor in the etiology of osteoarthritis of the hip and knee, frequently resulting in intractable pain, debility, and eventual joint replacement.

The feet, with their three arches – two longitudinal and one transverse, deserve special consideration. As the foundation of uprightness, plantar arch rebound and the tibiotalar mechanism mediate the immediate perpendicular relationship between uprightness and the “flat” earth.

The feet demonstrate an especially dramatic mid-stance transition from active, absorbent shock absorber into a rigid lever for push-off. One critical focal point of this motion occurs at the lis franc line.

The Ordered Pathway, Phase Two: the spinal spring and the nature of spinal levers

As described above, the oscillating segments of kyphosis and lordosis provide a spring-like function that disperses impact and therefore ideally reduces its collision with the downward force of weight.

Any breakdown in the integrity of the spinal curves contributes to the relative loss of spring function in the spine and the acquisition of pathologic lever-hinge function. A lever is characterized by a loss of both translation and dispersion equity, as the incoming vertical shock vector collides with the downward weight-bearing vector at the lever fulcrum, typically at a single disc level but also involving secondary discs which can be local or, depending on the specific breakdown, distal. This fulcrum acts as a hinge, and as a focal point of pathologic absorption it will be the potential site of arthritic degeneration, frequently accompanied by degenerative changes (to a lesser extent) in the discs immediately surrounding the fulcrum. It is not uncommon for there to be multiple fulcrums in a spine with pathologic curvature.

The degenerative patterns that accompany the loss of specific curves are typical and predictable. Loss of cervical lordosis tends to lead to degenerative changes at the anterior bodies of both the transitional lower cervical and the mid-thoracic vertebrae. Loss of lumbar lordosis typically creates a fulcrum at the anterior bodies of the lower lumbar vertebrae and the transitional segments of the thoracolumbar junction.

In addition, the loss of rebound further compromises the efficient handling of shock and weight-bearing forces, eventually leading to a collapse of the spinal structure into hyperkyphosis. When the degeneration of lordosis is advanced, and accompanied by loss of bone density (osteoporosis), stress fractures of the spine are likely to occur.

This discussion is continued in Chapter 5.

Torsion and counter torsion

Rotation vs. torque: two dimensional vs. three dimensional

Structural deviation is not linear but rotatory; instability causes us to torque. The resultant distortions are transmitted across local and unilateral boundaries. Torsion, the root word of “distortion,” is a passive, subtle and pathological force of consequence, imposed on the body as a result of extrinsic and internal forces or circumstances and the organism’s response to these forces, resulting in a collision of vectors that often are not immediately obvious.

Linear relationships are skewed in ways both direct and consequential. Torsion blurs all linear relationships; right and left, anterior and posterior, superior and inferior, and internal and external orientation are not relevant to an understanding of body dynamics. Torque is a spiral that can twist in any possible direction, in three dimensions and into the fourth dimension, motion. In this way a right leg rotation can be directly implicated in a chronic left shoulder, arm, or neck problem.

Torsion is typically accompanied by homeostatic counter-torsion as the organism attempts to right itself, upright and on center. The ability to determine the primary sources of distortion in each individual is key in effectively solving the puzzle of the patient before us.

Multiple axes of rotation and counter-rotation

The adaptive life can, over time, lead to multiple axes of rotation and counter-rotation, each an example of the relationship between vitality and collapse. The ideal of perfect balance implies that the structure is unified in its provision of the dual tasks of activity: directed at the outer world while maintaining intrinsic stabilization. The ideal axis of rotation of a body is singular and should reside in the midline, specifically in the spinal column. All of the limb functions should flow easily from this center. As previously discussed, the fragmentation into multiple agendas creates conflict in the organism’s task management.

Primary and secondary torsion

When the failure of local stabilizing dynamics results in the torsion of an immediate joint or limb, the torque can be said to be primary. Secondary torque occurs when a primary torsion causes a gear-like rotation or counter-rotation to adjacent or distal structures. If the leg torques, it can create a secondary axis of rotation which compromise the orientation of the pelvis, and therefore the torso and scapula, to a central axis.

For example, a pelvic rotation resulting in a shift in the presentation of the glenoid fossa can adversely affect the opposite arm when sitting at a keyboard template. The resulting carpal tunnel syndrome has its solution distal from the site of pain.

Fixation

The term fixation refers to several ways in which a dysfunction has become fixed and presents as an obstinate limitation to freedom of flexibility, motion, stabilization or wellness. Fixation can take several forms.

1. Fibrosis or scar tissue is the limitation to freedom of movement caused by physical tissue that binds two or more structures together, limiting their mobility and therefore their function. Fibrotic fixation can be the result of traumatic injury, surgery, inflammation or stasis. Organs can become fibrotically adhered to each other or to connective tissue structures due to acute or chronic inflammation, malposition or prolapse. Fixations, including surgical scars, are a source of binding and tend to create a self-propagating loop, causing stasis which leads to further fibrosis.

The degree to which fibrotic adhesions can be resolved is variable, depending on the circumstance. Fascial adhesion can often be improved with skilled bodywork. In cases of chronic, long-standing inflammation, fibrotic adhesions, and especially cicatrix due to deep trauma, pathology or surgery, can be challenging.

2. Vertebral, joint or segmental fixation is the chronic limitation of free motion between vertebral or joint segments. Segmental fixation is synonymous with subluxation, in which a bone has fallen not out of the joint, as in dislocation, but within the joint. Ideally a joint head should almost float in the socket, suspended in the joint in perfect tensegrity. Poor stabilization of either the passive or active component of a joint will result in a fixed and limited joint, increasing its vulnerability to the forces of weight, impact, leverage and propulsion.

Joint fixation might originate distally, a distortion transmitted as a consequence of whole-body torsion.

Joint fixation is often accompanied by fibrosis, especially when irritation and stasis has been long-standing. Vertebral fixation can also possibly be the result of a neural feedback response to organ or other tissue irritation. In this case it might function as a kind of neurologic circuit-breaker, reducing the irritation of constant feedback as an accommodation to chronicity.

Mobilizing a fixated joint can free it from fibrotic adhesion, but in many cases mobilizing a joint will not effectively restore long-term function to the joint because the bones have no intrinsic way of stabilizing themselves. Bones are stabilized or can be distorted by the integrity of the active function of muscle antagonism and the passive contribution of ligaments, fascia, joint capsules and other elastic tissues. The bones are also subject to lever distortion arising from distal origins.

3. Adaptive pattern fixation is a somatonic fixation of adaptive behavior that has been automated for proximate convenience and efficiency as discussed throughout this text. The details of adaptive fixation in an individual can often be comprehended and reduced by examination and appropriate treatment of the stabilizing structures, including their behavioral relationships.
4. Emotional fixation develops according to the principles of adaptation. If an individual survives experiences that are irreconcilable, he will have no choice but to go on. As with any injury, the individual will have created adaptive strategies that allow him to limp along until the wound is no longer fresh, and the emotional scarring can continue to affect their interpretation of, and reaction to, ongoing experience.

An irreconcilable experience that has been survived can be frozen or bookmarked in the dark memory, preserving the possibility that it might one day be revisited, reviewed and reconciled. The storage of memory in the tissues has been explored and documented repeatedly. In cases where, despite retrieving and reviewing the events in psychotherapy, their effects continue to manifest as behavioral or somatic pathology, specific somatic and somato-emotional approaches to the restructuring of tissue memory might be helpful/appropriate.

Stubborn remnants of somatoemotional wounding often involve components of fear, guilt, complicity, and shame, not always rational but nonetheless embedded in the psychic matrix and forming the basis for ongoing, involuntary patterns of filtering, interpreting and expressing interactions.

Visceral dynamics

Organs in their fluid capsules are subject to a dynamic relationship between volume, pressure and prolapse that can bear directly on the body in multiple ways. Expanding tissue fluid compartments create pressure gradients that impose on adjacent spaces, into the fascial net, and contribute to body distortion.

When encapsulated organs in the thorax and abdomen become inflamed, they can create competency volume and pressure dynamics in these semi-closed environments that can communicate across the diaphragm and compromise stabilization in several ways.

For example, a distended abdomen not only extends outward but can also produce upward pressure against the diaphragm and thoracic cavity. One well-recognized consequence of this is hiatal hernia, in which the cardiac sphincter of the stomach intrudes against or through the diaphragm, leading to chronic heartburn and potential damage to the esophagus. Chronic pressure against the diaphragm can also impede the expansion of the lungs and lead to a stiffened, less resilient diaphragm muscle.

The distended abdomen, by its increased mass, also creates a shift in the distribution of weight. In addition, compromised organs are prone to prolapse. Prolapse of the abdominal contents increases downward pressure on the musculoskeletal system while creating strain on the suspensory and peritoneal ligaments. A prolapsed kidney can slide down the psoas towards the lower abdomen. Adhesions can develop, creating long-standing torsional pulls in the fascia, contributing to body distortion and weight-bearing burden. Simultaneously, musculoskeletal distortion can contribute to the compromise of body cavities and organ spaces in a familiar feedback loop.

The totality of the effects of musculoskeletal-visceral loops are not sufficiently studied, but it is reasonable to consider how living under conditions of compression and distortion might compromise the function of the heart and lungs, liver and pancreas.

Soft fulcrums

Swollen internal structures, medical and cosmetic implants, tumors and lipomas are among factors that can create a fulcrum in tissues, introducing distortions to the the linear tension of muscles and fascia. In addition they can exert direct pressure on body structures including the bones. Physical distortion in the torso might also compromise the living space of the viscera.

Breast implants can exert a fulcrum-like pressure between the pectoral muscle and rib cage that can adversely affect the thoracic and interscapular region as well as the ribs. This pressure translates easily to the posterior ribs and can introduce torsion into the whole body. It's possible that one implant of a pair can be fixated while the other is fine.

Fluid dynamics in joints

Fluid dynamics also affect multiple fluid-bearing joint tissues including discs, cartilages, and bursae. Distortion of intra-articular fluid dynamics directs pressure gradients within and against the tissues of joints, contributing in turn to joint degeneration. This is discussed further in Chapter 5.

Hinge and saddle joints, such as the knee or interphalangeal joints, deserve a special mention. These two-dimensional joints do not easily tolerate three-dimensional distortion. For this reason, their failure can be due to forces delivered from above or below.

The location of the complaint is not necessarily the location of the malfunction, and there is rarely only one region of symptom or one site of origin. It all depends on what has happened to the individual in the course of her life, and the details of our body and how we have used it. The reason we have injured ourselves and the reason we are not healing might be two separate issues.

Stages of injury

Traumatic injury can initiate a cascade of events involving multiple structures, near and far, a dynamic process that can increase in complexity and consequence for years to come. In the same way that a minor auto collision can result in multiple replacement parts, injury to the body can affect multiple structures and systems. A diagnosis such as Medial Collateral Ligament Sprain will also be likely to require attention to other ligaments, muscles, and retinacula, both local and distal.

Three components of injury:

1. The primary injury or injuries; often, but not necessarily, obvious and painful.
2. Disruption of the secondary involvements; associated structures whose anatomy and function have been disrupted but might be less immediate, less painful, and less noticeable.
3. The adaptive response, an accommodation which allows continuing immediate and daily function during the period of acute injury. The adaptive response in many cases is not obvious or painful and can accrue indefinitely.

Secondary and adaptive dysfunctions frequently live on as vulnerability. They can linger for years after an acute injury has resolved. Detailed anatomical examination can reveal the details of conditioned interactions.

The complex of adaptation

In summation, the process of adaptation includes:

1. A proximate, initial adaptation, such as the immediate need to rise and walk after spraining an ankle; a limp is initiated spontaneously, pragmatically, and brilliantly.
2. Accommodation: the limitations imposed by the injury compel the organism to initiate an ongoing process of creating strategic behaviors in response to the ongoing demands of daily life – walking, sitting, lifting, carrying, reaching, bending, rotating. As new tasks present themselves, the necessary neurologic resources are committed, and we accommodate to the best of our ability.
3. Automation/integration: The new behavioral patterns are automated and integrated with existing functions and pre-existing adaptations, a process related to the muscle memory that accompanies any skilled task that is practiced repeatedly. Automation allows us to store an adaptive behavior such as a limp and to consistently recall the behavior without having to reconfigure it each time. The behavioral adaptations, stored and habituated, create neurologic patterning, a kind of behavioral template that relates the new behavior to the body as a whole. This process continues throughout the healing period and beyond.

4. Stacking/entanglement: Patterns stack up like a tangle as new adaptations utilize pre-existing adaptive pathways that have been previously integrated, creating new, increasingly complex patterns and pathways.
5. Muting, or normalization, is the accommodation of adaptive behavior into the perception of normal. A new baseline norm is adopted in order to minimize discomfort and distraction. It's not uncommon for a patient, when asked if they are in pain, to answer, "Only the normal pain."

Muscles and ligaments can demonstrate impressive resilience even decades after alteration from trauma and adaptation. Like repairing a short in an electrical system, it's possible that a relatively brief interaction with the proprioceptive mechanism of a muscle or ligament can lead to long-term resolution if it is the appropriate one.

Structural integrity

It is, of course, an advantage if all of our anatomical components are present, normally formed and intact. Any structure that is not properly formed or whose form has been traumatically, degeneratively or surgically altered represents a possible limitation of the long-term ability to adequately stabilize that structure. For example, a glenoid fossa that is congenitally shallow or whose labrum has been torn might allow the head of the humerus to move freely beyond what is safe. In a person with a femur that is congenitally shorter than its matched pair, or which has been shortened after traumatic fracture, it might be difficult to achieve the same structural balance that is possible in someone with an equivalent pair. Nonetheless, in all cases it is to the patient's advantage to be in the most efficient conformational habitus that can be achieved.

The articulating surfaces of bones are ideally shaped and padded to allow the intended motion and to restrict any unintended motion. This is true of all joints and is especially notable in the posterior arch of vertebral joints. Each facet is aligned to allow the adjacent segments to accommodate either flexion and extension or rotation, or sometimes both within their limits. Beyond this, the vertebrae, like all bones, are passive; they do not have the ability to move or stabilize themselves. These functions are provided primarily by muscles and ligaments, as well as by the push-pull lever forces of other skeletal components that are themselves driven by muscle, ligament and vector/pressure dynamics.

Barring physical anomaly, either congenital or acquired, the primary functional components of stabilization upon which we can effectively focus our therapeutic efforts are muscles, ligaments, and associated elastic tissues such as fasciae and joint capsules. Because muscles contain the most neurologic innervation and feedback mechanisms, and therefore the most adaptability, they frequently bear primary responsibility for stabilization and are commonly the first thing to check when determining the cause of instability; however all structural components are equally important. Because the smallest dysfunction can create significant havoc, it is necessary to identify and restore any and all failures of stabilization. The most important component of any system is whatever is its weakest point.

Collapse

Collapse can occur when a joint can no longer be stabilized by the soft tissue tone that supports it. Collapse can be due to overwhelming trauma, incremental microtrauma, referred stress secondary to disease or organ dysfunction, or from the eventual failure of proximate adaptive changes that have been acquired over time due to past trauma and microtrauma. And of course, anatomical anomaly, congenital or acquired, can present an ongoing challenge to stabilization that can be difficult to fully resolve but might be successfully managed.

Joint collapse can be subtle and can often go unnoticed, in part due to the adaptive process which strives continuously to find equilibrium. The body might adjust to the deficit by slightly rotating in order to access the competence of another support system. This adaptation can increase the burden on the adapting structure but it might be able to mask the deficiency for some time before its stability begins to be compromised as well. And so on. Adaptive capacity can be impressively large, can be passed on from structure to structure, and can progress over a prolonged time. Adaptation by its nature tends to obscure the relationship between cause and effect.

We rarely injure only one structure, and complexity can develop incrementally as adaptive behaviors create interdependent relationships between seemingly unrelated regions. Structures committed to supporting inadequacy in other regions are assigned increased responsibility, and as adaptations develop complexity over time, the presentation of symptoms can seem obscure.

When a stabilizing structure cannot perform adequately, it can deliver forces — weight, thrust, torsion, impact — to other structures and joints both proximal and distal. A poorly calibrated triceps can manifest as shoulder weakness, and when the person attempts to lift a heavy load the weight can fall onto an unsuspecting and already-compromised lower body, injuring the low back or hip.

In this case, the patient presenting with low back pain has a primary triceps injury as well, and will benefit greatly from measures taken to restore the triceps as well as the low back. It's possible that the low back injury might not fully resolve until the triceps insufficiency is restored.

Similarly, a knee vulnerability can deliver burden to the opposite shoulder. Each individual case is unique and specific. An understanding of the adaptive relationships between seemingly distal but interdependent functions can facilitate deep and long-lasting resolution.



In January 1986 the Space Shuttle Challenger exploded 73 seconds after launching, killing all seven crew members. The investigation revealed that two redundant O-ring seals in a joint in the Space Shuttle's right solid rocket booster had failed, causing the external fuel tank to explode. In this case, the most important components in that highly technical machine that day were two rubber rings.

Chapter 5: Degeneration: Osteoarthritis, Disc Syndromes and Visceral Prolapse

Wear and Tear

Osteoarthritis, or degenerative arthritis, is the deterioration of one or multiple joints, usually involving the breakdown of the articular and periarticular soft tissue with concurrent osteophytic changes in the bone adjacent to the joints. Also known as Degenerative Joint Disease (DJD), the most common form of osteoarthritis is not a disease but is a wear-and-tear syndrome of cause and effect governed by a logical sequence of events. Osteoarthritic degeneration occurs at sites of persistent irritation due to altered contact pressure, especially at any site at which an incoming impact vector collides repetitively with a weight-bearing vector. The situation is not unlike that of driving a vehicle with poor shock absorbers and unbalanced tires, leading to uneven wear. While joint degeneration may not be absolutely preventable, the rate of degeneration might be minimized by an understanding of the applicable principles of biomechanics and physics. Altered contact pressure also occurs when there is torsion or angle distortion between two or more bones at a joint.

Optimal shock absorption is actually shock dispersion. The absorption of impact is degenerative to both living and non-living systems. A primary goal of structural engineering, and of the design of our bodies, is to manage impact forces by dispersing them out of the system as much as possible. Secondly, any compression that must be absorbed by the system should be dispersed evenly throughout the system without a focal point. Any focal point of opposing forces is likely to be a site of deterioration. Two types of osteoarthritic degeneration are discussed here - spinal and peripheral joint.

The anatomy of intervertebral discs

Intervertebral discs are situated between the vertebrae from C2 to the lumbosacral joint. They consist of a gelatinous **nucleus pulposus** surrounded by concentric bands of dense, fibro-cartilaginous **annulus fibrosus**. The discs, when healthy, account for twenty percent of the length of the spinal column. The cervical and especially the lumbar discs are thicker than the thoracic discs and they are wedge-shaped, being thicker anteriorly than posteriorly, thereby contributing structurally to the cervical and lumbar lordosis. The thoracic discs are relatively flat; thoracic kyphosis is due to the wedge shape of the thoracic vertebrae rather than the discs. Therefore, the degeneration of the intervertebral discs can contribute significantly to the loss of lordosis in the cervical and lumbar areas.

The juvenile disc

The nucleus pulposus is a fluid remnant of the embryonic notochord. At birth it is a discrete, elastic sphere; large, soft, and gelatinous. The fibro-cartilaginous annulus fibrosis is arranged in approximately 12 concentric bands around the nucleus. The fibers of the innermost layers of the annulus fibrosis are diagonal, with alternating layers running diagonally in opposite directions, each layer out being increasingly less oblique than the one beneath it until the fibers of the outermost layer are arranged vertically. The outermost layer is composed of collagenous fibers and receives some blood supply from peripheral blood vessels, but this vascularity does not reach the interior cartilaginous layers, which are avascular and receive their nourishment through diffusion from the vertebral end plates. The annulus fibers, when intact, contain the nucleus and are also sufficiently elastic to accommodate its fluctuations.

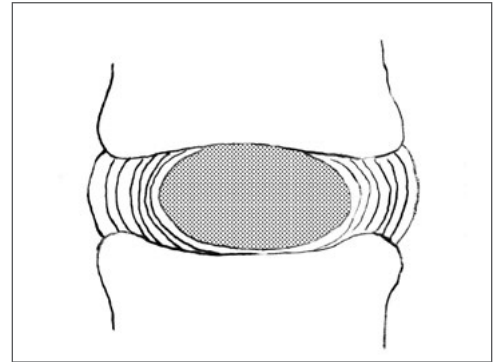


Illustration: cross section of juvenile disc.

The juvenile discs are among the strongest components of the body, being nearly impossible to damage. In early life, the vertebrae will usually break before the discs, except in the cervical spine where forcible flexion can cause rupture of the discs; otherwise the discs can only be injured by being intruded upon by fracturing bone fragments or by being violently pierced by a foreign object.

The mature disc

By the tenth year of life, the notochord cells have disappeared from the nucleus pulposus, and the nucleus begins to lose its distinct nature, becoming discolored and increasingly amorphous, with reductions in its water-binding capacity and elasticity. The mucoïd material begins to be replaced by fibrocartilage derived from the annulus fibrosis and the cartilage of the vertebral endplates. As time goes on, the nucleus pulposus becomes more and more difficult to distinguish from the annulus fibrosis.

Similar structural changes occur in the annulus fibrosis. As its water imbibing capacity diminishes, it loses elasticity, becomes increasingly brittle, and begins to form fissures which are directly related to the change in the nucleus pulposus. As the fissures form, the nucleus fills out into them, losing its spherical integrity and becoming amorphous.

Shock cushion

The healthy intervertebral disc performs two primary functions:

1. The nucleus functions as a ball bearing for spinal motion.
2. Vector dynamics: the spherical shape of the nucleus and the elasticity of the annulus accommodate compression, tension and torsion at the intersegmental level.

The cycle of intervertebral disc degeneration

As the deterioration of the intervertebral discs continues, a cyclical feedback mechanism creates a spiraling degenerative cycle:

1. The loss of spherical integrity in the nucleus pulposus diminishes the efficacy of discal shock dispersion, increasing the pathologic absorption of shock in the disc and contributing to further breakdown of the annulus fibrosis and thereby further loss of nuclear spherical integrity.
2. As the discs degenerate, they lose both height and their wedge shape, contributing to the loss of lordosis and an increase in pathologic shock absorption.
3. As the disc loses height and begins to spread out laterally, the vertebral endplates respond by remodeling to contain them. This osteophytic development is a purposeful and necessary adaptive response to the collapse of the disc and is often erroneously misinterpreted as a meaningless deposition of calcium. Without this response the discs would form aneurism-like bulges and would be more prone to rupture.
4. As the degenerative changes in the structure of the disc cause an increasing loss of lumbar lordosis, the posterior wedging of the lumbar spine due to the effects of all flexion behavior, including sitting and bending, is dramatically increased. This forces the nucleus posteriorward with greater force, with the resulting effect of driving a wedge of pressure into the annular fissures and enlarging them.
5. As the destructive cycle of annulus fissures, the amorphous breakdown of the nucleus pulposus as it spreads into the fissures, and the loss of lordosis continues, the nuclear material creeps farther and farther posterior into the posterior wedging of the lumbar discs caused by sitting and other repetitive flexion behaviors. As the fissures in the annulus work their way through the laminae of the annulus fibrocartilage, the nuclear material can eventually reach the collagen fibers of the outermost layer, hovering on the verge of rupture. The rupture can occur suddenly, without warning; or periodic episodes of acute back spasm can accompany this creeping degeneration for years before the nuclear material finally ruptures through the outer layer of the disc, an event that is often precipitated by such seemingly benign acts as reaching down to pick up a tennis ball or reaching to the floor for a drink while sitting on the couch. The fragment of extruded nucleus pulposus, impinging against the nerve root, can create extreme, unrelenting pain, weakness and paresthesias along the course of the nerve. Herniated discs can appear at any spinal level but the most common sites of discogenic pain - the lumbar spine, with impingement on the sciatic nerve (sciatica) and cervical spine, with impingement on the brachial plexus (brachial neuritis) – occur in the lordotic regions, which as acquired curves tend to be especially vulnerable to distortion.

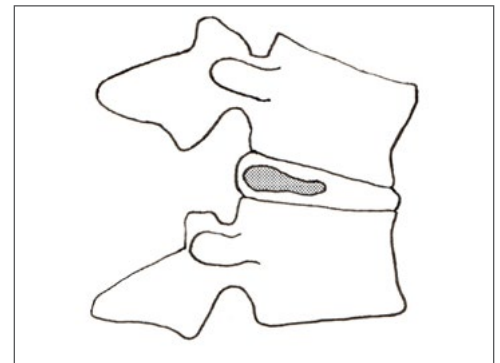


Illustration: Posterior wedging of a lumbar disc.

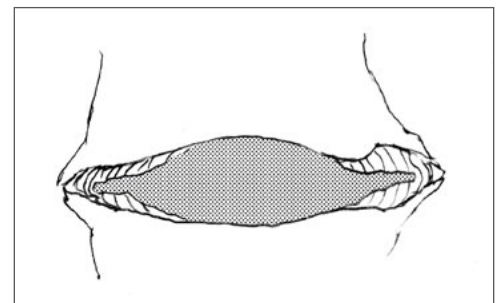


Illustration: cross section of degenerating disc / osteoarthritis.

Osteoarthritis and disc degeneration

Two primary factors that contribute to disc degeneration are compression and torsion. The compromise of spinal lordosis contributes to compression overload as the conflicting forces of gravity and impact are absorbed locally into the disc instead of being deflected out of the spine through the ordered pathway (discussed below). Concurrently, due to the failure of effective stabilization by the muscles and ligaments, as well as deranging pulls from scars and other fixations, axial unity is disrupted. The segments of limb and torso tend to rotate randomly in relationship to each other, driving vector forces into the joints, including the discs. These factors, along with the dehydration inherent to aging, create pressure and tension forces within the discs, leading to a failure of the annulus fibrosis to contain the integrity of the nucleus pulposus.

As the discs age, they become increasingly dehydrated and less elastic. As the annulus begins to surrender to the intrathecal force of the nucleus, it begins to develop internal cracks and fissures. The nucleus gradually loses its spherical shape, becoming amorphous as it spreads into these fissures. The discs begin to lose height, they flatten and spread; and as they begin to bulge out over the borders of the vertebral plates the vertebrae respond by forming osteophytes, in an attempt to extend the plates outwards, curving around the discs so as to contain them. By observing of the shape of the osteophytes we can infer the shape of the bulging discs.

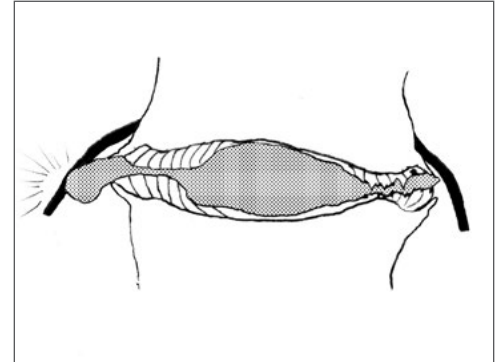


Illustration: cross section of herniated disc with nerve impingement and osteoarthritis.

By observing of the shape of the osteophytes we can infer the shape of the bulging discs.

Kyphosis and Lordosis

The spinal column is organized into convex (kyphosis) and concave (lordosis) phases that alternate with one another to form its typical oscillating shape. This oscillating shape forms a functional spring which when intact serves to efficiently disperse shock in several ways.

Kyphosis, the spinal convexity, is inherent — congenital and anatomical, it represents the fetal curve and under normal conditions is never absent. Kyphosis of the thoracic spine is anatomical. The thoracic vertebral bodies taper slightly anterior and the kyphosis is functionally anchored by the rib cage. The skull and sacral kyphoses are fused. Loss of kyphosis is rare, involving major force trauma leading to death or paralysis.

Lordosis, the concave curvature of the cervical and lumbar spine, is acquired after birth and is functional (not anatomical). Lordosis can be compromised; loss of lordosis tends to increase thoracic kyphosis and leads to degenerative changes in the spinal column. There are also relatively rare cases of pathologic hyperlordosis.

The spinal column at birth is kyphotic. Cervical lordosis begins to develop in infancy when the infant lifts her head and begins to look around. Lumbar lordosis begins when as a toddler she first lifts herself up onto her feet.

As life progresses, cervical and lumbar lordosis tend to decrease; the acquired, vital expression of uprightness deteriorates into a pathological version of our original kyphosis, anatomically rigid and unsuited to upright posture. (There is an interesting parallel here with cellular degeneration, in which the cancer cell somewhat resembles the zygote.) We become hunched over.

Vitality, the enervating life force that animates the tissue and the individual, is recognized in many cultures around the world as chi, qi, kundalini, prana, vital force, life force.

Vitality expresses itself in multiple ways. It is uprightness, tone, turgor, vigor.

There is an anatomical basis of vital force. In the center of our spinal cord is the central canal - our true anatomical core - a pressurized column of cerebrospinal fluid rising upwards against the pull of gravity.

Lordosis, the acquired curves of the lumbar and cervical spine, is integral to uprightness, the postural organization of vitality in defiance of gravity.

It is interesting to note that that joy, curiosity, vivacity and extroversion tend to express themselves as looking upwards (lordosis) while shame, sadness and introversion are characterized by looking downwards (loss of cervical lordosis). When traumatized, we drop down and curl into fetal position (kyphosis).



The soft midsection: the abdominals and spinal compression

The soft-tissue region of the mid-torso, situated between the skeletal regions of the ribs and ilia, stabilizes itself largely by means of abdominal tone. When properly toned, the abdominals, especially the transverse abdominals, hold the mid-torso tightly in a corset-like fashion, lending uprightness to the spinal column and discs.

With good tone, the rectus abdominus holds the pubic bone upwards and the thoracic inlet downwards towards each other, pulling the pelvis up and supporting the optimal weight-bearing angle of the sacrum.

The abdominal obliques contribute to this task and they also act as stabilizing bands. As they wrap around and insert into the posterior ribs, they bind the upper body bilaterally to the lower body. Failure of one or more of the obliques creates a torsional instability of the torso on the pelvis with wide-ranging consequences to the entire structure.

Lastly, the transverse abdominals are a vital component of torso integrity. While most musculature has a vertical orientation, or at least a diagonal one, the abdominal obliques with their horizontal orientation - midline to midline - are uniquely situated to provide the vital function of binding the soft-tissue, mid-torso tube tightly, thereby narrowing and lengthening the mid-torso and with it the lumbar vertebrae and discs.

Imagine a water balloon as representing the mid-section. If you firmly squeeze the middle of the balloon, it lengthens as it narrows. If you loosen your pressure the balloon shortens and widens.

A person with an abdominal “spare tire” and a bulging mid-section is likely to be experiencing ongoing compression of the lumbar spine and collapse of the body weight onto the pelvis, hips and legs.

A primary exercise for the abdominals, especially the transverse abdominals, is **vacuums**.

Exercise: Vacuums:

The vacuum, the core exercise of “core” exercises, is a specific tightening of the abdominal muscles. Setting and holding abdominal tone is the first step in many exercises intended to improve muscle control while strengthening.

There are three aspects to performing a vacuum:

The first aspect is to pull the navel inwards toward the back (Black arrows). This primary skill, while simple, can be difficult for some people at first try but with guidance and practice it can be mastered. This motion will automatically tend to pull the upper abdominals downward.

The second aspect involves tightening the rectus abdominus muscle by pulling the pubic bone upward toward the navel and the ribs downward toward the navel (Red arrows).

The third aspect involves tightening the transverse abdominals inward toward the midline. The transverse abdominals are horizontal from midline front to midline back; in other words, they wrap around the body. Pulling in the transverse abdominals narrows and lengthens the soft mid-torso (Blue Arrows).

These motions, described individually, are practiced simultaneously.

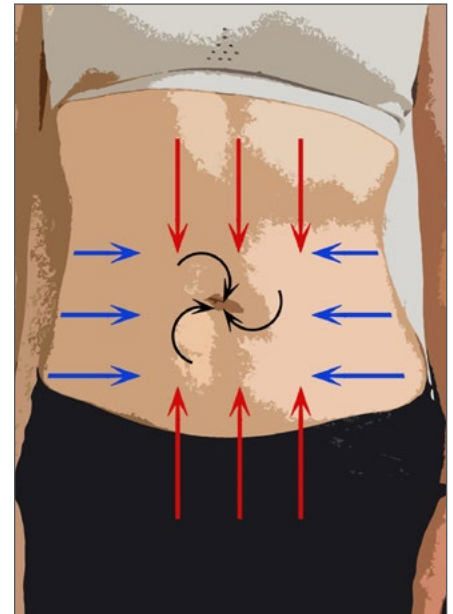
Vacuums are performed repetitively, exhaling on each one. A set of fifty can be accomplished in about one minute. They are usually practiced while standing but can be performed while supine, seated, on all fours, and even while driving.

The abdominal muscles are a crucial factor in stabilizing the core. Our current vernacular often refers to the abdominal muscles as the core, but the actual structural core of the body is the spinal column and within it the spinal cord. Other factors include the tone of the entire antagonist system and the integrity of spinal curvature.

Toning the abdominals also helps to regulate the tone of the entire abdominal cavity and viscerae.

Visceral tone

The internal tone of the viscera and their support structures are a component of abdominal tone. Internal structures must also be able to hold their place. Swollen or prolapsed organs introduce distortion of mass in three dimensions, creating pathological pressure gradients, altering the distribution of weight, and further distorting impact vectors. This dynamic also creates a vulnerability loop in which collapsed abdominal contents are more vulnerable to further impact, contributing to further collapse. These dynamics weigh on the lumbar discs and might tax the ability of venous return to the heart and lymphatic drainage, which are both delivered from the lower body against gravity.



Exercise: Vacuums.

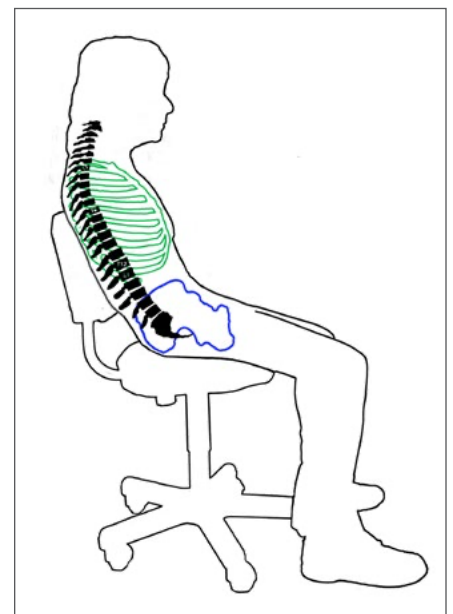


Illustration: poor sitting posture.

The suspension of the organs in the abdominal fascia offers minimal defense against the absorption of shock. The specific pathologic effect of such trauma is not clearly defined but is easily imagined.

The phenomenon of organ prolapse can be observed in many human cadavers and it is worth investigating, for example, how microtraumatic factors might contribute to the surrender of the kidneys or transverse colon to the persistent force of gravity. It is not uncommon on autopsy to find a kidney that has descended down the chute of the psoas into the lower abdomen. Because of their common suspension in the mesentery, and the continuity of the internal membrane system, the organs can exert a structural influence on one another, and on the musculoskeletal system, through reciprocal tension.

We might also consider the effects of pressure and tension gradients - compression, torsion, and shock from mechanical factors - on the hydrostatic pressure in the visceral and extracellular fluid spaces and how this might impede the ability of the blood and lymphatic vascular systems to efficiently deliver nourishment to and remove waste from the tissues. Several in-depth explorations of these phenomena have been published. The writings of Jean-Pierre Barral, D.O. on this subject are especially informative and are listed in the Bibliography.

Lumbar discs: loss of lumbar lordosis

Intact lumbar lordosis of the five lumbar vertebrae provides a stable transition between the sacrum and the thoracic kyphosis. This forms the basis of the spinal spring and is especially challenged by repetitive slouching, bending and lifting. Repetitive flexion of the lumbar spine creates posterior wedging in the discs, discussed below. In addition to stressing the lumbar discs, sacrum and pelvis, the loss of lumbar lordosis tends to increase thoracic kyphosis and drives the head forward.

The loss of cervical lordosis

Cervical lordosis constitutes the upper segment of the spinal spring, ideally providing buoyancy that helps to float the head. The loss of normal cervical curvature creates compression conflict, especially in the lower cervical discs and cervical-dorsal junction, leading to arthritis in the cervical segments. Cervical lordosis is commonly compromised by the loss of lumbar lordosis, which tends to collapse the chest and thrust the head forward.

A less obvious consequence of the loss of cervical curve is degeneration in the thoracic spine, easily observable using a model of the spine. When the cervical lordosis is intact, compression of the neck results in a healthy spring function, translating the vertical vector conflict into multiple smaller horizontal vectors. In the presence of a straight neck, compression creates a lever fulcrum in the anterior mid-thoracics. It is common to see anterior osteophyte development in the mid thoracics. This thoracic degeneration most likely has a cervical origin.



Illustration: compression of an intact spinal spring.

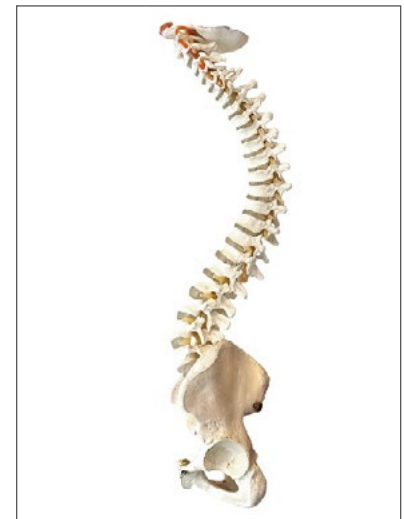


Illustration: compression fulcrum in the anterior thoracic spine due to loss of cervical curvature.

Torsion

Distortion in the body is not linear but is torsional. As the body adapts to adversities it torques around multiple axes of rotation, both primary and compensatory. Torsion obscures the relationships between left and right, anterior and posterior, upper and lower, and internal and external. A right leg impact (ascending) can be delivered to the left shoulder. A poorly stabilized torso rotates and delivers an uneven distribution of weight (descending) to the pelvis and torso. A rotated leg distorts the pelvis and torso while sitting and therefore the arms no longer extend from a centered perspective, which can contribute to the development of carpal tunnel syndrome from repetitive use of a keyboard and cursor. The torsional interconnectedness of anatomical relationships relates each body part to every other body part.

In addition, torsion presents a direct mechanical stress on the tissues, delivering impact and pathological stretch vectors at the joints which deteriorate the articular surfaces and chronically distort the ligaments.

Sitting maladaptation

A primary factor contributing to the loss of lumbar lordosis in Western society is sitting in chairs. This is a difficult adaptation at best. For many of us, our exposure to long sitting began in primary school and continued through our youth and beyond, establishing a loss of lumbar lordosis in early life.

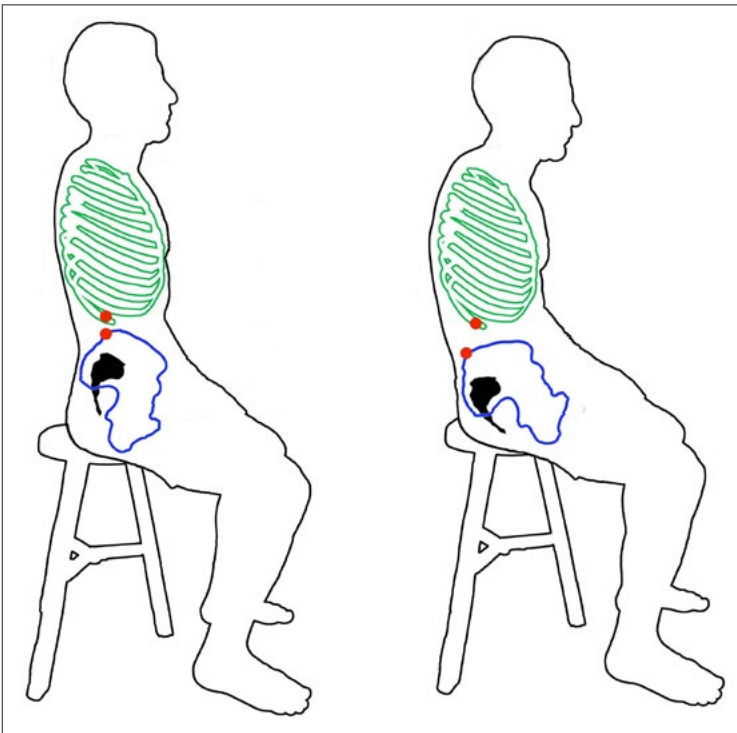


Illustration: ideal upright sitting posture and slouch.

A simple way to think about how to sit is to consider the relationship between the pelvis and rib cage. In ideal sitting posture, the crest of the pelvis rests directly beneath the twelfth rib; here the lumbar lordosis finds a suitable base in the correct sacral base angle. In slouching, with the crest of the pelvis falling posterior to the twelfth rib and the sacral angle approximately horizontal, the lumbar lordosis is compromised or lost, and the lumbar spine instead conforms to the kyphosis of the sacrum and thoracic spine in more of a C-shape. This exaggerates the kyphosis and as a result the shoulders appear slumped forward, the chest collapses, and the head is thrust forward. No amount of pulling the shoulders back can correct the effects of this lower back failure.

The seat of a chair represents an immovable barrier which acts on the long lever of the femur to throw the pelvis posterior and the sacral base horizontal.

It is difficult to sit up straight for long because as soon as you relax, the chair bottom acts on the femur, levering the pelvis posterior, flattening the lumbar lordosis, increasing thoracic kyphosis, hollowing the chest and thrusting the head forward. The collapse that occurs during sitting is often carried into standing posture and tends to increase as time goes on.

It is simply more natural to slouch in a standard chair. Lounging chairs, couches and drivers seats all replicate this circumstance. A well-placed lumbar support is an ineffective attempt at overcoming this problem; it is preferable that the lumbar curve be maintained intrinsically.

The loss of lumbar lordosis results in the familiar syndrome of posterior disc wedging with concomitant posterior nucleus pressure and the stretching of the annulus fibers, posterior ligaments and joint capsules, leading to the thinning and weakening of these structures. The absorption of shock by such a disc can have destructive consequences, encouraging further degeneration of the weakened disc in a familiar cycle of deterioration and vulnerability.

As discussed above, as the disc breaks down it loses height and begins to spread out, and the vertebral plates respond by remodeling to accommodate the expanding surfaces of the disc in an effort to support and contain it. The shape of the disc can be deduced from the shape of the osteophytic development. The presentation of “degenerative disc disease” on x-ray is an appropriate adaptive response to the collapse of the disc.

Center of gravity and thoracic compression fractures

Ideally, the center of gravity in a body should reside in a column down the center of the vertebral bodies, each vertebral body resting squarely on the vertebra below and in turn squarely supporting the vertebra above. In this ideal situation, each nucleus pulposus would situate along this central line, functioning as a viscous ball bearing for any given motion.

The collapse of the lumbar spine that is typical of a lifetime of slouching in chair creates a chronic increase of spinal kyphosis that can shift the center of gravity toward the anterior edge of each lumbar and thoracic vertebra, while simultaneously thrusting the head forward on a caved-in chest. A characteristic fulcrum in this posture is the anterior bodies of the thoracic vertebra, a form of hyperkyphosis resulting in osteophytic degeneration, frequently seen on xray. The collapse of the spinal spring can be carried into standing posture, where it is subject to impact shock.

When combined with a condition of advanced osteoporosis as seen in some older people, especially older women, this same collision of forces at the anterior thoracic spine can result in the collapse of the vertebra, frequently in the lower thoracic vertebra close to the thoracolumbar transition.

Thoracic compression fractures present as a wedge-shaped vertebral body (wedge deformity) that causes the person to fall forward on their spine, from which they cannot recover as the vertebral plates are no longer parallel. The person who suffers from this catastrophic collapse will be unable stand upright, assuming a hunched, painful posture.

The possibility of this degenerative failure is further reason to maintain the center of gravity in the center of the body. Postural awareness is an important skill to develop, but mundane everyday life, especially exercises which are good for maintaining healthy lumbar discs, including vacuums, cobra and the keystone bridge can help to maintain the integrity of central balance and decrease the possibility of vertebral stress fracture in the future.

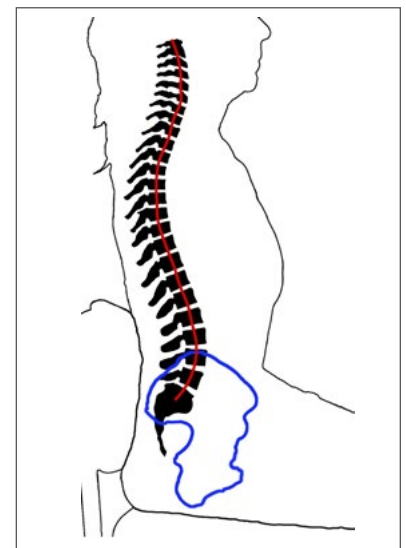


Illustration: ideal spinal center of gravity.

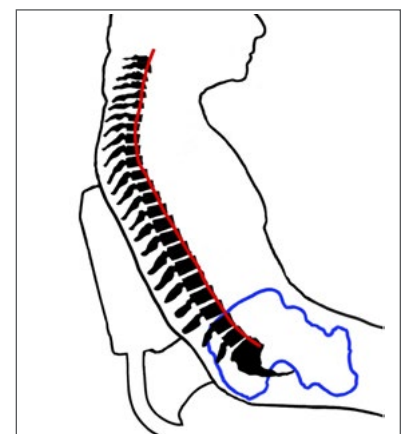


Illustration: pathologic anterior center of gravity.

The function of intervertebral discs

The intervertebral discs function as bearings in the facilitation of range of motion and in the dispersion of shock forces. The spherical nucleus is ideally designed to provide this dual function of deflecting all impact regardless of its variation, and accommodating flexion, extension, lateral flexion, and rotation in its bearing function. In flexion, extension, and lateral flexion the disc will flow toward the open wedge. While the intervertebral discs are often referred to as “the shock absorbers of the spine”, their role in shock absorption is secondary. If they are forced to function as primary shock absorbers they will break down at an accelerated rate.



The impact of pathologic absorption on discs

When a disc is forced into the role of fulcrum, it becomes the site of impact of opposing vectors of impact and weight-bearing. The impact will contribute to the development of cracks and fissures in the annulus, and as the nucleus spreads into the fissures it loses its spherical integrity, becoming distorted and amorphous and therefore less efficient in both its shock-dispersion and motion-bearing roles. The spreading nucleus then acts as a wedge that is driven into the cracks, furthering them along. Thus degeneration begets degeneration. As the nucleus become an amorphous blob within a failing annulus, the entire disc begins to collapse, losing height and spreading out horizontally beyond the edges of the vertebral bodies. The vertebral body, which like all bone perpetually remodels to accommodate whatever stresses it encounters, will begin to develop osteophytic lipping in an attempt to provide a shelf for and contain the spreading disc. This appears on radiographs as lipping and spurring, the hallmark of osteoarthritis.



Illustrations: compression fracture.
Case courtesy of Henry Knipe,
Radiopaedia.org, rID: 51804.

In the photo to the right, evidence of a rotatory impact vector can be observed in a male skeleton, demonstrating evidence of osteoarthritis as well as osteoporosis. The shape of the collapsing and spreading discs can be inferred from the shape of the osteophytes as they remodel to contain them. Note the bowl-like shape of the osteophytes, curving up from below and down from above in an attempt to contain the spreading discs.

- At the lumbosacral disc, the evidence of impact is relatively minor and bilateral, slightly more on the left (individual's right).
- At L5-4 the osteophytes are significant, and predominantly to the left. The bulging disc is spilling over the anterior of the vertebra, not unlike a prolapsed abdomen.
- At L4-3 the impact seems to center, with osteophytic growth significant and predominantly on the right, evidence that the impact vector is spiraling from left to right.
- At L3-2-1 & T12 the vector conflict is relatively negligible and there is slight lipping to the right.
- The impact vector has spiraled out of the spinal column and seems to be directed toward the individual's kidney, splenic flexure and spleen.



Photo: lumbar osteoarthritis.

Peripheral joint degeneration

Hip arthritis can be understood as the direct consequence of the repetitive absorption of impact vectors, often colliding with lateral weight distribution at the hip joint. This failure of the ordered pathway suggests the presence of a persistent limp, the remnant of a historical injury to foot, ankle or knee, possibly all of these. It is estimated that the average person takes between one million and 1.5 million steps a year. A runner takes many times this number. The minimum force impact while standing still, equivalent to our body weight, is amplified by running, jumping and many forms of dancing, and running downhill multiplies this force dramatically. Impact force enters the foot and ascends to the knee, is absorbed at the angle of the femoral neck, continuing into the sacroiliac joint and spine, possibly contributing to spinal subluxations.

Secondary vectors (scatter) can emerge from sites of impact in random directions, including vectors that rebound, intensifying compression. For example, a shock to the right hip can break into several smaller vectors, some of them ascending into the torso while also eliciting rotation in the pelvis, sending increased compression down the left leg to the knee, ankle and foot. Secondary vectors are especially attracted to already vulnerable regions, compounding the burden on previously compromised joints.

Because of the complicated interaction of injuries, adaptation and activity, it is often true that the resolution of one complaint is dependent on the resolution of a distal, seemingly unrelated dysfunction. Shoulder, knee, and other injuries can persist due to the effect of unrelated traumas, both previous and subsequent. The reason that an injury has occurred and the reason that it is not fully healing are often two distinct subjects. By observing the relationships of sequential inhibition, discussed in Chapter 9, these factors can often be revealed and minimized.

The role of lever forces in the transmission of shock

The long bones act as levers which, in transmitting the forces of shock and weight-bearing through the body, can amplify these forces. Force vectors into the joints can be successfully disbursed, and therefore reduced, via the ordered pathway or can potentially collide and be absorbed at any juncture of levers (joints). A joint that is the site of repeated pathologic absorption will be vulnerable to accelerated degeneration of both its soft-tissue and hard-tissue components.

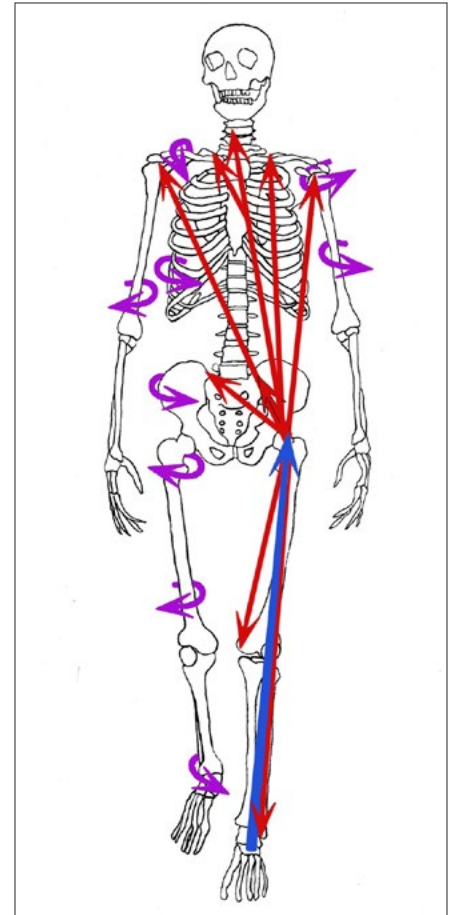


Illustration: secondary vectors.

The impact of pathologic absorption on injured structures

As stated previously, the cause of injury and the reason one fails to satisfactorily recover from injury may be two different subjects. The influence of microtraumatic forces (such as vector scatter), even those that are normally harmless, may be amplified when applied to an injured or adapted structure that is sensitized to impact, torsional and pressure forces. Recovery may be hampered, and the somatonomic response may be to choose a proximate adaptive response as its best immediate option under the circumstances. Therefore the key to healing in the shoulder could reside, for example, in the lower limb or pelvis.

The Loose Armature – Excavator

Imagine a machine with a long, hinged arm, similar to an excavator. The lower arm swivels on a steel base that's bolted to a foundation with four bolts.

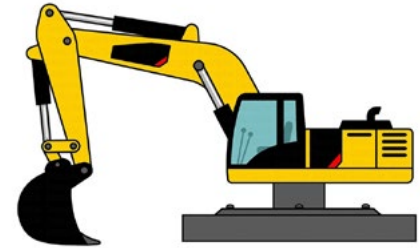
There are two primary factors that affect the structure of this machine: motion at the hinges and impact when the weight of the armature strikes the ground. The hinged arm of this machine raises, rotates and drops, each time hitting the ground with some force.

At some point one of the four bolts anchoring the base to the foundation becomes slightly loose. Now every time the arm falls to the ground, the impact resonates through the entire machine and as the armature lifts, turns and falls, one corner of the steel base lifts up just a bit and the arm motion becomes just slightly wobbly. Over time as the arm goes through its motion, the motion is less smooth, slightly less precise, and the impact of the shock causes the loose bolt to gradually loosen more. As this continues, the edge of the steel plate begins to lift just a bit, exerting an increasing lever force of the plate under the bolt, lifting it incrementally up and beginning to lift the two bolts on either side.

As the base becomes increasingly unstable, the armature, designed as a two-dimensional hinge, becomes wobbly and begins to experience a shock vector at the elbow, delivering disordered lateral and torsional forces that rebound back to the base, subtle at first but increasing in force as time goes on. A two-dimensional hinge does not tolerate three-dimensional distortion, especially critical if the force is repetitive and violent. The armature begins to exhibit a jerking motion that creates uneven wear on the elbow hinge and the bolts that hold it.

Eventually, every time the arm lifts and drops there is a shudder that goes through the entire machine as its motion is increasingly disturbed by secondary horizontal, torsional, and absorptive motions that were not intended in the design of the mechanism. As these forces continue, the bearings at the swivel on the base begin to wear. The impact on the metal of the arm by the hinge begins to harden and become brittle, and eventually the bolts at the elbow hinge become loose until one breaks, and a crack appears in the metal. Ongoing use of the machine will create more and more widespread damage.

What began as a small defect initiated a process of degradation that eventually impacted and degraded every aspect of the machine, both functional and material. This machine, if not attended to, will be subject to failure, all because of one small loose bolt and the failure to address the problem at its origin, when the problem was simple.



Phase one breakdown of the ordered pathway: the persistent limp

The common inversion sprain of the ankle presents a classic stress dilemma: the will to function (walk) against adversity (the injury). Here is an exemplary illustration of a proximate (short-term) strategy that has been integrated into the ultimate (long-term) configuration of the nervous system. The adaptive strategy in this case is the limp, which allows us to continue functioning as normally as possible while avoiding further injury as much as possible. The persistence of the adaptation is not due directly to the injury, but rather to the need (will) to function in the compromised state.

There are many limps; a common one involves lifting the forefoot on the injured side, toes up, the foot externally rotated, the bulk of weight-bearing shifted to the well leg, and a shortened stride time on the injured leg. This foot does not follow the normal gait pattern of heel contact, mid stance, and liftoff, but will instead strike the ground rigidly with only the heel (“peg leg”).

Walking, of course, is a somatonomic function, and whenever non-conscious function pushes into conscious awareness, we experience this as discomfort or pain. It is the goal of the somatonomic mind to return the walking function to the non-conscious realm as quickly as possible so that we can focus our full attention on the task of the moment, whatever it may be.

After a time we are able to limp around without thinking about it. and as the injury heals we gradually allow our weight to settle back onto the foot – the injured, adapted, changed foot, which accepts the load as best it can, and might not be the same going forward.

The gait function can be permanently altered, and the management of weight-bearing and shock absorption might permanently be less efficient, a phase-one breakdown of the ordered pathway. As the shock vector enters the foot it might spiral off-center and collide with the weight vector in the hip, a microtrauma leading to hip arthritis. The injured subject might now be a prime candidate for hip-replacement surgery later in life.

As previously discussed, there is often a specific moment of injury and a specific moment in which we need to conjure an adaptive strategy, but there is not a specific moment of healing in which it would be especially appropriate to discard the adaptive strategy. In many cases the remnant of the injury and adaptation can be identified even decades later and is readily demonstrated. In this case, if a pattern of adaptation elsewhere in the body is cleared, we might see that when the person gets up and walks, the newly resolved pattern instantaneously reconfigures itself just as it had been previous to treatment. This is best viewed as intentional behavior and occurs only because the organism is better off with the adaptation, given the complexity of the circumstances.

An impact vector arising from a gait alteration due to foot, ankle, knee or hip injury can diverge, delivering a force into the iliosacrum and subsequently to the spine, with some vectors ricocheting back down the leg to the knee, ankle and foot, and others scattering into the torso, traveling to either shoulder and the neck, and being absorbed by the visceral compartments along the way.

When scatter vectors are introduced into a collapsed lordosis, the force of compression - the descending vector of weight meeting the force vector of impact ascending from below - will focus at the fulcrum points that occur from this failure, frequently at the apex of thoracic kyphosis and the transitional regions of the lumbosacral, thoracolumbar, and cervical-dorsal junctions. These areas, as well as any random area that serves as the focal point for the collision of compressive forces, can tend to show evidence of arthritic degeneration over time.

It is likely that a chronic adaptation pattern might involve spinal circuit breaking. If a vertebral adjustment doesn't hold, then it's possible that spinal adjusting alone will not resolve the behavior, and in fact might have a deleterious effect by denying the organism its adaptation without remedying the need for it.

This lends insight into the phenomenon of chronic pelvic rotation (short leg syndrome). If a poorly-managed shock vector is ascending up a leg with each step, the pelvis might have rotated out of the pathway of the incoming shock, minimizing the rate of hip degeneration. If this is the case, it might not be doing the patient a service by repeatedly adjusting his pelvis back into the line of impact.

Phase two breakdown of the ordered pathway: loss of lumbar lordosis

The loss of lumbar lordosis can occur due to excessive bending and lifting, frequently from manual labor, or from long hours of sitting.

Additional factors of inefficiency

Increased vulnerability of the discs to impact and torsional vectors can be due a mixture of traumatic and micro-traumatic factors. They might involve a combination of phase one and phase two failure, as well as horizontal and spiraling vectors subsequent to torsion and collapse of torso and cervical structures. All of these factors can be involved simultaneously.

Synchronicity: adaptation in situ

A classic case of real-life adaptation will typically involve an adaptive hologram: multiple simultaneous factors, all representing adaptations arising from the individual experience of the patient. In a typical case of chronic back pain, these might include loss of spinal curvature due to trauma and chronic use; gait adaptations subsequent to limping; remnants of past physical trauma such as sprained ligaments, damaged cartilages, and scars; neuromuscular signaling errors; behavioral adaptations to sensitive joints and viscera in order to avoid further impact; inefficient distribution of body mass, the imbalance of pressure gradients in the numerous fluid compartments and channels; the effects of reciprocal membrane tensions; metabolic, nutritional and toxic factors; and numerous other feedback and feed forward mechanisms. There are also the more subtle but very powerful effects of tissue memory, including potential recall of both physical and emotional pain. This can all represent a significant management challenge for the organism.

Impact and visceral loop

One example of vector failure in the body is visceral prolapse. Prolapse of the breasts, abdomen, uterus, kidneys and colon are readily observable. These structures are subject to the influences of gravity and ascending impact. While it is inevitable that some structures will tend to fall with age, the persistent absorption of shock is likely to accelerate prolapse.

Because multiple factors can contribute to visceral malposition – vector antagonism, repetitive motions, pre-existing and disparate connective tissue failures (old injuries), conflicting pressure gradients, scarring and adhesions, space-occupying lesions and so on, it's not possible to measure the effect of any single factor. Nevertheless, the conflict of antagonistic vector forces in the body, while difficult to measure, are specific and can be considerable in their effect on the individual.

The physiological effect of these forces on the function of organs, vessels and fluid circulation is even more difficult to isolate but again worthy of consideration. There is reason to believe that the efficiency and health of tissue, of a cell, has a relationship to its ability to receive nourishment and purge waste. What is the effect of repetitive impact on the heart, the lungs, stomach, liver, kidneys and pancreas, on the body compartments, the flow of tissue fluid and CSF through distorted spaces and compelling pressure gradients? How does the repetitive absorption of impact and the cramping of space affect the ability of parenchymal cells to perform with optimal efficiency?

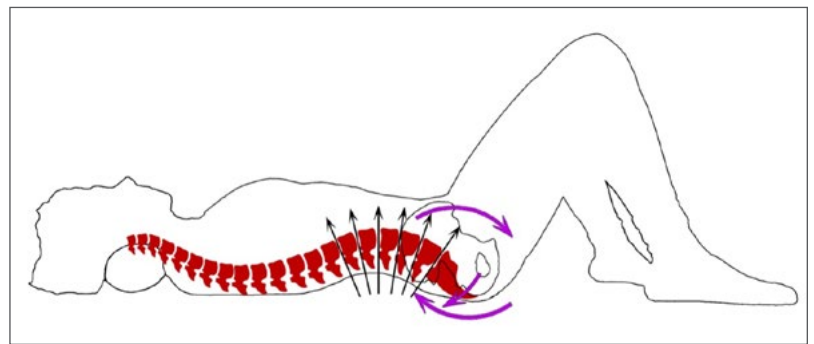
All of these factors occur simultaneously. There is not one solution to the problem of pain and degeneration. General fitness, the maintenance of abdominal tone, a reasonable diet, and the ability to respond to life situations with a resilient point of view are all important. What can be isolated and identified by physical examination is the integrity of neurologic tone in the proprioceptive connective tissues. The contribution of calibrated and balanced connective tissue tone cannot be underestimated.

Some exercises for the restoration and maintenance of lumbar lordosis

The Keystone Bridge

The Keystone Bridge is a most effective daily exercise for the low back and mid-back, especially when accompanied by neck stiffness. It specifically addresses the effects of sitting and bending forward which are a daily strain (microtrauma) on the lumbar discs, muscles and ligaments. The use of computer screens and cell phones can accelerate sitting stress, as we tend to lean forward towards the screen, frequently while slouching in our chair.

Think of how many hours many of us have spent sitting over the course of our lives. By the time we graduated from high school, we had already sat for around 15,000 hours in the classroom. We might also have sat on a train, car, bus, or bent forward on a bike. We might have sat at home doing homework and watching screens. Most of us sit to eat. This is only until the age of eighteen; we can multiply this by many times to estimate our lifetime hours of sitting. Many tens of thousands of hours.



The collapse of your lumbar curve due to sitting can reduce your body's ability to manage the impact of standing, walking, running, and sitting. As discussed elsewhere on this website*, an intact lumbar curve is necessary to efficiently disperse shock. If the lumbar curve is collapsed, the shock is absorbed directly into the discs (microtrauma).

Sitting and bending cause the low back discs to become wedge-shaped, with the open wedge toward the back. This form of compression gradually deforms and displaces the gel (the nucleus) inside the disc, which is fundamental to its shock-managing capability. As time goes on, the disc also becomes dehydrated and more stiff. Eventually, under years of posterior pressure, the nucleus can break through the back of the disc: a herniated disc. Almost always toward the back, pressing against the sciatic nerves and causing pain that is often unrelenting.

The Keystone Bridge creates an anterior wedge in the lumbar discs, an effect opposite to that of sitting, encouraging the nucleus of the disc to drift forward toward the center of the disc. It stretches the ligaments that have been tight and tightens the ligaments that have been chronically stretched. And importantly, it is intended to restore the transitional point between the low back and mid-back where the curve should be changing direction. This is important for the integrity of the spinal spring.

In the Keystone Bridge exercise, the third (of five) lumbar vertebra is the keystone, the center of the arch.

The Keystone Bridge is an active, sustained stretch, held for a minimum of ten to twenty minutes or more. Holding the stretch longer and more times a day will enhance its benefits. It is performed slowly and with attention to nuance, while lying face-up on a carpet or exercise mat.

Place a cervical support under the neck, as the neck and low-back curves have a synergistic relationship. A hand towel, folded lengthwise and rolled up, is perfect for this. The head should rest on the ground.

The knees are bent and held together, the feet are apart, creating a tripod with three points of contact: both feet and the sacrum.

Lying on your back, feel your spinal column relax to the ground. (If this is difficult and painful, try lifting the pelvis up off the ground and resting the upper back first, gradually dropping the pelvis down as comfort allows.)

Begin the bridge by slowly pivoting the pelvis forward. The tip of your tailbone goes down, and the fronts of your hips roll toward your feet (violet arrows in the illustration). This begins to lift your back in an arch. Keep pushing the pelvis slowly but determinedly forward, pivoting onto the tip of the coccyx, and slowly begin to lift the lumbar vertebrae, beginning with the lowest, feeling each segment in the arch. The third lumbar vertebra (of five) is the keystone, the center of the arch.

It is important to keep the ribs relaxed to the floor during this exercise. The thoracic spine, which is attached to the ribs, curves in the opposite direction to the lumbar spine.

As the minutes progress continue to lift the lumbar vertebrae while continuing the forward push of the pelvis. This exercises the arch of the five lumbar vertebra from the bottom up. It takes some time for a dehydrated disc to drift forward through dehydrated fibrocartilage.

The Keystone Bridge can also be an effective solution for acute sciatica. In this case, it must be performed consistently and it will likely hurt. I had a herniated disc some years ago; the pain was excruciating and relentless. Since I was already in pain and couldn't get off the floor anyway, I managed the pain as best as I could and did the Keystone Bridge for 8-10 hours a day. It hurt, but I was fully and permanently recovered in one week from an injury that frequently requires surgery.

It is a sound idea to consult a medical specialist when suffering from a possible herniated disc.



Keystones

A keystone is an architectural invention of the ancient Romans that maintains the structural integrity of an arch. It can be seen under old stone bridges and over old stone doorways and windows. The keystone is the center stone in the arch and has a specific shape which holds the arch.

In the Keystone Bridge exercise, the third (of five) lumbar vertebra is the keystone, the center of the arch.

Cobra

Cobra is a yoga asana (posture) that exercises spinal extension. Cobra introduces both lumbar lordosis and anterior wedging of the discs. An excellent daily exercise, it does not affirm the transition from lumbar to thoracic curves, as it extends the entire spinal column including the thoracic spine. Cobra is correctly practiced slowly and with deliberation. The object is to lift your skull in relationship to your neck, and then each vertebra on the one below, one at a time.

Lie face down with arms to your side. Begin by rolling the eyes all the way up, maintaining this throughout the exercise. This helps to maintain optimal form. Each step of lifting yourself up is accompanied by a slow, even breath.

Slowly lift your roll your forehead forward, then your nose, then your chin. Lift the base of your skull on your neck, and then begin to elevate your neck. When you have lifted your neck as high as you can, begin to lift your shoulders and chest off the floor without the use of your hands.



Illustration: Cobra.

When you have raised your torso as high as you can without the use of your arms, place your hands directly underneath your shoulders, fingers facing each other, and begin to slowly lift your torso, one vertebra at a time, until you have raised up as much as you can, breathing the entire time. The legs should remain on the floor. Hold your full extension for a count of ten, or twenty or thirty, with slow, even breaths.

Begin to lower in the reverse order. Lower your torso until you can hold your shoulders and chest off the ground without your hands, then lower your neck to your chin, then your nose and forehead. Lastly, allow your eyes to roll back to neutral.

McKenzie Extensions

New Zealand physiotherapist Robin McKenzie developed a method for treating spinal conditions in the 1950s. A McKenzie Extension is similar to a Cobra. It can be performed in stages according to the tolerance of an acute injury.

A McKenzie Extension can be practiced statically or by slowly lowering and raising the body to pump the discs.

Chapter 6: Neurologic Circuit Breaking and Vertebral Adjustment: Utilizing The Central Principles of Chiropractic

The name Chiropractic means “practice by hand.” The ability of the human nervous system to perceive, and to transmit and receive benefit directly from one person to another is especially difficult to objectify.

Chiropractic originated in 1895 when Daniel David Palmer thrust on the back of a deaf man, Harvey Lillard, and Lillard’s hearing was spontaneously restored. Although there are no reports of this outcome having been reproduced in clinic or laboratory, D.D. Palmer’s inspiration has carried chiropractic to this day. The early proponents of chiropractic observed improvements in their patients, but tended to behave not unlike religious evangelists of their time—couching their concepts in jargon, making exaggerated and unsubstantiated claims, and adhering to their faith with charismatic fervor while defending themselves as best they could against a strong and unrelenting attack from a skeptical, hostile and increasingly powerful medical establishment that only understood certain things. It’s not difficult to find evidence of paranoid thinking in the writings of both D.D. Palmer and his son B.J., as well as in their adherents and detractors as they bickered amongst themselves, condemning and expelling heretics, disbelievers, infidels and traitors. Despite these criticisms, chiropractic has introduced important concepts into the field of musculoskeletal therapy.

Four fundamental concepts derived from a chiropractic point of view

Four concepts that have evolved from the chiropractic point of view:

1. Both healing (“innate intelligence”) and degeneration (entropy) are inherent. Healing is a process of organization; degeneration is a process of disorganization.
2. The nervous system is a communication system. There are four important aspects to this concept:
 - A. Communication is a primary factor in function, dysfunction, and healing.
 - B. The practice of healing is a communication between practitioner (doctor) and subject (patient).
 - C. The healing process itself is communication between the subject/patient and the self.
 - D. The purpose of treatment is to facilitate better communication within the individual.
3. The spinal column has circuit breaker function (vertebral subluxation) and this function can be utilized therapeutically.
4. The spinal column has motile function the status of which is reciprocally influential with the neurologic circuit function.

The relationship of motion and neurologic function in vertebral segmentation is underscored by the fact that in embryogenesis, each vertebral body is formed from the parts of two adjacent sclerotomes; with the centers of each sclerotome, the perichordal discs, forming the intervertebral discs. Hence the alignment of the spinal nerve roots (the junction of the central nervous system and the peripheral nervous system) and the dorsal root ganglia with the site of intersegmental motion at the intervertebral discs.

Innate Intelligence [The Chiropractor's Adjuster p 491-493]

D.D. Palmer taught that within each of us is an intelligence beyond that of the five senses or common intellect, which he called, "Innate intelligence, known also as Nature." It is "a segment of that Intelligence which fills the universe... that intellect which superintends the vital and vegetative functions... the one who took possession with the first breath ..." and "was the intelligence which had formed the embryo and assisted in the growth of the fetus." It "is conscious of its acts, and is not sub-conscious, below normal; neither is it a consciousness beneath any other". This he contrasted with "Educated mind, ...an intelligence which starts out as a blank, learns to think and reason, its knowledge gained by daily contact with its surroundings." "These two thinking entities exist in the same body; one is all wise, knows all there is to be known in regard to the portion of matter it has under its control; the other knows nothing except as it is acquired".

Palmer's idealistic vision of the organism and somatonic mind recognizes the purposeful intelligence of the autonomic function in healing and in the maintenance of homeostasis. Medicine calls this "vis medicatrix naturae", the healing power of nature, the natural curative power inherent in the organism [Dorland's Illustrated Medical Dictionary, 25th Ed. p 1720]. It also manifests as the homeostatic mechanism. If we cut ourselves, the cut heals; if we break a bone, the fracture mends. We can also refer to this as "somatonic mind" or simply "the organism".

This point of view is especially appropriate in the evaluation of musculoskeletal deterioration, as it is in many cases not a disease process but is a logical consequence of our response to physical challenge.

Both degeneration and healing are inherent; why then does healing so often present such a dilemma, why does the seesaw of health and failed health balance on such a mysterious fulcrum? In order to answer this riddle, it helps to see the situation from the inherent viewpoint, that is, from the same point of view as the organism. Furthermore, we might recognize that in situations in which we cannot discern logic. Logic nonetheless exists.

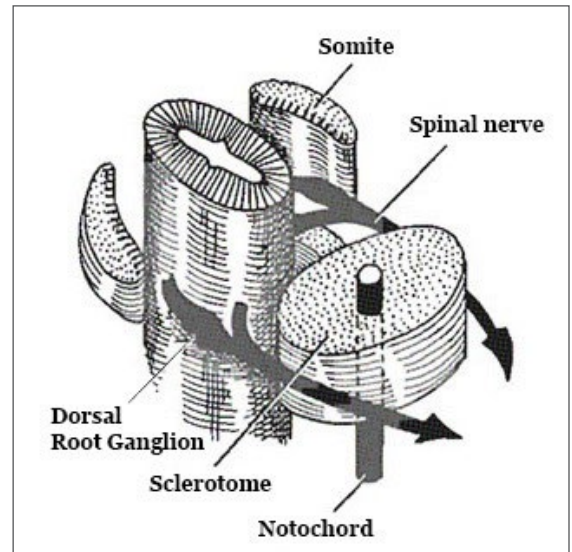


Illustration: embryonic disc and nerve roots.

The spinal circuit breaker: vertebral subluxation

Subluxation, the central concept of Chiropractic, appears as a positional displacement of a vertebra, with neurologic consequences. The concept has been controversial, especially with traditional scientific and medical authorities, since it was first defined by D.D. Palmer in 1895. Some of the non-chiropractic resistance to the subluxation principle originates in the unsubstantiated claims that chiropractors have made, and in the lack of scientific evidence for its validation. Subluxation has historically been defined in chiropractic as “nerve interference”, and chiropractic adjustment has traditionally been thought to remove the interference. This inchoate concept was expressed in its embryonic form by Janse, et al., in *Chiropractic Principles and Technique* (1947):

“The most important information which we can possess is the knowledge that the message which we are reading is not gibberish.” (re: code-breaking)

—Norbert Wiener, *The Human Use of Human Beings*.

“The theory... underlying spinal adjustment may be summed up in five principles:

1. That a vertebra may become subluxated.
2. That this subluxation tends to impingement of the structures (nerves, blood vessels, and lymphatics) passing through the intervertebral foramen.
3. That, as a result of such impingement, the function of the corresponding segment of the spinal cord and its connecting spinal and autonomic nerves is interfered with and the conduction of the nerve impulses impaired.
4. That, as a result thereof, the innervation to certain parts of the organism is abnormally altered and such parts become functionally or organically diseased or predisposed to disease.
5. That adjustment of a subluxated vertebra removes the impingement of the structures passing through the intervertebral foramen, thereby restoring to diseased parts their normal innervation and rehabilitating them functionally and organically.”

Like much early 20th century scientific thinking, the original concept of subluxation as one of mechanical irritation to the nerves with causal consequences can be further refined. Palmer believed that adjustment of the spinal segments was a panacea that could cure all disease.

Evidence of spinal circuit breaking can be readily demonstrated by the clinical response of dysfunctional muscles to vertebral adjustment. Often, muscles that will not lock on manual resistance testing will show a remarkable, temporary recovery after spinal adjustment. While clinical evidence also suggests that vertebral adjustment alone will not reliably produce a long-term improvement in function, an appreciation of vertebral adjustment, when properly regarded and utilized, provides insight into significant and otherwise elusive neurologic processes.

Circuit breaking in the nervous system

The neuromuscular system is a bioelectrical system; it acts by means of action potential, which is a threshold event, demonstrating “all or none” behavior. In other words, neuromuscular function is a binary phenomenon. With an understanding of the binary nature of the neuromuscular system, the mechanisms of strategic behavior can be explored. We are concerned with two types of circuit breaker mechanisms: spinal circuit breakers and peripheral (proprioceptor) circuit breakers.

Circuit-breaking as strategy

The phenomenon that Chiropractic refers to as vertebral subluxation can be thought of as a physiologic behavior with strategic advantages to the organism. While the original chiropractic concept maintains that the subluxation causes mechanical irritation to the nerve root which adversely affects motor control, neurologic circuit-breaking might be best regarded as an afferent (sensory) response intended to facilitate adaptation to adverse situations.

Why would the organism find it advantageous to mute its neurologic signalling? According to Selye, we have two options in response to stress:

1. To change the stressful behavior by avoidance or confrontation, thereby eliminating it or altering it so that it is no longer stress-inducing
2. To tolerate the stress by adaptation or accommodation: learned behavior.

Consider the situation in which we live with a persistent stressor; for example smoking. The first time we inhale smoke our body reacts with coughing and choking, a proximate reaction. If we persist in smoking, the organism finds a way to adapt and it adopts a more long-term strategy. The behavior is not going away, and the organism stops actively rebelling against the irritation and begins to accommodate to it.

The facilitated segment

Also known as a sensitized segment, the theoretical concept of the facilitated segment was first proposed by Irvin Korr DO in 1947. This model suggests that vertebral segments become hypersensitized due to the high-volume convergence of spinal and visceral signals, creating a lower threshold of excitement of afferent signaling, resulting in altered efferent function in both the musculoskeletal and visceral systems (via compromise of sympathetic function). The details of this osteopathic model differ somewhat from those of the classic chiropractic model of vertebral subluxation causing nerve interference. Both focus on the vertebral segment as a primary cause of dysfunction.

Vertebral subluxation

The traditional mode of treatment in Chiropractic is the vertebral adjustment. Traditionally this has been applied by means of a quick, forceful thrust to the vertebral structures. There have also been a variety non-force adjustive techniques, for reasons both practical and aesthetic. Some people simply can't tolerate the forceful adjustments, and others prefer a quieter, less intrusive means of affecting the relationships of the vertebrae. Others prefer the dramatic release of thrust adjustments; many people who visit chiropractors would feel incomplete if they were to leave the visit without receiving an adjustment.

It has been my experience that vertebral adjustments, whether active or passive, have limited long-term effect, in the same way that setting a circuit-breaker switch in an electrical system that has a short-circuit provides only a temporary solution. Everything seems fine for a while, until the system is engaged, and then the circuit breaks again. If the problem is recurring, it is not sensible to keep resetting the breaker. It's necessary to identify and correct the short in the system. In this case, the circuit breaker still has a vital function. After the problem is corrected, it is necessary to reboot the breaker.

Symmetry

One traditional means of evaluating the rationale for chiropractic treatment involves measuring the angles of distortion of various vertebrae in relation to the one above and below. While the data culled from this procedure can demonstrate objective deviation from an idealized "normal", it does not validate a conclusion that adjusting the vertebral segments can resolve these imbalances for more than a short time. Subsequent x-rays don't show vertebrae that are level and uniformly oriented.

Evaluation of body symmetry is not solely the domain of chiropractic. Many bodywork disciplines rely on visual observation of symmetry. Asymmetry is not an indicator of high value because there is no symmetry in nature - no symmetrical person, animal, plant or rock formation. What is of value is not symmetry but balance; not visual balance but functional balance in motion and under load.

Vertebral adjustment

Neurologic circuit-breaking can be seen as an adaptive response to a perceived set of circumstances. Consider the previous model of the common home electrical system. If we find the circuits off, our most logical first option is to go to the circuit breaker box and reset the circuit breaker. If the power is restored and stays that way, we may never question why the break occurred. If, however, the circuit breaker shuts off again, it's likely that there is an active short circuit in the system. In this case, we have two related but separate phenomena at work. Flipping the circuit breaker switch won't fix the short, and fixing the short won't restore the circuit breaker. It is necessary to both fix the short and restore the circuit at the box. In a similar way, while it might seem necessary to adjust the patient at every visit, it is rarely sufficient.

Vertebral fixation can occur for both extrinsic and intrinsic reasons. Impact, tearing and other traumatic events occur simultaneously with adaptive circuit breaking due to the need to accommodate to physiological stresses as well as to injured states. The state of a presenting patient represents the logical best that the organism has been able to do, given the complexity of its circumstance. Therefore, simplifying its agenda is a primary goal of treatment.

If a chiropractic adjustment doesn't hold, it's worth considering that the adjustment did not address the problem at its core. It's possible that the organism has returned to its pre-correction state for purposeful and appropriate reasons known to itself, if not to the doctor. For example, chiropractors frequently compare right and left leg

length. Barring anatomical anomaly, the cause of a short leg is recognized as a consequence of pelvic rotation. A posteriorly rotated pelvis will tend to elevate the acetabulum, leading to the appearance of a short leg on that side. In many cases, adjusting the pelvis will restore equal bilateral leg length. But on subsequent visits, the same leg will often appear short again. I was taught that the pelvis might need adjusting routinely, sometimes as frequently as daily.

This raises a fundamental question of whether the organism is truly intelligent. If it is, then we might consider the possible advantage of a rotated pelvis. Disunity at the ankle or knee can be directing an impact vector up the leg into the hip joint. If the pelvis rotates to avoid the shock, the rotatory motion of rotation somewhat disperses the brunt of the impact, helping to avoid or reduce an immediate consequence of pain, and deferring the degenerative consequences of repeated impact absorption as well.

Therefore applying the same adjustment again and again can grate against the innate intelligence of the body, denying the somatonic self its adaptive response, and forcing it to eventually configure a more complex adaptive response. In this case, the chiropractor might be doing the patient more harm than good.

The first known chiropractic adjustment of Harvey Lillard by D.D. Palmer had an immediate effect. It might be reasonable to assume that if a vertebral adjustment doesn't hold after it is applied that it might not be the singularly most appropriate option. If the subluxation or adaptive pattern continues to return, this is not a random, haphazard or unintelligent phenomenon. It might be the organism's adaptive prerogative, in some way to its advantage, and invites further investigation as to why the behavior returned to the previous adapted state.

Vertebral adjustment will often turn a muscle on that had been failing, evidence of a neurologic function in the adjustment. But often the restoration will not last; it's not uncommon that the simple act of rising from the table and walking ten steps and back will restore the pattern of dysfunction, because when the organism is confronted with weight-bearing and motion it encounters the same need for strategic adaptation that it has been living with. Like the short circuit in an electrical system, when the power flows through the circuit it immediately finds the short and the breaker flips. After the short is repaired it's necessary to flip the breaker to restore power.

A more cogent example is to be found in a computer. Casually restarting a computer will usually have no effect on its function. Occasionally a glitch in a computer such as memory overload will be resolved by a simple restart, like a good night's sleep after an exhausting day. But if an application becomes obsolete or corrupted, or the directory is corrupted, restarting won't address the problem – the software needs to be upgraded or reinstalled, or the directory rebuilt. Now restarting the computer has a specific and essential function – the computer has to be restarted in order to pick up the change in the program.

It's possible during the clinical process of restoring proprioceptive-motor function that, after a treatment, instead of a muscle turning on, every muscle in the body will turn off; the patient will be unable to lock any muscle. The body's entire proprioceptive-motor function appears to have shut down. This can indicate that the intended change has been achieved, but that the dysfunction was long-standing and deeply intergrated into the adaptive hologram. The change in neurologic behavior has left the organism momentarily confused. The previous pattern has been eliminated but organism has not yet integrated the new pattern. In this situation, vertebral adjustment can function like restarting the computer - the response is often immediate and the new locking pattern will be reset.

Peripheral circuit breakers

The sensorimotor circuit between the muscles and the brain originates in the proprioceptive receptors embedded in the muscle fibers, elastic tissues and joint capsules. This model of circuit breaking in the proprioceptive organs is supported by clinical experience. The specific mechanisms described here are based on observation of the neuromuscular response to proprioceptive muscle work, supported by examination, observation, and study.

Signaling errors

Two types of interrelated sensorimotor adaptations, signaling errors are common: proprioceptive errors and inhibitory patterns. Both patterns represent strategic configurations that were adopted at some time in the patient's history for deliberate purposes, and both are relevant to the loss of neuromusculoskeletal stabilization. A muscle can exhibit either pattern or both. These changes in muscle interaction are usually intentional and proximate, subsequent to trauma or microtrauma and the need of the organism to find strategies to keep functioning in the face of these challenges. Occasionally the cause of an adaptive reconfiguration will seem obvious; more frequently it will be obscure. Trauma tends to be random, but the response is purposeful, at least in the short term.

Proprioceptive errors

When the patient cannot lock a muscle at will, it means that although he may be able to move the muscle, he can't precisely locate it in space. In this case, the somatic brain image (the representation of the muscle in the brain) does not exactly correspond with the actual status of the muscle in "four dimensional" space: three dimensions plus timing. The resulting behavior mimics weakness on resistance testing, but will not usually respond to strengthening exercises because the muscle is not weak. Its timing is off, due to a loss of proprioceptive acuity.

Inhibitory patterns

Communication between the muscles is an integral and ongoing necessity for the complex tasks of sensorimotor and musculoskeletal function. Individual muscles routinely facilitate and inhibit each other in the course of everyday life; in any given motion, synergic muscles are recruited and opposing muscles are assigned as stabilizers. In the course of long-term adaptive behavior, however, the relationships between the muscles can become complicated as subdivisions of teleologic centers are created and maintained in response to various life situations. It is possible for one muscle to have cause to both facilitate and inhibit another muscle, and for these priorities to change rapidly, even in the course of performing a single activity. Muscles confused in this way will often exhibit a pattern of sequential inhibition, in which a muscle, when engaged, will inappropriately inhibit one or multiple other muscles. Sequential inhibition can result in the sudden failure of joint stabilization as an antagonist muscle is switched off at the specific moment that it is needed to provide anchoring.

The recognition of sequential inhibition in a patient's neuromuscular signaling will, in many cases, illuminate the functional cause of chronic vulnerability. For example, a construction worker who reports that his back is chronically weak, and that he frequently experiences strong pain in the back of his lower ribs when performing demolition, might demonstrate a sequential inhibition pattern between the left latissimus dorsi and the right psoas; in other words, when the left latissimus dorsi is engaged in wielding a crowbar, the right psoas fails, allowing the pelvis to rotate and straining the back. In this example, restricting treatment to the area of complaint might provide only ameliorative relief, but detecting and eliminating the sequential inhibition pattern might allow the worker to perform his job in the future without the recurring weakness and injury.

(George Goodheart observed this phenomenon and called it "reactive muscles", but did not pursue its significance.)

Clinical Applications

The ultimate intention of clinical treatment is to achieve a long-term reduction of vulnerability to pain, injury and the tendency toward degenerative change by permanently simplifying the agenda of the organism. It might be unreasonable to use the word permanent when speaking of a phenomenon as transitory as life, but it is reasonable to attempt to free the body from any trace of an injury whenever possible. It is possible a good deal of the time.

In the case of many self-limiting musculoskeletal injuries, the cessation of noticeable pain is not the end of the story. “Pain-free” is not an accurate indication that the organism is at pre-injury status, but can indicate an adaptive state which allows the organism to continue to function with acceptable comfort. The process of injury, recovery and activity creates secondary adaptive relationships that might themselves be linked to other adaptations, to other responsibilities.

Another adaptive strategy is normalization, resetting the baseline of perception. The organism can learn to live with a limitation so that it no longer even recognizes it as limitation, through a mechanism such as “competitive inhibition”, in which the nervous system, faced with the prospect of a long-term irritant, such as living next to a freeway or in a noisy city, relegates the noxious stimulus to the background and no longer notices it. It’s common, for example, when measuring cervical range of motion, to find that a person has lost significant rotation of their head and doesn’t realize it.

For these reasons, the consequences of trauma (or microtrauma) commonly leads to a sequence of barely-perceived accommodations that can result in long-term degenerative conditions years later. After the acute symptoms have abated, the associated shifts in function can persist in ways that are subtle and affect the person in multiple and wholly unanticipated ways. These coping mechanisms are in the form of behavioral assignments that are not revealed by standard orthopedic tests, imaging, or blood work. In resolving these adaptive remnants and their limitations, we can help the organism to return to a more direct and efficient functional state.

The degree of neurologic complication is specific to each person, each injury, each history, and the specific activities involved. All of these factors create neurologic patterns that are individual, unique, impossible to predict, and best revealed by anatomical examination. Vertebral adjustment can play a role in this process.

Chapter 7: Principles of Function and Healing: Considerations in evaluating of the patient

“All complication is complicated.”

Neural logic

Life is not logical – a meteor could fall from the sky and hit someone in the head, a virulent infection might overwhelm our defenses. But the organism - that which organizes - operates according to logical, common-sense principles that are simple and reliable, with much of the complexity arising from the large number of components interacting with one another. That the organism is logical might seem to be an obvious statement, yet we find in the clinical field and in the literature of health care little or no reference to logical, organized behavior in relationship to dysfunction, degeneration, and disease. When we address the body, we are addressing the organism.

The organism never behaves randomly, even when we don't understand the logic. The logical basis of the organism is especially readable in the musculoskeletal system. The behavior of the biomechanical organism is frequently based on proprioceptive information that has been adaptively altered and is therefore inaccurate or premised on multiple and conflicting agendas. In these situations, the logic may not be easily discernable without a skilled and revealing examination protocol. It is a distinct advantage to perceive and comprehend the point of view of a patient's somatonic behavior if possible.

The somatic mind

The brain and nervous system are the physical representation of mind, of perception and will, which functions through the neurology. We separate the central and peripheral nervous systems conceptually so that we can discuss and study them, but in reality the brain and nervous system - in fact the entire organism - function as a synchronous unit. The somatonic mind permeates the body microscopically and ubiquitously via the nervous system.

It is the way in which the body is organized and utilized that ultimately affects our function, therefore it is useful to remember that when we touch the body, we are communicating with our subject's inner motive. The muscle is more than flesh, it is also brain and mind, and to disregard its intelligence would be to miss the vital point.

The nature of neurologic communication

The primary function of the nervous system is to communicate, and the basis of successful communication is accurate perception. Afferent function serves as the basis of consistent neurologic organization. The organism relies on the accurate monitoring of its fluctuating status in order to ensure an optimal response to any situation. We have to know where we are in order to know where we're going. In the musculoskeletal system, proprioceptive data provides the basis of appropriate reciprocity as we move and exert. It seems possible that there is a similar loss of reliable sensory feedback in various chronic disease processes, including cancer.

The role of internal communication has been a primary focus of chiropractic from its inception.

Healing as communication

Interactive modes of healing are a form of communication. Because the function of healing is contained within the individual, the ideal healing relationship is one in which the communication between the healer and the subject facilitates improved communication between the subject and himself, allowing the subject to more effectively tap into his innate healing function.

The levels of organization

The somatic nervous system is organized hierarchically on multiple levels. We see something, the arm reaches out and picks it up. The arm, coordinated with eyes as well as with the rest of the body, moves smoothly as a single unit. Internally the motion is complex. Each muscle is facilitated or inhibited sequentially, each assigned a dynamic role as prime or synergistic mover or stabilizer, depending on our body position and our intended next position and intended movement. The basis of this entire process is the neurologic perception of our body – our torso, limbs, and ultimately each muscle in three-dimensional space.

It's similar to the way software is constructed. On the surface is the user interface, which is typically command driven. Beneath this is programming code, an assembly language and underlying all of this is binary function, the basis of the succeeding layers: circuits turning on and off. This all occurs simultaneously, imperceptible to the user.

The will to action occurs as in a word processor: we simply act, just as we simply write. Unseen is the mechanism of the somatic mind, similar to the assembly language of the word processor. Just as the writer is unaware the programming code, we are casually unaware of the rapid, constant switching on and off of neural circuits.

The somatic mind ceaselessly surveys the efferent landscape of the organism and assigns a role to each component as it deems appropriate, adjusting continually to the ever-shifting situation. As we move through an action, the binary role of each muscle is assigned either as a mobilizer or stabilizer, primary or synergist, similar to the binary basis underlying all computer code. And of course, the electrochemical impulse of life itself animates all of this just as electricity animates the electronic realm.

A manual resistance exam reveals the binary status of the individual sensorimotor circuits, muscle by muscle, ligament by ligament, indicating whether each circuit is capable of responding appropriately to the individual's will to lock in place. If not, then all of the simultaneous levels of organization are potentially altered.

The advantage of physiologic focus

The degree to which an organism can maintain its teleologic center, or unity of purpose, determines its degree of adaptive efficiency in the moment. Ideal physiologic focus is centeredness, the commanding view. Optimal focus, singleness of purpose, allows the organism to manage its tasks with the least effort and ultimate advantage. Loss of teleologic unity results in the fragmentation of focus and the tendency towards randomization of concerns, locking up the organism in an adaptive tangle and therefore making it less available to meet the challenges of the moment.

Perfect health is simplicity, which favors efficiency, economy of effort. To be healthy is to be resilient.

Disease and dysfunction

The essential basis of pain, degeneration and poor health is dysfunction. In chronic cases, poor function may preclude pathology by a considerable length of time, even decades. To improve the pathology without improving the functional efficiency of the system is to achieve only partial potential.

The etiology of cell and organ dysfunction is difficult to objectively assess, for reasons including a lack of binary feedback mechanisms in these systems and the very nature of chronicity, in which the factors of degradation are multiple and subtle, occurring over significant time. The binary nature of motoneuron response makes objective assessment of the musculoskeletal system readily available.

Symptoms as an expression of the functional state

The impressive ability of the organism to continue functioning in less-than-ideal conditions contributes to the masking of dysfunctional states. The prismatic nature of the adaptive process can shunt the burden of dysfunction onto other systems, and these systems themselves have their own adaptive capabilities.

The consequences of dysfunction are simultaneously compounded and diluted, and we can continue in this way for much of our lives, until a system finally breaks down. In the interim, a lack of optimal function might result in a myriad of tolerable challenges expressing as a lack of vitality as well as a complex of physical, mental and emotional manifestations that in many cases cannot be obviously linked to any specific origin.

The improvement of function in any system can provide relief to a distal aspect of an individual's experience in ways that cannot be directly attributed. An individual might report an easing of her burden, her vitality, her moods, feelings and thoughts. Her digestion or reactivity might improve, her cyclic symptoms might reduce.

Healing and the asymptomatic state

The relationship between past adaptation and present symptoms can be subtle, and is nonetheless significant. When an acute symptom resolves there are two possibilities: we can heal or we can adapt. Subjectively we rarely know nor care which of the two has occurred. We simply want to do whatever we want to do, with a minimum of interference. But there is a fundamental difference. Healing implies a simplification of function and an efficiency of economy. Adaptation is by its nature a complication of function, detoured function carrying an energetic liability which might or might not be perceptible at the time. When we adapt, there is a potential consequence in the future as the adaptation runs its course, and we might never make the connection between the subsequent ultimate event and the series of subtle proximate changes that we have made along the way.

There are multiple considerations in evaluating efficacy of care. The liabilities of mistaking the asymptomatic state for healing include an increased vulnerability to injury, pain and degeneration in the future. Anatomic examination provides an opportunity to identify adaptive behavior independent of symptomatology.

Adaptive mechanisms that hide dysfunction include: Suppression: intervention, including medical intervention, that is intended to prevent the expression of a symptom. This can sometimes be a good thing, but in the case of musculoskeletal complaint, suppression is rarely an ultimate solution. Examples of suppression are the introduction of aspirin to suppress a fever, or cortisone to suppress inflammation.

Masking: the substitution of one state for another to enable continuance, a satisfactory short-term solution. The use of crutches could be considered as an example of masking. An example of this in the emotional life is putting on a happy face when depressed. Masking and suppression are closely related.

Increased tolerance: the organism exhibits a well-documented ability to tolerate increasing exposure to stressful influences of all kinds. An example of this is living near a freeway; after a period of time, you might not notice the noise. Another example is the increased tolerance typical of smoking, alcohol consumption or drug use.

Muting: the toning down of a symptomatic intrusion so that it is no longer as noticeable as it was. An example of this is becoming accustomed to a limp and relegating it to the background, where it can almost be forgotten. Increased tolerance and muting are similar strategies.

A man brings his car to his mechanic and tells him, “This warning light just came on”. “No problem,” says the mechanic. He lifts the hood and pulls the wire to the light.

Somatization: the expression of irreconcilable emotional pain as physical pain. Sigmund Freud called this “conversion.”

All of these behaviors are closely related and can contain elements of one another. The differences between them are subtle and circumstantial; a person who lives with chronic pain might typically incorporate all of them. The important thing about them is that they are all proximate strategies that allow us to continue functioning while avoiding, or at least decreasing, our discomfort or distraction. There might be ultimate consequences that we might not recognize as such.

Healing and curing

For the purpose of discussion, we might distinguish between healing and curing. Healing is a process that originates within the organism and can be assisted according to the organism’s principles. Curing is provided from without, according to principles extrinsic to the function of the organism. Both healing and curing have their advantages. Curing is the strength of allopathic medicine in the treatment of acute and dire circumstances. Healing is typically a slower process, and can be less reliable when the pathology is advanced.

Different healing modalities are like different languages, each a mode of communication between practitioner and the subject. Acupuncture, homeopathy, osteopathy and chiropractic each speak their own language, utilizing their own vocabulary and their own syntax, each using their unique voice toward a goal of unity and harmony.

The primary intent of healing is that the communication between the practitioner and the subject improves the communication between the subject and himself, thus allowing the intrinsic healing nature of the organism to right itself. Curing can save the day but can present complications that create ancillary problems.

The adaptive hologram

Stress is cumulative; from an adapted vantage we further adapt. A new adaptation utilizes the pathways in place at the time it is configured and can integrate into the matrix of acquired behaviors, arranged hierarchically, similar to a tangle of knots. Under every knot is a knot, and under every adaptive pattern there is the possibility of another linked adaptive behavior.

Because of the cumulative inter-relatedness of adaptations, each adaptation potentially contains any or all other adaptations within its pattern, just as one small piece of holographic film contains the entire hologram. An adap-

tive behavior can potentially recall adaptations that have seemingly been resolved because these patterns were present at the time of adoption and are integral to the complex adaptive structure.

There are several factors to consider when addressing a persistent symptom, even when the symptom originates from an obvious incident.

The reason we have injured ourselves and the reason we are not fully recovering are often two separate subjects. When trauma is absorbed into the matrix of a pre-existing adaptive hologram, the new injury is enmeshed with the previously existing state as well as with the subsequent demands on the organism to perform while in the compromised state.

The pre-existing adaptive state is not always obvious – an adaptation hovering below the threshold of perception can serve as a factor that complicates the ability of the organism to organize an effective response to the new demands placed upon it. The old adaptation might then need to be discovered and resolved before the patient can recover from the more recent injury.

For example, a patient presents with right sacroiliac instability and low back pain which she has had for three years. She says that even lying in bed, she feels like her right low back, pelvis and leg are sinking into the mattress. She is in constant pain and can't find a comfortable position. Some days she goes to bed feeling okay and wakes up in pain. She has seen a primary physician, two chiropractors, has gone through a course of intensive physical therapy and also reports that she had approximately ten sessions with an osteopath who worked on repositioning the relationship of her internal organs. She says that this last work was rewarding and relieved some of her discomfort, especially a component of inguinal discomfort which has now gone away, but the low back pain persists at a similar frequency and intensity. There is also a contralateral interscapular pain and neck stiffness on waking that improves somewhat as the day goes on.

Examination reveals various insufficiencies in her lower body but restoring them does little to alleviate her pain. But after discovering and restoring the failure of her right posterior abdominal oblique muscles, she reports that for the first time in three years she has been sleeping with minimal pain. In addition, she took a long walk and experienced a noticeably reduced level of pain. She says that she feels hopeful.

She then discloses that four and a half years ago she was backing out of her driveway when her car was rear-ended. She was rotated fully to the right, looking back over her shoulder. Because her car was not fully parallel to the vector of impact and she was backing up, there was a pronounced torsional factor. She states that her neck has been stiff and sore since the incident, but she didn't think to mention it because it wasn't so bad and she has gotten used to it. After discovering and restoring the integrity of the left costotransverse ligaments, semispinalis capitus, and stylohyoid muscles, her low back pain goes away and does not return, and her neck pain is greatly relieved.

Similarly, the patient who experiences a moderate whiplash can suddenly complicate an asymptomatic instability in the pelvis and torso, and this vulnerability can complicate and hinder her recovery. The neck injury has been introduced into an adaptive tangle that was already there. In such a case it might be necessary to stabilize the pelvis and torso in order to achieve lasting relief in the neck.

These are two aspects of injury: incidental trauma and persistent adaptations. You might step in a hole and turn your ankle. Or if the ankle is chronically unable to provide consistent stabilization, the ankle might simply invert in mid-stride and turn slightly under, leading to a ligament sprain: a common experience. Chronic and repetitive use patterns introduce further variations of this phenomenon.

The Complex of Healing

The interaction of multiple mechanical and emotional adaptive strategies creates symptoms and difficulties that confront most of us over the course of our lives. Our ability to resolve these conflicts affects our health, our well-being, and our success in living the most creative and productive life.

The strategies that we use to survive and function in the course of our life can subsequently create conflict in other aspects of our life. Each of us can experience injuries and wounds, physical and emotional, from the earliest age that create strategic adaptation and character armor, protective devices that by their nature tend to create confusion between proximate and ultimate priorities in the organism. Wounding, whether primarily physical or emotional, often includes aspects of both.

Strategic adaptation, the response to wounding, is always logical from the proximate point of view of the organism. Even in situations in which the logic is not obvious, there is internal logic. The process of healing often involves the retrieval and reordering of this logic.

Simple physical adaptation is mechanical in nature. Pure mechanical adaptations are often the most simple and straightforward to resolve. These adaptations, when chronic, can contribute to degenerative structural conditions such as osteoarthritis, chronic tendinitis and other musculoskeletal and joint conditions.

The resolution of mechanical adaptations can simplify the adaptive burden on the organism and reduce its workload, freeing up adaptive energy that can be reassigned to complete daily tasks and to assist in the resolution of that portion of the adaptive burden that is not purely physical.

Physical adaptation tends to be relatively straightforward and can be illuminated by physical examination. The configuration of emotional adaptation can be more complicated and more challenging to resolve. Emotional imprinting can be more likely to evoke fear as well. The resolution of strategic mechanical layers can assist in enabling emotional healing by reducing the adaptive burden.

The benefits of neurologic simplification

Our organism is an economic system; the currency is ATP and the balance sheet is reflected in our expenditure of energy and the assignment of our resources, the distribution of function and responsibility. Our wealth is our health, our vitality and our resilient immunity.

Adaptation implies a complication of function, the recruitment and commitment of resources and energy redirected from other functions, leading to degenerative or pathological consequences in our future.

Healing implies a simplification of function, a freeing up of adaptively assigned resources with a concomitant liberation of energetic economy.

The full biologic relationship between our past, present and future is difficult to demonstrate objectively because of the very nature of adaptation, which tends to obscure the relationship between cause and effect, especially in regard to chronicity. The energetic, mental, emotional and attitudinal benefits of streamlining the neuroadaptive agenda are therefore anecdotal, and are yet abounding. There are no guarantees and no rules, but there are principles.

Emotional underlay

Physical adaptation can be accompanied by an underlay of emotional adaptation that might require resolution in order for the physical injury to resolve. Or it might be that a physical injury needs to be resolved so that an emotional fixation can be relieved.

The persistence of emotional wounding is sometimes referred to as stress storage or tissue memory. There is also the somatization of emotional pain, in which an overwhelming emotional pain can be expressed as physical pain.

A woman in her late thirties presented with a complaint of deep pain in her right leg of two weeks duration. She had no experience of recent injury and had first felt the pain in bed, which increased on arising. The treatment proceeded normally and she felt better afterwards. On her followup visit a week later, she told me that after the visit she had gone home and spent the evening crying, spontaneously recalling an event from her high school days, some twenty years before. While on a skiing trip with a group of friends she had taken a fall resulting in a compound right leg fracture. She spent the next two weeks in a hospital bed with her leg casted and in traction, and while helplessly immobilized she learned that her boyfriend had gotten together with another girl on the ski trip. She hadn't thought of this episode for years but after the treatment the memory and grief flooded back in. The next day she felt a shadow of sadness and was able to move on with perspective, feeling no need for further action. This is an example of somatoemotional release, reflecting a relatively mild trauma in a healthy individual. In other cases the trauma can be more acute, the wound deeper, and the person can be more seriously affected.

Trauma to the emotional self often creates a kind of psychic node, in the way that a bookmark might be placed before the book closed. The trauma is an irreconcilable experience and yet a traumatized person must go on with their life. The emotional bookmark might be regarded as representing the possibility, the hope, that the irreconcilable can be reconciled. It allows a revisiting of the traumatic event or its consequences and presents an opportunity for reinterpretation, if not of the event itself then of the ways in which the event has affected the feelings, attitudes and behavior of the traumatized person. Techniques that address this phenomenon are not the subject of this book, but they are important and can function synergistically with biomechanical work.

Emotional stress functions according to the equation of stress, the same fundamental principle as mechanical stress: the need to continue on in the face of adversity creates strategic adaptation. Unlike mechanical adaptation, emotional adaptation does not express itself in binary terms and is not easily discoverable by objective examination. Emotional stress in many cases can arise from wounding by other individuals behaving badly. These scars can evoke terrifying emotions and create a profound, lifetime spiritual and existential dilemma. Healing at its deepest is the resolution of the spiritual dilemma and suffering that can alter the course of a life. We cannot change what happened, but it might be possible to reclaim aspects of ourselves that have been sacrificed to suffering, and to redirect the focus, the energy of that suffering to more beneficial expressions.

Chapter 8: Orthopedic Resistance Testing as an Indicator of Proprioceptive Integrity

When dealing with mechanical dysfunction it is important to establish clear therapeutic goals and a plan for proceeding forward. A comprehensive anatomical examination of the specific structures and mechanisms that stabilize the body provides singular insight into the dynamics at play in the etiology of pain and degeneration in each individual.

In the absence of structural anomaly, which can be congenital or acquired, the primary factor of stabilization is the functional integrity of antagonist muscles, ligaments and associated connective tissues such as joint capsules, fascia and other membranes. They are the natural focus of a gateway exam.

There can be a substantial difference between diagnosis and functional evaluation. For example, consider a case in which water is seeping from the base of a wall onto the floor. The diagnosis might be “water on the floor.” Evaluation might reveal that there is a leak in the roof. The water is coursing under the roofing, falling down a stud, across a beam, and down another stud, all unseen behind the wall until it finally spills onto the floor. The site of the leak in the roof and the site of the puddle on the floor have no obvious relationship, and yet the relationship is direct. The course of the water as it makes its way down is not predictable, and a similar leak in a different roof will likely follow a different course. Adaptation, like water, follows the path of least resistance.

Diagnosis can frequently be not more than a naming of the region affected, such as “rotator cuff syndrome” or “tendinitis.” A detailed anatomic exam can reveal the specific structures involved. The problem might be in the lateral head of triceps and the coracoacromial and coracohumeral ligaments. Another person with a similar diagnosis of rotator cuff syndrome might have a failure of triceps and infraspinatus.

Manual resistance testing of muscles has been utilized in multiple ways since Dr. Robert W. Lovett first began to utilize gravity testing at Harvard University in 1912. Traditionally muscle testing has been regarded as an indication of strength and graded according to various scales. The Lovett system graded muscles as Gone, Trace, Poor, Fair, Good and Normal. Another system commonly used today grades the muscles on a scale of 1-4, with grade one representing an inability to hold the muscle in position against gravity, and grade 4 representing satisfactory resistance to applied pressure. In their text *Muscles: Testing and Function*, Kendall and McCreary assign positive and negative gradations to the Lovett scale, arriving at thirteen gradations.

Resistance testing as utilized here is not an indicator of muscle strength but rather of the integrity of proprioception. It is a binary sensorimotor response. The muscle will either lock in response to the person's will to lock it, or it will not; it will be either facilitated or inhibited, on or off. What can be observed is signaling and assignment.

Stabilization is acuity-dependent; the effective antagonist must track the motion of the joint precisely in terms of position, strength and timing. Failure to lock indicates that the perception of the muscle is imprecise. The muscle is poorly calibrated. By checking the proprioceptive/ γ -motor loop with resistance testing, the accuracy of sensory function can be deduced from the motor response.

Because myoneural function is a binary phenomenon, there are three grades of muscle response: Gone: in which there is pathologic neurologic deficit, acute or chronic tissue damage, or muscle atrophy

1: in which the muscle locks, demonstrating proprioceptive integrity

0: in which the muscle fails to lock, demonstrating a lack of proprioceptive integrity

All other grades of muscle dysfunction are demonstrations of recruiting activity or improper testing procedure. Patients who suffer from severe injury, joint arthropathy, neurologic deficit or atrophy may be poor candidates for resistance testing.

Ligaments, fascia, joint capsules and associated connective tissues can be tested in a similar manner. Although they often contain less proprioceptive fibers than muscle tissue, they also respond well to testing and treatment. While this text sometimes refers to muscles for the sake of brevity, all references to muscle testing and response apply equally to ligaments, joint capsules, fascia and other connective tissues as well.

Proprioceptive integrity

Neuromuscular function - and life itself - is first and foremost a sensorimotor phenomenon. We perceive, evaluate, decide, and act. The organism receives input from the proprioceptive system and assembles a somatic image which we rely on intrinsically as the basis of both motion and stabilization. We know without looking that our knee is bent or our hand is palm-up. If the accuracy of spatial recognition of the muscle or ligament in the brain is inaccurate, the response will be less than optimal. A person's motor function can seem normal while their stabilization function is compromised and vulnerable. The process of adaptive normalization can reinforce this perception.

Resistance testing evaluates the integrity of each proprioceptive-motor circuit, and manual recalibration of the proprioceptors can restore the proprioceptive acuity in each muscle and ligament, leading to profound and long-lasting improvement.

Binary system

Muscle locking conforms to a fundamental principle of nerve function, the "all or none" rule, which states that motor neuron function is a threshold, binary phenomenon. The ability to lock is an indicator of this binary function; the muscle will either lock or not.

If the muscle can successfully be locked on command, we can assume that the muscle is being accurately represented in the sensorimotor cortex and that the subject is therefore accurately reading the muscle in space. If the muscle fails to demonstrate a locking point, this indicates that the subject might be unable to accurately locate the muscle spatially due to poor calibration of the proprioceptors, a γ -motor function. Because the efficacy of stabilization depends on the acuity of proprioception, failure to lock can indicate a chronic vulnerability.

Neuromuscular reassignment

Pain and adaptation are two consequences of both traumatic and microtraumatic injury. When injured, we can reconfigure the way we use our body, for example by the altered gait of limping. The new gait allows us to fulfill the dual priorities of adaptive behavior: to provide as near normal function as possible while simultaneously avoiding further injury as much as possible.

By automating adaptive behavior, the limp does not have to be recreated each time we begin to walk. In addition, automation helps to reduce the distraction that an adversity represents. The behavior, codified and locked in to the neuromuscular system, allows the organism to regard the newly-patterned behavior as a normal state.

In this way, after the acute stage of an ankle sprain we might limp along with a gradually diminishing awareness of discomfort for several weeks until we no longer notice it at all, leaving only the altered gait as a kind of behavioral scar.

The manual resistance test as indicator of adaptive strategy

Observing of the binary behavior of muscle locking can provide unique insight into the language of physical adaptation. A muscle or ligament that is not acutely injured and cannot hold its place can be regarded as a structure that is not being accurately represented in the somatic cortex. The muscle is not weak, it is poorly calibrated. In binary terms, it is off at a moment when it is being willed to be on. I believe that this is primarily a factor of timing.

A muscle that has been reassigned and subsequently integrated into an adaptive pattern has been utilized for reasons that are intentional, logical and intelligently configured for short-term benefit. As we live, act, react and adapt through the years, our organism becomes increasingly invested in the adaptive process. Carrying responsibilities from the past tend to make us less available in the present.

By thoroughly examining and charting the anatomical components of the neuromusculoskeletal system, we can gain insight into the details of adaptive accumulation. It is exquisitely simple and yet deeply profound.

Two aspects of neuromuscular dysfunction: proprioceptive-motor errors and sequential inhibitory patterns:

Utilizing resistance testing, two aspects of neuromuscular dysfunction can be observed. A proprioceptive-motor error is the simple failure of an individual muscle to lock in response to the subject's will to lock it. This is the most basic indication of proprioceptive/ γ -motor dysfunction - a local, individual muscle behavior in which the locking action fails due to imprecise sensory perception. The proprioceptors are not properly calibrated.

A finding of simple proprioceptive-motor error can represent a relatively fresh or uncomplicated adaptation. A patient will sometimes maintain that they could not hold a muscle because the position is painful, but in many cases the test is painful because they cannot hold the muscle.

A sequential inhibitory pattern is a neuromuscular behavior in which one muscle, when engaged, changes the behavior of other muscles by inhibiting their response. The inhibitory response can be localized or system-wide, and can affect the relationship between seemingly unrelated muscles. Sequential inhibition can reveal an adaptive behavior that was adopted in response to a past injury and has been woven into the neurostructural net. The behavioral implications of past injury can reach back decades, often originating in incidents that have been forgotten.

A muscle that inhibits the response of other muscles can be seen as recruiting the support of those muscles ("target" muscles) by redirecting their attention from their previous, simpler and more localized focus to one in which they have been recruited to attend, as best they can, to the compromised stabilization that the inhibiting muscle has been unable to sufficiently provide. The redirected muscle is distracted from its normal role, its focus divided by multiple tasks.

Sequential inhibition of muscles (see also X-E-3)

Muscles are in continual communication with one another as they balance the dual functions of simultaneously providing both mobility and stability. When the organism perceives that a primary antagonist is unable to provide adequate stabilization, it will mobilize secondary antagonists. The provision of secondary antagonists is essential and routine; the organism will always find a way until the point at which it cannot.

In any position, given the next intended position, a primary muscle requires that some muscles pull with the motion (co-agonists) and other muscles lock against the motion (antagonists). In the next moment, the opposite assignments might be required as the arm changes direction. It is the moderating influence of antagonist function

that prevents the mobilizers from pulling the joint apart. Any number of assignments might be configured as the body bends, turns, twists, and exerts.

By testing muscles sequentially it is possible to gain insight into the configuration of adaptive behavior that an individual organism has adopted and integrated into its function. When muscles are tested sequentially - testing one and immediately following with another - it is evident that engaging a muscle can cause other muscles to redirect their focus. A muscle that was facilitated will suddenly be inhibited; a muscle that was inhibited will now be facilitated. This behavior is consistent and reproducible.

Secondary antagonists are a detoured function, not as efficient as the primary antagonist. A recruited muscle is not at an optimal vantage to provide the function of the original muscle. In addition, adaptive reassignment tends to divide its focus. The native function of a target muscle, now tasked with a dual assignment, is compromised.

Secondary muscles often work in concert with other primary and secondary stabilizers. Over time, their focus can further fragment as they become enmeshed with the accumulated details of a lifetime of adaptations. A muscle might be balancing multiple assignments in multiple situations. It does the best it can, and in the short term this might be adequate.

For example, if the acromial fibers of deltoid become unable to hold their place, the clavicular and scapular fibers of deltoid might be able to cooperate, each extending their tensile reach halfway in order to cover the territory of the middle deltoid. In this simplified example, the responsibility of the anterior and posterior fibers is increased, and they are somewhat less available to cover their original territory. They might perform this adaptation so efficiently that the person is unaware of it, but over time there might be a slight twinge when moving a certain way or while lying on their side, so mild and occasional that they only mildly and occasionally notice it. They further adapt by learning to accept or ignore the discomfort, blending it in as normal. We see this frequently when we ask a patient if their low back or neck bothers them and they reply, "Not really, just the normal pain."

The capacity for adapted function is impressively deep and broad. Muscles can recruit stabilization from distal structures in surprising ways, creating automated patterns that reflect the unique history and demands of an individual life.

Selye observed that in states of acute crisis, unrelated symptoms can seemingly resolve. The chaos of the acute stage compels the organism to reorganize, and as it does so there can be a reordering of the entire system. With this in mind, the breakdown of an acute episode presents an opportunity to examine the details of failure. By skillful observation of adaptive behavior, it is possible to simplify, to economize function with the intention that the course of treatment might leave the patient in a better condition than they were before the injury.

Stacking: the interaction of adaptations

Adaptive patterning is arranged in a hierarchical configuration which is ordered according to several criteria, including chronology, severity of injury, frequency of use, and importantly how crucial a function is to the overall performance of the organism. A left wrist injury in a right-handed person might be less likely to create a lasting consequence because it was not used frequently during the recovery period. A weight-bearing adaptation is likely to engender long-term complications because the function of weight-bearing is so prevalent and so necessary. It would be further complicated by the activity of running. A set of functions utilized in a daily job is a likely source of complication because of its frequency and necessity.

Tangle of knots

The hierarchical layers of adaptive strategy can be untangled through prioritized layers much like a tangle of knots. The structure of a classic tangle is simply a knot over a knot over a knot. Similarly, adaptations are stacked in layers of strategic reassignment, a binary reassignment on top of previous binary reassignments.

The complexity of a tangled rope is determined by the potentially large number of knots and the length of the rope as it's pulled through the untangling process. The complexity of our overall adaptive pattern is complicated by the number and necessity of strategic reassignments that have been accumulated over the course of a life.

A seriously tangled rope is used up in the tangle and is not available to be used as a rope. The degree to which it must be untangled in order to be used depends on the intended use. If we're tying down a tarp, it's possible that a partially untangled rope could have enough length available to be usable for the task despite still being partially tangled. If the rope is being used to belay someone on a mountain, a single knot could prove to be fatal. Similarly, a patient might decide that a certain degree of improvement is satisfactory and cease treatment before full objective recovery is achieved, or they might be inspired by their improvement to pursue full objective recovery.

When unraveling a tangle, you must find the free end and untangle the top knot first. Now the next underlying knot has become the new top knot. Proceeding in this manner progressively frees up more rope. With a large tangle it might seem at first as though no progress is being made, and yet as time goes on the untangling progresses.

In the neuromusculoskeletal system, the "free end" is the primary adaptation, that adaptation that presently creates the most global effect on the body. When the primary adaptation is cleared, the next primary adaptation, which was already there, is revealed. There might be a series of progressive adaptations which are primary in their turn. It's not unusual to find that a significant adaptive pattern is revealed only after a previous pattern is resolved. For this reason, continual re-examination is an essential component of the process of restoring proprioceptive efficiency.

Each person presents with a unique adaptive tangle. The magnitude of an individual adaptive tangle can vary according to the details of their case. There can be similarities to aspects of adaptive complexes in different people, but each individual requires attention to the specific details of their adaptive structure as the case progresses.

Diagnosis vs. evaluation

Diagnosis and evaluation are not the same thing. In many cases of physical dysfunction the diagnosis is a description of the immediate symptom or region; an evaluation provides insight into the dynamic that has created the symptom. Using an example from a previous chapter, in which water seeps out from beneath a baseboard and the base of a wall, the diagnosis might be "wet floor" and the evaluation would lead to the discovery of a leaky roof.

Consider, for example, the act of throwing a ball. The scapular muscles that cock the arm back must rapidly shift their role from mobilization to stabilization as the arm enters the acceleration phase. The details of timing and coordination are critical. Failure to adequately stabilize the humerus through this transition can result in the head of the humerus impinging forward in the joint, stressing the long head of the biceps and the bicipital ligament because they are in the line of fire. In this case, the diagnosis would be bicipital tendinitis, an anterior condition; evaluation would show the primary failure to be the inability of the posterior structures that stabilize the scapula and humerus to successfully manage the reversal of forces. The biceps injury must be addressed, but the ultimate solution extends beyond the site of injury. The status of the relevant posterior muscles and ligaments might need to be resolved before the patient might safely throw a ball again. In addition, failure to address the underlying cause leaves it in place to become further enmeshed with subsequent adaptations.

Examination: the Baseline Exam (Muscle Map)

Anatomic examination is the single most essential component of interaction with a patient, providing the basis for all future interaction. A thorough anatomic examination enables an accurate evaluation of injury and its consequences.

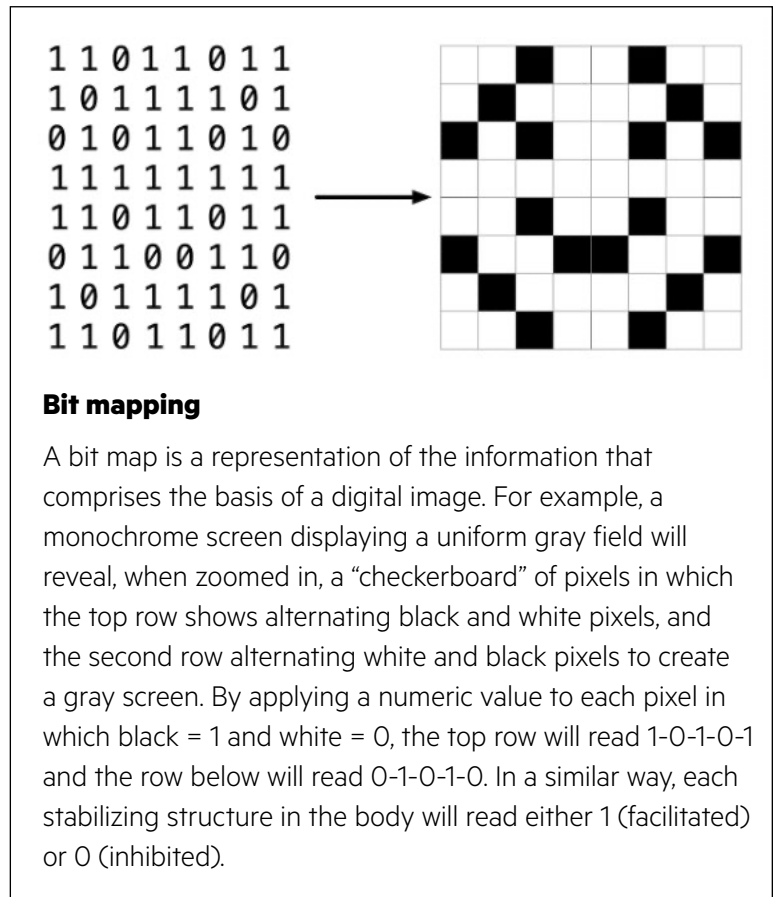
Before embarking on a course of treatment it's imperative to understand the nature of the problem before formulating a strategy for proceeding, setting goals for each visit. A back pain might be due to a stabilization failure of the iliolumbar ligament, or the lumbocostal ligament, the transverse sacroiliac ligament, the gluteal enthesis, or the medial Intertransversarii muscles of L3 & 4. It might involve several of these components in series. The problem might originate in a distal, seemingly unrelated location. Each presentation is unique to the individual and the situation.

After completion of range of motion and orthopedic examination we can begin to investigate the underlying proprioceptive-motor configuration of the organism, observing the response of each anatomic stabilizer, including muscles, ligaments, joint capsules, and fasciae, to a manual resistance test, and charting the results. The exam findings are a bit map of the somatic cortex, providing an comprehensive overview of the neuromuscular status of the organism from its own neurologic vantage. Because neuromuscular locking is a binary function - an expression of either facilitation or inhibition - this skilled and thorough examination can reveal significant useful data about the status of proprioceptive-motor integrity and its relationship to the complaint as well as to any future vulnerability.

Muscle testing

Muscle testing, the traditional form of manual resistance testing, has commonly been regarded as a test of muscle strength. Kendall and McCreary suggest a detailed, graded scale of muscle strength in response to resistance testing, but most of these grades are best regarded as indications of recruitment. Activation of a motoneuron is binary response; a muscle when properly isolated will either lock or not lock, with no gray zone. By observing the muscle in terms of its binary function we are able to examine something of the status of the organism at a primary level.

Muscle testing has been used over the years as in indicator of many things. I originally encountered muscle testing in the early 1970s as a chiropractic patient in the context of Applied Kinesiology, which interprets muscle locking as a indicator of multiple system functions, including that of acupuncture meridians, organ and endocrine functions, nutritional imbalances, the need for "reflex" stimulation, and emotional imbalances. I was intrigued by this at the time and began my professional education looking forward to becoming a "new age" endocrinologist.



It didn't take long in professional practice to recognize a glaring shortcoming of this methodology; it requires an investment of blind belief in the interpretations that comprise its basis. I was taught that various muscle "weaknesses" indicated specific organ and glandular imbalances; for example, "weakness" of sartorius indicated a weakness or overload of the adrenal glands. Failure of the right pectoralis on muscle testing indicated a problem with the liver. And so on. These relationships, accepted on faith, are assumed to be valid despite the fact that there is no way to perceive these relationships directly.

I once advised a patient with chest pains to consult a medical doctor to rule out a possible heart condition, and was dismayed to learn that he had visited a local "alternative" MD who tested a few muscles and dismissed his concerns without further inquiry.

Despite abandoning these interpretations, it was obvious that the examination of muscle locking was a real phenomenon. Wanting to have confidence in the information that I shared with my patients, I decided to rely on direct observation to understand what I was seeing.

The Manual Resistance Examination

Muscle locking is an indicator of an intact proprioceptive-motor loop, a neurological intersection of time and space. Resistance testing is not a test of strength, but is a demonstration of precise spatial recognition and the timing of activation. A person should normally be able to lock a muscle at will. Failure to do so reflects a failure to precisely locate it.

The image shows two sample completed muscle exam forms. Each form is a grid with columns for 'Name', 'R', 'L', and 'B' (Right, Left, Bilateral) sides. The rows list various muscles and ligaments. The forms are filled with checkmarks and handwritten notes, indicating the results of the resistance tests. The left form is dated 03.27.2024 and the right form is dated 07.08.2024. The forms are organized into columns for Right (R), Left (L), and Bilateral (B) sides, with rows listing various muscles and ligaments. The forms are filled with checkmarks and handwritten notes, indicating the results of the resistance tests.

Illustration: sample completed muscle exam forms.

Antagonist muscles must closely track the motion of a joint in terms of position, strength and timing. If an antagonist cannot track properly, there is vulnerability. We live with our vulnerabilities constantly and encounter them randomly.

Determining the specific locking point of a muscle in place requires minimal pressure; in fact, it is typically easier to identify the integrity of locking when using moderately light force. One reason for this is that stronger pressure often causes an exaggerated response, encouraging the recruitment of synergistic muscles.

When a muscle or ligament locks it exhibits a specific, rigid stop, typically within a millimeter or two of the starting position. The lock is relatively effortless, especially obvious when the testing pressure is not overwhelmingly strong or fast. When there is no lock point, the muscle, ligament or joint submits uniformly through the range of the test without discriminating one location over another. It is not a question of strength; the question is rather: where in space does the muscle show a specific lock point?

It is important to properly isolate each anatomical component by correct position, accurately aligning the fiber orientation from origin to insertion to minimize the effect of synergist muscles. Watch for evidence of recruiting: shifting, bracing and other forms of synergy. Synergist recruitment can produce stiffness without locking, and can present a false positive, especially if the tester misunderstands the object of the test to be strength.

Some muscles contain fibers that vary widely in their orientation, such as gluteus medius, the fibers of which travel diagonally from anterior to posterior, straight vertical, and diagonally from posterior to anterior in the same muscle. The varying fiber orientations require that the muscle be tested not as a single entity but in the direction of each fiber. In fact, it is possible that a single fascicle of a muscle can fail in the midst of similar fibers that seem to accompany it in orientation.

In addition, all muscles have leverage polarity – when in different body positions, they can have very different functions. An obvious example of this is when a body is upside down. The former base of the muscle is now the free end, the former free end is now the base. This can complicate the presentation of certain athletes, such as gymnasts, acrobats, dancers, and climbers.

Resistance testing is not limited to muscles but can be applied to any proprioceptive structure.

Graphing the results: the neuromuscular bitmap

Evaluating the neurologic bitmap

The form generated from the exam represents a snapshot demonstrating the sum total of neuromuscular adaptation that has been acquired and maintained in the organism from birth to the date of examination. (Any adaptive change previously adopted and subsequently resolved is irrelevant as it no longer exists.) This is similar to a financial statement that shows the total accumulated resources, in which money previously earned and spent is not considered.

There are four types of findings on a neurologic bitmap exam:

1. Clear – the muscle locks, indicating normal function in which the muscle performed accurately and bilaterally. There will be no box checked.
2. A unilateral failure, in which the muscle failed on either the right or left. One box is checked. Multiple unilateral patterns can line up vertically on the form, for example when several muscles are off in one limb, forming a vertical pattern.

3. Bilateral failure, in which both the right and left muscles of a pair have failed to lock. Three boxes are checked: Right, Left and Bilateral in a horizontal pattern. Horizontal patterns can appear as a block of bilateral dysfunction, indicting a similar failure of multiple muscles in both right and left lower limbs.
4. Sequential inhibition, signifying a primary adaptation, indicated by a dot drawn over the mark in the checkbox. Sequential inhibitions will sometimes be revealed on initial exam, demonstrated by a sudden failure of multiple or all muscles after testing a specific muscle. In this case, going back and re-engaging the initial muscle will result in the subsequent failures returning to function and the exam can then continue. Sequential inhibitions can also be revealed later in the course of treatment, suggesting that adaptive behaviors can be stored in layers.

Scanning the examination form reveals a pattern of muscles and ligaments that do not lock in accordance with the will to lock. Again, locking behavior is not a function of strength but is best regarded as an indicator of an intact proprioceptive-motor loop. In other words if the subject cannot lock the muscle, it means that she cannot precisely locate it. Because stabilization is acuity-dependent, the muscle is therefore not a competent stabilizer and will be likely to recruit adaptive behavior from other structures to manage its task.

From this overview it's possible to begin to determine the hierarchy of organization, in order to ascertain the optimal starting point for treatment. We are looking for the most primary adaptation, that adaptation that exerts the most global effect on the rest of the body, and without resolution would likely present a persistent obstacle to progress.

The determination of neurological hierarchy

Neuromuscular dysfunction can be the direct result of traumatic or repetitive injury, or it can signify an adaptation to injury or to the stress of chronic use. Most commonly it is a combination of these – adaptation in response to the need to perform daily tasks when injured, adaptation while recovering from injury, and adaptation in the presence of accumulated adaptations to everything that has occurred over the course of a lifetime. Multiple adaptations interact in myriad ways, depending on the details of all of the present and historical circumstances. The exam reveals a set of findings whose origins can range over a wide range of personal space and time.

When evaluating the exam form, we are looking for possible interrelationships or dependencies between the dysfunctions in order to determine the organizational hierarchy in which they exist. Like the previously discussed tangle of knots, the pattern we are seeing consists of adaptation over adaptation over adaptation, acquired chronologically and ordered according to the priorities of the organism. There will be a primary adaptation — the adaptation that shows the greatest, most universal effect on the organization of the neuro-adaptive pattern. This is the first order of business. The primary adaptation is not always apparent from the initial exam and sometimes it will be necessary to do a bit of exploring. When the initial primary adaptation is resolved a new primary adaptation might be revealed, just as a new top knot is revealed when the knot above is untied.

Iliolumbar Ligament			
Lumbocostal Ligament			
Iliotibial Band			
Posterior Gluteus Medius/Minimus			
Quadratus Femoris			
Thoracolumbar Aponeurosis			
Gluteus Maximus			
Piriformis			
Internal Obturator			
Superior Gemellus			
Inferior Gemellus			
External Obturator			
Sacrospinous Ligament			
Sacrospinous Ligament			
Sacrococcygeal Ligament			
Iliococcygeus			

Illustration: isolated vertical pattern.

Costotransverse Ligaments			
Rhomboid Major			
Rhomboid Minor			
Supraspinatus			
Subspinous			
Infraspinatus			
Teres Major			
Triceps, Long Head			
Triceps, Medial Head			
Triceps, Lateral Head			

Illustration: isolated horizontal pattern.

If a muscle or ligament locked on examination, it will obviously not be part of a dysfunctional pattern and can for the immediate time be disregarded. The pattern as revealed on the form might show very few details or there might be so many checks on the page that it is difficult to discern the details.

Scanning the completed muscle exam will reveal three possible visual patterns which correspond directly to the findings. They can be described as isolated, vertical and horizontal.

An isolated dysfunction is a limited, possibly single dysfunction that exists apart from other regions of dysfunction. Isolated dysfunctions might be scattered here and there on the page and show no obvious relationship to other patterns on first look.

A **vertical** pattern is a sequence of unilateral dysfunctions in the same region. On the exam sheet they will appear as a stack, a vertical column of check marks.

A **horizontal** pattern indicates bilateral dysfunction of a paired muscle, both right and left. On the exam form the third column is checked to make it simple to observe bilateral dysfunction while scanning the form. Horizontal patterns can present as a block or cluster of bilateral dysfunction, as in the case in which all of the lower extremity muscles cannot be locked on command. A bilateral pattern can indicate both right and left individual dysfunction, but most frequently it indicates a neural circuit pattern that is general and not specific.

Bilateral patterns that appear as clusters might be regarded in the same way that we might regard a home in which an entire room or sequence of rooms is shut off. There might be multiple electrical devices that don't work, but as they are on the same circuit it's possible that there is a single cause.

The number of non-performing devices doesn't tell us what is going on, but it suggests the way to approach the problem. We might find that the breaker panel is not in the same room but is at another location in the home.

It's also possible that when the circuit failure is addressed, some unilateral failures that could not be perceived when everything was shut down will now be observable. A short in a socket couldn't be isolated until the general failure was resolved.

The primary adaptation

Determining the optimal starting point - the primary adaptation - is a the first step in proceeding with treatment. If the primary adaptation is not obvious when first studying the exam form, it can usually be determined in the first therapeutic visit by a combination of further examination and direct perceptive skills, discussed in the following chapter.

Chapter 9: The Restoration of Proprioceptive-Motor Integrity

This discussion of the clinical aspects of treatment is under construction.

If you would like to contribute to the creation of this teaching site please contact us through our website form.



Chapter 10: Glossary of Terms

Adaptation energy: the energy expenditure diverted from the autonomic reserve to maintain adaptation

Adaptive conflict: the loss of central autonomic focus (the teleologic center) due to the competition of multiple adaptive concerns

Adaptive hologram: the pattern of synchronous, interrelated and interlocking adaptations that coexist in the neurologic structure of an organism and carry the potential for influencing and even reconfiguring one another. This is the basis of the holistic concept.

Adaptive liability (expenditure/debt/overhead): the total of adaptation energy (the energy required to maintain adaptation) and adaptive conflict (the loss of central focus due to the competition of multiple adaptive concerns) in an organism

Classic stress dilemma: the will to function vs. a compromised ability to provide that function. This is the motivation for adaptation.

Dispersion equity: the equal distribution of shock amongst all of the vertebral discs

Divergence (scatter): the fragmenting of a shock or weight vector into multiple, more random vectors that can scatter in all directions subsequent to vector collision

Holism: the whole-system approach to health care based on an appreciation of the synchronous, simultaneous nature of the adaptive hologram in an organism

Holographic memory: the behavioral phenomenon of interrelated adaptation patterns that has its basis in the cumulative nature of adaptation. Because we further adapt from an adapted state, the structure of a neurologic adaptation can incorporate any previously adopted strategies. Therefore, any portion of the adaptation pattern has the potential to recall the whole pattern.

Impact vector: a directional force that enters the body to be dispersed or absorbed. Impact can be traumatic, as in a collision; or microtraumatic, as in a poorly managed shock vector from walking

Microtraumatic stress: A stress syndrome in which no one event is of perceptible significance but in which the cumulative effect of multiple events is degeneratively traumatic.

Muting: A long-term strategy of stress management in which a noxious influence or a chronic adaptation pattern is integrated into the baseline so that it is no longer recognized.

Neurologic baseline: AKA “Baseline Norm”, the status of the neurologic tone at rest which the brain recognizes as “normal” and which it relies on as a basis for stabilization, regulation and motion

Ordered Pathway: the route through which shock absorption is handled efficiently: Foot, leg, pelvis, sacrum, to spinal curves, which act as a spring to disperse the shock out of the body

Pathologic absorption: the absorbing of a shock vector by the tissues subsequent to the failure to efficiently disperse the impact

Pegleg: A loss of normal gait function in the foot (heel strike, mid-stance, pushoff) as a function of limping in favor of a rigid gait in the affected leg that favors heel strike

“Pillar of Adaptation”: a neurologic “structure” of layered proximate configurations which interact with and rely upon one another based on the history of the individual

Proximate: a short-term concern (vs. Ultimate)

Reciprocal tone: the means of neurologic stabilization of the musculoskeletal system. When neurologic muscle tone is balanced, the muscles act as cables to support each joint on all sides

Scatter (divergence): the fragmentation of a vector force, such as shock, into multiple, random, disordered vectors (multifurcation) that deviate from the ordered pathway and are delivered with traumatic effect to various body locations. Scatter can continue in the same general direction, can deviate diagonally, or rebound on the opposite direction, affecting distal structures.

Sensory circuit phenomenon: the mechanism of neurologic circuit breaking, which influences the sensory perception of the somatic (and possibly the visceral) system as a means of adaptation. There are spinal (vertebral subluxation) and peripheral (proprioceptive error and inhibitory pattern) aspects to this behavior.

Sequential inhibition: an adaptive behavior pattern in which one muscle, when engaged, inappropriately inhibits one or multiple other muscles, leading to a failure of neuromuscular stabilization and thereby allowing chronic weakness and vulnerability to injury

Somatic brain image: the fully-assembled image of the self that is assembled in the lower and higher levels of the brain and culminates in the somatosensory cortex and the parietal cortex. The integration and evaluation of the information supplied by the proprioceptive afferents occurs at the segmental levels of the spinal cord, in the dorsal nuclei of the brain stem, in the reticular formation, localized subcortical regions, and over wide areas of the cerebral and cerebellar cortices.

Shock Vector: an impact force that enters the body and is either dispersed or absorbed. Shock vectors may be vertical (walking) or random (trauma)

Stacking: the layering of adaptive configurations, one upon another, forming a “pillar of adaptation”, a structure of layered proximate configurations which interact with and rely upon one another in an ultimate pattern

Strategic Investment: an adaptive strategy or strategies that has been maintained and carried past the acute or initial phase and into the long-term, where it may no longer be advantageously relevant. There may be a pattern of layered adaptation strategies that has been adopted and retained in an effort to respond to the stress dilemmas encountered (the will to function against a compromised ability to function). (see stacking, pillar of adaptation)

Stress: the demand on a system to respond or process. The demand can be active or passive.

Subluxation: A partial dislocation which a bone falls within the joint, as opposed to luxation or full dislocation in which a bone falls out of the joint.

Teleology: the doctrine of purposeful behavior; the study of design, purpose and utility in nature

Ultimate: a long-term concern (vs. Proximate)

Vertebral subluxation: the slight displacement or fixation of a vertebra in relationship to the segments above and below it that represents an adaptation with both structural and neurologic consequences

Weight-bearing vector: The force of body weight that travels downwards toward the earth (gravity). The weight-bearing vector utilizes the same ordered pathway as the microtraumatic shock vector encountered in walking (which travels upwards)

Chapter 11: Recommended books and resources for reference in daily practice

Keeping it short and simple. I have learned to refer continually to anatomical resources, as it is difficult to discover what I think I already know.

Color Atlas and Textbook of Human Anatomy. Volume 1: Locomotor System

Werner Platzer

Thieme

I keep this book nearby and use it daily. It is a concise and handy reference in musculoskeletal practice. There are a few oversights (stylohyoid, mylohyoid) but it contains almost everything. Includes invaluable illustrations of muscle attachments on bones, and action diagrams illustrating the motion of each muscle. For understanding stabilization function, reverse the arrows.

Thieme Atlas of Anatomy

Gilroy, MacPherson, Ross

Based on the work of Schuenke, Schulte, Schumacher

Thieme

A larger and comprehensive reference from Thieme, beautifully illustrated.

Neumann's Kinesiology of the Musculoskeletal System: Foundations of Rehabilitation

Donald A. Neumann

Mosby

This is an wonderfully written book, deep and accessible, well illustrated. You will learn a lot.

Grant's Atlas of Anatomy

Agur, Dalley

LWW

The classic Grants Atlas and its companion Grant's Dissector contain drawings of laboratory dissections. Grants shows some unique views, for example looking up into the axilla from below. Also shows the attachment sites of muscles on the bones.

Trail Guide to the Body

Andrew Biel, LMP

Robin Dorn, LMP

Milady

A resource for learning to identify what is beneath the skin. Even years later, I can pick up this book and learn something.

Color Atlas of Anatomy: A Photographic Study of the Human Body

Rohen/Yokochi

Igaku-Shoin, New York/Tokyo

There are several good photographic cadaver atlases. This is the one I use.

Wikipedia

Wikipedia contains a wealth of anatomical information, some of it not easy to find elsewhere (for example, the quadrate ligament).