PATTERN OVERLOAD

by **Paul Chek, HHP**

WARNING

The workouts and other health-related activities described in the programs presented by the C.H.E.K Institute were developed by the author to be used as an adjunct to improved strengthening, conditioning, health and fitness. These programs may not be appropriate for everyone. Individuals who suffer from any disease or are recovering from an injury of any sort should consult their physician regarding the advisability of undertaking any of the activities suggested in these programs. The author has been painstaking in his research and the presentation of the material in these programs. He is neither responsible, nor liable, for any harm or injury resulting from this program or the use of the exercises or exercise devices described herein.

PATTERN OVERLOAD

When you wake up in the morning and roll out of bed, do you have nagging pain in your shoulders, knees or back? Do you compare your body to an old truck that still runs pretty well, once it's warmed up? The times you show up at the gym without wrist straps, knee wraps or your lifting belt, do you immediately think, "Man, this is going to be a rough workout"? If you answered "yes" to any of these questions, chances are you are suffering from Pattern Overload.

Pattern overload describes injury to soft tissues resulting from repetitive motion in one pattern of movement, or restricted movement in one or more planes of motion. Although pattern overload is much more common in an environment such as machine training, which restricts freedom of motion, I have also treated numerous cases of pattern overload in workers and athletes who were unrestricted in their training movements.

This article will help you determine if you are experiencing Pattern Overload in your own training programs or assist in identifying the issue in your clients and patients.

1. The causes of Pattern Overload
2. How machine training is one of the main contributors to Pattern Overload
3. The overlooked effects Pattern Overload has on our joints and neuromuscular control
4. Tips for avoiding Pattern Overload in your training programs

CAUSES OF PATTERN OVERLOAD

Pattern overload results primarily from:

- An inability to properly load share
- Being isolated or restricted to a specific motion with loss of movement freedom in one or more planes
- Over-use of any given pattern of movement, regardless of freedom of joint motion

INABILITY TO LOAD SHARE

The human body is highly intelligent and remarkably efficient. To protect itself from unwanted injury the body will naturally sequence the recruitment of muscles to provide optimal load sharing across as many muscles and joints as possible. For example, when performing a bent-over row, the body will select the appropriate motor sequence to divide the load among all the pulling muscles (1). This allows each working muscle to make its maximum contribution when most favorable with regard to optimal length/force and length/tension relationships.

An example of faulty load sharing can be witnessed in those individuals who have been taught to adduct their scapulae prior to initiating a pull with the lats and other muscles. This faulty motor sequence disrupts load sharing by first recruiting the scapular adductors, shortening them beyond the range of their optimal length/force and length/tension relationships, which then leave the scapulohumeral musculature to perform the remainder of the work. This often leads to strain and trigger point development of the teres major, teres minor and infraspinatus muscles, or otherwise known as pattern overload (1, 2).

The athlete who regularly performs pulling exercises in the manner described above will likely have a shortening of the scapulohumeral musculature which eventually leads to faulty scapulothoracic rhythm. The result is scapulae that rotate prematurely during all pulling or abduction movements. Over time, this results in stretch weakness of the middle and lower trapezius, and rhomboid musculature. Individuals with this type of dysfunction will present themselves clinically as experiencing pain between the shoulder blades and often demonstrate reduced range of motion in shoulder abduction, internal rotation and shoulder flexion.

Through careful observation while training in the gym, you will notice that athletes fitting the movement pattern described above chop their pulling movements into segments. The pull is usually initiated rapidly, favoring use of the now lengthened scapular adductor muscles. The pulling motion is terminated after 60 - 70% of the normal pulling range because the optimal working range of the short/strong scapulohumeral muscles and now lengthened scapular adductors has been reached; the scapular adductors are not weak, per say, they are just strong at the wrong time.

This pattern of overload, and many others can be seen during many exercises commonly performed in the gym. Although it may take a skilled therapist or corrective exercise specialist to identify many of them, it is safe to assume that your average gym rat or pocket calculator physical therapist with a wild new idea about how to perform an exercise is not going to improve upon “Mother Nature.” It has taken millions of years of natural development in the central nervous system (CNS) and peripheral nervous system to develop recruitment patterns that provide optimal load sharing. To test my theory, I consulted some of the oldest known experts on pulling, climbing and exercise (Figure 1). They told me, “if the body works, don’t try to fix it!”

Figure 1: Paul consults the experts

ISOLATION OF MOVEMENT BY RESTRICTING 3-DIMENSIONAL FREEDOM

If you are a bodybuilder, your primary mission is to make your muscles BIG! Even though building bigger muscles is far from a new concept, using machines to build bigger muscles is a new concept that the body may not always appreciate. To illustrate my point, consider Earle Liederman's book, Muscle Building, published in 1924 (3). In his book of 217 pages, Liederman does not show a single exercise being performed on a machine with a fixed axis of rotation.

It was 58 years later (1982) that Bill Pearl's book, Keys to the Inner Universe, was published. Here, we began to see a transition from pure free weight training to the periodical use of Universal machines, although the book is predominantly free weight exercises (4).

Jumping forward only four years to 1986, we can see another progression in the use of machines in Bill Pearl's Getting Stronger (5). Pearl now includes significantly more machine exercises, including drawings of machines that are of the Nautilus family, equipment most of you will recognize as the beginning of the machine era. Although modern publications continue to share a similar variety of machine and free weight exercises for bodybuilding (6, 7), a quick visit to the gym makes it clear that the percentage of machine exercises being performed is far greater than free weight exercises.

For most women, avoidance of free weights is driven by the fear of getting too BIG. For the average male going to the gym, there is little instruction on the use of free weights; in fact, there is beginning

to be a shortage of free weights, period. I was recently in Venice, Italy, where the heaviest dumbbell I could find in two gyms was 25 pounds and in the only other gym, the gym for bodybuilders, the biggest dumbbell was 50 pounds. Even in the US, there are an ever-increasing number of gyms opening up with NO FREE WEIGHTS!

When asked, gym owners site "safety" as the main reason they don't provide free weights, or in many cases, why they have such a sparse selection of free weights. To appreciate and share my concern for the lack of functional exercise apparatus, one must have a technical appreciation for what it actually takes to make an exercise functional. [For a more in-depth look at the principles of functional exercise see my book *Movement That Matters* (8)] Although functional exercise principles are beyond the scope of this article, Pattern Overload is one of the ills which directly results from exercising or stressing the body in ways it was not designed for; it's kind of like taking a sports car off-roading in the woods! Machine use plays an enormous role in the development of Pattern Overload, but more on that in the section called "Bodybuilding Machines and Pattern Overload."

OVERUSE OF ANY PATTERN OF MOVEMENT

The terms repetitive stress injury (RSI) and cumulative trauma disorder are commonly used in a physical therapy or medical practice to describe tissue breakdown and injury due to repetitive exposure to a particular movement. These injuries are common among athletes, musicians, workers who perform data entry and assembly line workers. Pattern Overload describes RSI in the athletic performance and conditioning environment.

Pattern Overload is a major source of injury with amateur and professional baseball pitchers, quarterbacks, tennis players and golfers, to name a few. In fact, Schmidt (9) states that a professional quarterback throws approximately 1.4 million passes and a professional basketball player shoots roughly 1 million baskets in their careers. Pattern overload is also one of the primary sources of injury among the swimmers and distance runners I treat clinically.

Whenever someone performs, conditions and/or trains using predominantly one pattern of motion, or has poor motor skills in a given pattern of motion (10), the risk of injury to the respective working tissues is elevated. To avoid pattern overload in athletes performing repetitive motions, the conditioning coach and/or therapist must be careful not to prescribe exercises that serve to load weakened tissues unless there is specific therapeutic intent and sound rationale for such training.

For example, the in-season tennis player coming to the gym to condition for tennis (a sport of high-speed lunging) may very well have a significant degree of breakdown in the working tissues from practicing and competing alone. Should that athlete opt to, or be directed to perform high volume or high-intensity lunging exercises in the gym, the chances of sustaining injury to the knee extensor mechanism and ligaments, hamstrings or low back increase significantly.

The same scenario can be frequently seen in the throwing athlete, who may be suffering from a mild anterior instability of the shoulder joint. Upon arriving at the gym, the coach often includes heavy bench press and other specific exercises such as medial shoulder rotations on a cable machine. If the athlete has any degree of pain or inflammation in the joint, there is likely to be a corresponding deficit in stability. Continuing to perform exercises which load the same tissues that were insulted during practice and competition will only serve to reflexively inhibit local stabilizers, encouraging Pattern Overload (the exact mechanisms are explained later in this article). This commonly results in bench warming time for both amateur and professional athletes.

To avoid this more dynamic, multi-dimensional pattern overload, care must also be given to assure that the athlete/individual have adequate functional stability to perform the movement pattern of concern. Today, with the massive increase in the number of people working in a seated position and our overindulgence with machine training, there is a tremendous lack of movement skill in the population at large (8). This means that much more attention to detail must be applied to learning, teaching and execution of seemingly common free weight exercises and movement patterns (8, 39).

Another underlying cause of pattern overload is poor or non-existent periodization of any given training and conditioning program. In addition to periodizing general stressors to the body, care must be taken when writing programs to execute exercises in the correct order. Some general rules for organizing exercises in a program are (10):

- Exercises should always progress from the most complex to least complex movement patterns
- Exercises should progress from those requiring the highest level of movement skill to the least demand for movement skill
- Exercises should generally progress from those requiring the least base of support to those providing the most base of support
- Exercises should progress from those requiring the greatest cognitive demand to the least cognitive demand

The only exception to these guidelines is when an elite athlete is being trained by a professional coach trained in the science and practice of strength and conditioning.

Note: Those wanting comprehensive education on program design and program writing will find references 10, 16 and 39 helpful.

BODYBUILDING MACHINES AND PATTERN OVERLOAD

Now that we have seen how and why Pattern Overload occurs, let's delve deeper into machine training and how overuse and/or abuse of this type of training greatly increases your chance for developing Pattern Overload.

To appreciate why machines have become a primary modality for building muscle, we must explore the concepts of neuromuscular isolation (1, 11, 12, 13, 14) and intramuscular training (15, 16).

NEUROMUSCULAR ISOLATION & INTRAMUSCULAR TRAINING

To better appreciate the concept of neuromuscular isolation, we must consider that at any given moment, the human body has a finite amount of neurological energy with which to drive it's population of approximately 250,000,000 muscle fibers (17). To help you appreciate the importance of the neuromuscular isolation concept, consider your body as though it were a car. In a car, the electrical system is dependent upon the battery for it's primary energy source and the alternator is responsible for recharging the battery. In our body, the CNS is analogous to the car battery and our heart is the alternator; the heart produces some 2.5 watts of power, which is 40-60 times more electricity than the brain (18, 19).

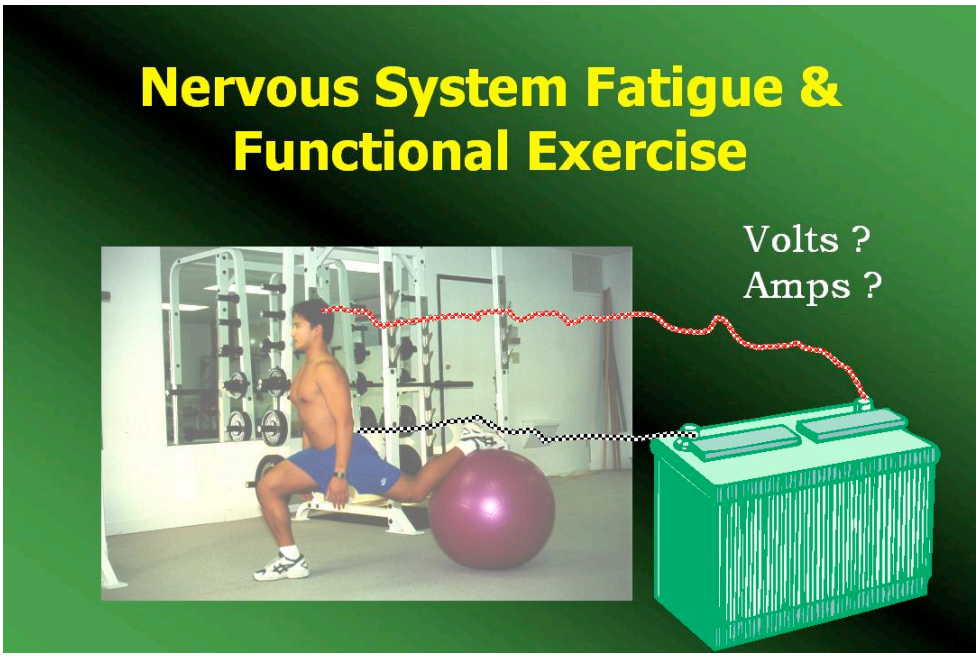


Figure 2. Nervous System Fatigue and Functional Exercise
Functional exercises require maintenance of your center of gravity over your base of support. As base of support and stability are reduced, the number of muscles necessary to complete a task increases. As the number of working muscles increases, so too does the demand for neurological energy; the greater the demand for neurological energy, the faster the central nervous system fatigues

Neuromuscular isolation is what it takes to produce optimal intramuscular training. When trying to build a muscle, it is necessary to recruit as many of the available motor units feeding that muscle as possible. The beginner may only be able to recruit 60% of his or her available motor units, yet with training may be able to achieve the ability to recruit up to 85% of available motor units (Figure 3.) (15).

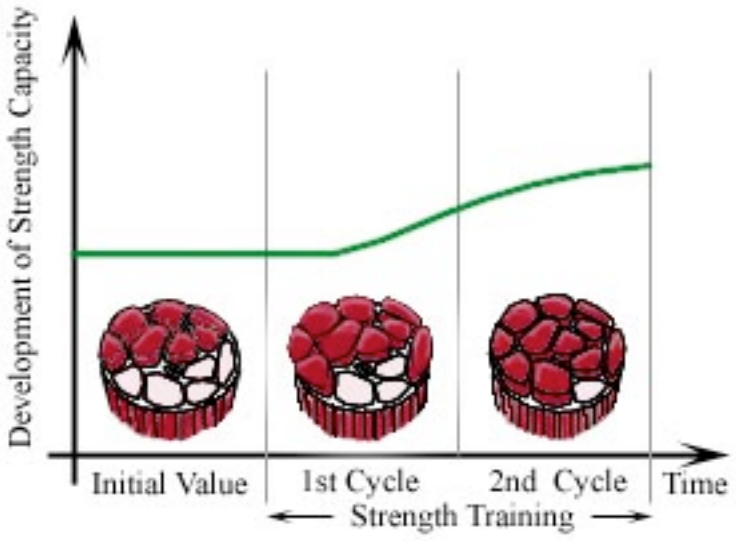


Figure 3. Effects of Intramuscular Training on Muscle Recruitment
With repeated exposure to high resistance training, the nervous system becomes capable of recruiting a greater percentage of the motor unit population serving the muscle exercised. During each phase of training there will be improved recruitment, assuming the challenge is progressed adequately to provide the needed stimulus to get to the next level of recruitment capability.
Modified From: Hartmann, J. and Tunnemann, H. *Fitness and Strength Training for All Sports.* Sports Books Publisher, Toronto, 1995 (15)

When you perform any functional compound exercise (performed unsupported while standing) (Figure 2), you are using virtually every striated muscle in your body. Using the above analogy as an example, this is like having the lights, radio, heater, windshield wipers, defrosters, cell phone and cigarette lighter all running in your car at once. This produces a massive electrical drain!

When attempting to build a muscle for the purpose of bodybuilding, it is advantageous to isolate the muscle, with minimal activation of other muscles. This leaves more energy for the working muscle, improving your ability to recruit the relevant motor neurons, just as turning the radio or heater off in a parked car will allow greater illumination by the lights.

As you increase your ability to recruit more motor units and more muscle fibers respectively, it is obvious you can lift heavier weights. Heavier weights means more tension in the working muscle and

a greater stimulus for anabolic adaptation. Perform intramuscular isolation training for a couple years on each of your major muscle groups and presto," you look like a bodybuilder!

THE PROBLEM WITH ISOLATION MACHINES

This sounds so simple you might ask, "So what is the problem?" Unfortunately, with the exception of a select group of machines, machines in general limit the natural movement of the body. I am sure you are all aware of the fixed axis of a knee extensor machine, the hamstring curl machine, the pec deck, and even the guide rails of a leg press. Unfortunately, these machines do not allow the body's nervous system the freedom it needs to protect the working joints and relevant soft tissues from injury. This is particularly important when considering that when lifting weights in an isolated manner, loads in working muscles, tendons, ligament and joint structures can become very high.

To illustrate my point, look at Figure 4, which compares the natural bar path during a free weight bench press with that of a Smith machine bench press. What is important to realize with regard to free weight training is that if you were to film someone for as many repetitions as they could possibly perform in one set, at any intensity level, they would never produce the exact same bar path two

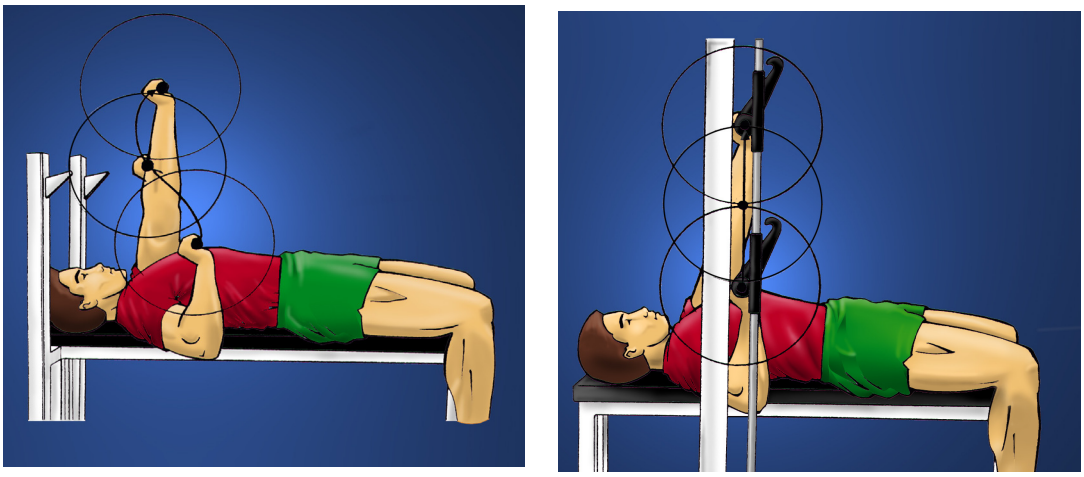


Figure 4. Natural vs. Unnatural Bar Path During the Bench Press
In the picture above, you can see an estimated natural bar path when performing a free weight bench press exercise. This bar path will change during every repetition in attempt to minimize fatigue and loading of the working tissues specific to the motor task. Below, the bar path on a Smith machine is demonstrated. It is clear that unless the athlete contorts his body below the bar while under load, the bar path is linear and unchanging. A consistent path of resistance on any machine may result in early synchronization of motor units, motor fatigue and loss of dynamic support. This is commonly associated with injury to the passive structures of working joints and often results in long-term injury!

times in a row! In fact, if you review research on elite Olympic lifters, you will find that not only does the bar path change slightly each time they lift, no two lifters produce the same bar path when executing the same lift (20).

The scientific concepts of neuromuscular isolation and intramuscular loading make logical sense with regard to building muscle and therefore fuel the bodybuilding industry's reliance on machines. However, strength coaches and therapists have only recently begun to acknowledge a strong correlation between machine training and musculoskelatal injuries. Therefore machine training, if used at all in a bodybuilding or training program, needs to be periodized and well-structured in order to avoid the commonly seen pitfalls of Pattern Overload.

PATTERN OVERLOAD AND JOINT HEALTH

SYNCHRONIZATION AND MOTOR UNIT FATIGUE

Current research clearly shows that the nervous system is capable of not only recruiting a specific muscle needed to perform a problem movement pattern, but it can also selectively recruit specific motor units, or segments within a given muscle (21). When motor units (MU) are recruited to perform any movement (from a Preacher curl to a snatch), the body attempts to rely on asynchronous stimulation of the working units. This is an attempt to save energy (some MUs work while the others rest) and keep movements as smooth as possible (22).

In concert with asynchronous stimulation and up regulating motor unit activation from small to large (size principle), varying the path of resistance (bar path) is another important mechanism for conserving energy and preventing unwanted overload in specific tissues. This is be clearly demonstrated by comparing the bar path of the traditional bench press and Smith machine bench press (Fig. 4). In fact, the body is so committed to energy conservation and protecting tissues from overload, as I previously stated, you could film the most elite lifters in the world and they would never produce the same bar path twice in a row!

While performing any machine exercise where there is a fixed axis of rotation or guided resistance, such as the Smith machine bench press (Figure 4), the population of muscle fibers experiencing maximum load is isolated. The MUs and muscle fibers most suited to move the working extremity in the chosen pattern and in the movement plane dictated by the machine will experience synchronization and fatigue much sooner than when performing the same exercise with free weights, or a 3-Dimensional freedom of motion.

As the fiber population specific to the movement pattern dictated by any given machine fatigues, one is left with progressively less dynamic control over the load and working joints, often resulting

in insult to the working connective tissue, tendon and muscle fibers. As dynamic, or muscular, support for the relevant joints fail, it is common to see a lifter do one of two things. They either squirm around on the machine attempting to find new fiber populations to move the load, (which is a dangerous means of changing fiber populations) or they attempt to use the stored elastic energy, or potential energy, of working connective tissues to complete the final reps of the set. Classic examples of this are bouncing the bar off the chest during the bench press, bouncing the thighs off the torso during a leg press, or springing the shoulders at end range on the pec deck machine. The result: damage to ligamentous and capsular structures of joints, not to mention the potential derangement of the joint itself!

These are no small potatoes when you consider the fact that connective tissue heals considerably slower than muscle (see side bar) and that motor control may be compromised secondary to damaged mechanoreceptors in relevant capsular and ligamentous tissues.

HOW FAST WILL I HEAL?

Muscle Tissue: Strains and minor tears heal quite quickly. This is predominantly due to the fact that muscle has an ample blood supply. Research shows only 7 days after a muscle strain, strength levels are 92.5% of maximum (23,24).

Ligaments and Tendons: It is generally accepted that there is little, if any, regeneration of these tissues once injured (23 (p. 19), 26). The healing times of ligaments and tendons follow the natural, four phase, progression of scar tissue development and maturation. The inflammation, granulation and fibroblastic phases begin within 24 hours, with wound closure happening in 5-8 days. The final stage, maturation, lasts between six months and one year. The scar is most responsive to stretch and remodeling for 8-10 weeks, and scar tissue shrinkage completes itself between 6 months and 1 year (26). Healing times for tendonitis will vary depending on how long it takes to identify the etiology of the problem!

PATTERN OVERLOAD, MECHANORECEPTOR DAMAGE AND JOINT STABILITY

Surrounding each joint is a joint capsule. This capsule is like the boot on a car's ball joints. The capsule aids in joint stability at end ranges of motion, serves to lubricate the joint surfaces with its synovial membrane and is loaded with proprioceptive neurons called mechanoreceptors (Table 1). There are also mechanoreceptors in the ligaments surrounding joints and special pain receptors called nociceptors that may be found in the capsule, ligaments, articular fat pads and blood vessels (27).

When an individual trains on machines with poor technique and/or overuses any form of guided resistance, the resultant fatigue and loss of motor control in the relevant movement pattern and plane of movement often leads to overload of the passive joint structures. Being predominantly collagen, these structures do not stretch well and do not bounce back well from repeated stretch either. The analogy and question I ask my patients is, "Do you remember when you last pulled a can of soda or beer from one of the six packs with plastic loops holding them together? What happened when you tried to put a full can back in the loop because no one wanted to use it at that time?" The answer is always, "It wouldn't stay in there any more." This is a simplified version of what happens when the joint capsule and/or ligaments are stretched in your body.

A joint with stretched capsular structures and articular ligaments begins to lose its optimal working relationships and eventually, particularly in the case of the shoulder, tries to fall out in positions specific to the dysfunction!

JOINT RECEPTORS	FUNCTION
Type I	Low threshold, slowly adapting static and dynamic mechanoreceptors. Tonic reflexogenic effects on neck, limb, jaw and eye muscles. Postural and kinesthetic sensation. Pain suppression. Facilitate the tonic muscle system.
Type II	Fast adapting, low threshold dynamic mechanoreceptors. Phasic reflexogenic effects on the neck, limb, jaw, and eye muscles as well as pain suppression. Facilitate the phasic muscle system.
Type III	High threshold, very slow adapting receptors. Have the same characteristics as a golgi tendon organ.
Type IV	High threshold, nonadapting pain provoking nerve fibers. These fibers have tonic reflexogenic effects on the neck, limb, jaw and eye muscles. They also induce cardiovascular reflexogenic effects. Facilitation can cause guarding in the tonic muscle system.

TABLE 1. Joint Mechanoreceptors

With decreased passive support from ligamentous and capsular structures, there must be a proportionate increase of dynamic support by muscles. Should the aberrant joint complex be mildly traumatized, the intrinsic stabilizers, such as the rotator cuff of the shoulder, will be taxed with the burden of trying to maintain an optimal axis of rotation in the now dysfunctional joint complex. Should they become chronically fatigued from repeated exposure to work and exercise, coupled with the newly added burden of trying to maintain optimal working relationships in the joint, an eccentric rotation of the most mobile segment in the joint is likely (See Figure 5).

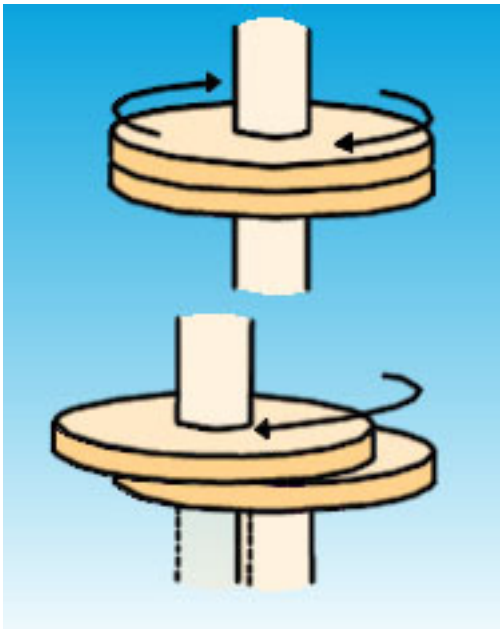


Figure 5. Concentric vs. Eccentric Joint Motion
The above diagram represents joint motion with maintenance of a concentric axis of motion. This simplistic diagram represents maintenance of an optimal instantaneous axis of rotation in a working joint complex which is necessary for long-term joint health. Below is an example of an eccentric rotation. As an eccentric motion is produced secondary to failure of the respective dynamic stabilizers (muscles), the joint's ligamentous and capsular structures are progressively challenged. Without restoration of dynamic stability, joint derangement is likely.

An eccentric rotation of the joint commonly results in what chiropractors refer to as subluxation. The joint complex demonstrating some level of instability as a result of pattern overload commonly begins to make popping sounds and clunking noises that did not previously occur. If the condition progresses, pain is associated with the unusual joint sounds and the patient can usually tell the therapist exactly what movement causes the problem; very often the movement mimics the exercise which induced the injury!

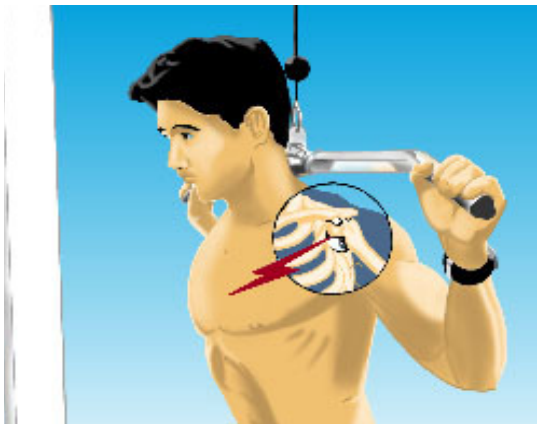
PROPRIOCEPTIVE DEFICITS AND LOSS OF NEUROMUSCULAR CONTROL

As the capsule and articular ligaments become progressively imbalanced (tight in some areas relative to other areas), there is progressive dysfunction in the proprioceptive messages being sent to the central nervous system with regard to where the joint is in space. This produces what is called a "proprioceptive deficit."

The athlete or worker with a proprioceptive deficit may establish a format for the employment of varying muscle recruitment order in an attempt to effect changes in joint position, leading to pathological motions (28). It is common to begin noticing a loss of performance during activities that require fine motor control. For example, the exercise enthusiast with pattern overload in a shoulder, often from performing such exercises as the behind head lat pull down or pec deck with extreme ranges of motion (See Side Bar Joint and Muscle Pain = NO LONG-TERM GAIN!), and who plays golf, will increasingly experience swing errors.

The result, as pattern overload progresses, is imbalance in the capsular and ligamentous structures of the shoulder that will not only send faulty information to the brain about proprioception (Figure 6), but there will also be compensatory facilitation of key muscles around the shoulder and possibly beyond.

Joint and Muscle Pain = NO LONG-TERM GAIN!



Due to poor ergonomic design and/or poor exercise technique, many exercisers repetitively insult their working joints and muscles. As you can see here, pulling the bar behind the head places the arm in full horizontal abduction and full external rotation, which places maximum stress and strain on the anterior joint capsule of the shoulder. As the capsular and ligamentous structures become progressively more lax, the brain begins to receive faulty information from the articular receptors (see Table 1). This leads to a loss of fine motor control and a progressive increase in pain and inflammation; both may lead to permanent loss of performance.

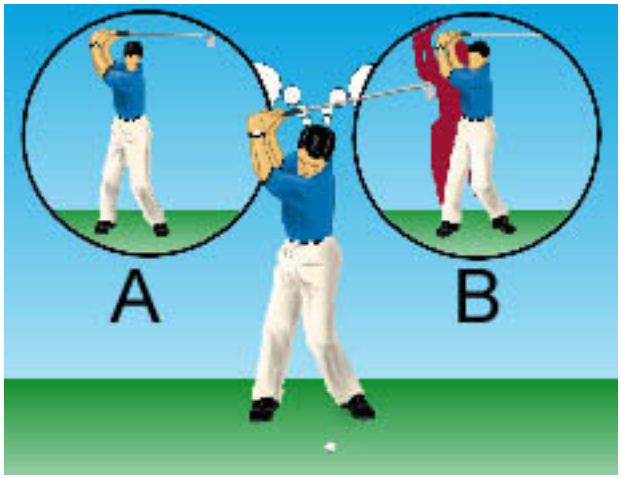


Figure 6. Proprioceptive Deficit and Faulty Motor Control

A. When joint function and proprioception are optimal, the motor command leaving the brain expresses itself quite accurately in the body.

B. When there is a proprioceptive deficit in one or more joints, the motor command leaving the brain contains the necessary information to produce the movement pattern seen in Figure A, yet it actually looks like the red overshadow in Figure B. This is often a source of frustration for athletes that have noticed a loss of performance in their sport after experiencing one or more injuries to joints.

Because the Type I mechanoreceptors are located in the most superficial portions of a joint capsule (27), they are the first to be damaged in any case of pattern overload that includes the joint capsule and ligaments. If the joint structure is damaged enough to traumatize the deeper fibers of the capsule, there will be destruction of Type II mechanoreceptors.

This is important to understand because the Type I mechanoreceptors communicate directly with the tonic muscles of the body and the Type II mechanoreceptors communicate with the phasic muscles of the body, facilitating these muscle systems respectively (29) (See Table 2).

When the capsule and ligament structures become overloaded and damaged, the resulting facilitation of the tonic musculature leads to the characteristic holding patterns and faulty movement patterns commonly seen by therapists and doctors. A classic example of tonic facilitation by tonic muscles surrounding the shoulder is seen in a postural holding pattern demonstrated by an elevated, forward-rounded shoulder with increased tone in the biceps, or increased postural elbow flexion. When performing movements such as lat pull downs, chin-ups, rows and shoulder abductions (with or without a dumbbell), the movement will be initiated from the upper trapezius with a shoulder-hiking action. In the case of shoulder abduction, there is often increased effort from the upper trapezius in the beginning of the motion to carry the arm through mid and upper ranges of abduction and there may be an associated pain with this movement.

The problem of pattern overload is not just localized to "the joint that hurts" per say. Clinical experience demonstrates that pattern overload patients often complain of "abnormal nagging pains of unknown origin." This is likely to result from faulty motor recruitment of muscles at distant locations. In fact, Dvorak and Dvorak have demonstrated what they refer to as a spondylogenic reflex syndrome (27, p. 38-40). Researchers placed traction and electrically stimulated mechanoreceptors at the C3-4 level and were able to record significant EMG (electrical activity) responses in muscles such as the sternocleidomastoid, trapezius, digastric, scalenes, triceps, rectus femoris and biceps femoris!

Their findings strongly suggest the electrical messages sent to the brain, as produced by varying intensities of stimulation and lines of pull on the joint capsule, may make the brain respond as if a corresponding preprogrammed pattern of motion were taking place. Dvorak and Dvorak identified this as distant recruitment patterns (27). For the individual suffering from pattern overload, this may present itself as an idiopathic hamstring strain, groin strain, muscle tear or spasm in a seemingly unrelated region.

Predominantly Tonic Muscles	Predominantly Phasic Muscles
Prone to Hyperactivity	Prone to Inhibition
Function	
Posture	Movement
Susceptibility to Fatigue	
Late	Early
Reaction to Faulty Loading	
Shortening	Weakening
Shoulder Girdle - Arm	
Pectoralis Major & Minor	Rhomboids
Levator Scapulae	Trapezius (middle)
Trapezius (upper)	Trapezius (lower)
Biceps Brachii	Triceps Brachii
Scalenes	Deep Neck Flexors
Subscapularis	Forearm Extensors
Sternocleidomastoids	Supraspinatus
Masticatory	Infraspinatus
Forearm Flexors	Serratus lateralis
	Deltoid
Trunk	
Lumbar and Cervical Erectors	Thoracic Erectors
Quadratus Lumborum	Rectus Abdominis
Pelvis – Thigh	
Hamstrings	Vastus Medialis
Iliopsoas	Vastus Lateralis
Rectus Femoris	Gluteal Muscles
Thigh Adductors	
Piriformis	
Tensor Fasciae Latae	
Lower Leg - Foot	
Gastrocnemius	Anterior Tibialis
Soleus	Peroneals
	Extensors of the toes

Table 2: Properties of Tonic and Phasic Musculature
Modified from (30) and (31).

TIPS FOR AVOIDING PATTERN OVERLOAD ON MACHINES

To avoid pattern overload and its many ramifications (expected and unexpected), I suggest the following precautions:

Avoid any machine that is ergonomically incorrect for your body

It is safe to say, that of the hundreds of machines available in gyms today, a very small percentage of them were designed by engineers with any training in human biomechanics, kinesiology or ergonomics. The result? A lot of machines that do not fit a lot of people!

If you attempt to use a machine and it does not seem to correctly adjust to your body's dimensions, chances are it will induce mechanical trauma to your body. Some classic examples are:

- A shoulder abduction machine that does not adjust to the motion axis of your shoulders. As you abduct your arms, the arm pads slide up and down your upper arm.
- A knee extension or hamstring curl machine that will not adjust to the axis of rotation that matches your knee joint. Again, the pads slide up and down your lower leg as you perform the exercise.
- A biceps curl or triceps extension machine that does not adjust to fit the length of your arms, disrupting the synergy between the axis of your arm joint and the machine's joints.

In any such case as described here, it is always best and most cost effective, both now and in the long run, to look for a corresponding free weight or cable machine exercise (cable machines are classified as free weights). However, as a last resort you may look for another machine exercise that better suits your body's dimensions.

Avoidance of terminal ranges of motion

The whole concept of "training through the full range of motion" is getting out of hand! No one has ever said, "Move the weight through a full range of motion as identified by joints popping, tendons snapping, muscles straining and ligaments becoming lax!"

As I have outlined above, training through any range of motion that threatens the articular capsule and ligaments will lead to faulty neuromechanical control of your joints. This will not only significantly increase the chance of injury for the rest of your life, (with the exception of expensive rehabilitation or surgical procedures) but such faulty training methods are a likely cause of lost performance in numerous sporting events, particularly those requiring fine motor control.

Examples of machine exercises that commonly provoke injury to the body that I consistently see in a clinical setting are:

- **The Nautilus Lat Pull Over:** A large percentage of people going to gyms suffer from lack of extension in the thoracic spine, which commonly results from crunches and sit-ups! Because of the integrated actions of the thoracic spine and shoulder during shoulder abduction and flexion (particularly beyond 140°), while in the top position (full shoulder flexion), there is excessive disassociation of the shoulder joint. This often causes trauma to the capsuloligamentous structures and impingement of the shoulder.

- **The Leg Press:** In any gym in the world, on any day, within any given hour, you will find some poor, mislead soul bouncing their thighs off their torso at the bottom position of the leg press. Now, this would not be so bad if half of them did not have every 45 pound plate they could gather for a country mile on the damn machine! This so-called "full ROM training" is a fantastic way to end up in a doctor's office with herniated L4-5 and/or L5-S1 discs. It is also a phenomenal way to produce spinal instability at the junction between your spine and sacrum. This is particularly important for females to pay attention to because they are generally more susceptible to ligamentous strain and stretch due to their smaller joint structures and hormonal fluctuations.

  The answer? Lower the load as far as you can comfortably, without your sacrum (bottom segment of your spine) ever coming off the pad! Another tip that many of my patients have found helpful is to find a bum bag, or fanny pack, that will hold a rolled hand towel. With the hand towel rolled to the thickness of your hand at your thenar eminence (thick part of your thumb muscles), place it in the bum bag and wear it lose enough so that it can be easily maneuvered around your body from front to back. Now, whenever on the leg press or any other machine producing a load that may flatten your back, simply place the bum bag behind you with the towel roll directly behind your belly button. This will protect you from excessive flattening of your lumbar spine under load, ultimately decreasing your chances of buying an orthopedic surgeon a new BMW!

Periodize your exposure to any form of guided resistance

It is best to limit your exposure to a machine to no more than four weeks at a time training on that machine, and no more than once every 3-5 days. Additionally, you should cycle off each specific machine for a minimum of two weeks and preferably for four weeks. By alternating exercises with this suggested frequency, you will decrease your chance of injury because you are allowing a healing response in the fatigued or traumatized tissues related to a specific pattern of motion. An added benefit is the development of more complete strength and motor skills due to the variety of motor stimulus.

With literally THOUSANDS of exercises available today, the only excuse for not being able to find alternative ways to condition any part of your body is mental laziness! My advice to you, novice or expert, is to read time-honored books on training, watch reputable training videos, hire a trainer or

C.H.E.K Institute-Trained professional, consult a knowledgeable strength coach, or simply watch individuals in the gym that appear to have more than a dozen brain cells firing at one time.

NEVER train a region experiencing joint or muscle pain

Pain always equals inhibition in the human body! If you are training in pain, you can rest assured that the muscles crossing any joint in pain are being shut off, resulting in progressive instability of the joint(s) related to that muscle. This is directly related to Hilton's Law, which states: "The nerves which supplied the muscles and controlled the movements of the part (joint) also served the skin and other sensory surfaces which were connected with that part" (32). The net result, "no gain if you train in pain!"

If you are training in pain, you will serve yourself well to learn how to use a Swiss ball. There are many methods to assess yourself and others, as well as exercise in the decompressive manner afforded by the Swiss ball (14, 33, 34). The Swiss ball also provides tremendous motor variety and can be used with many forms of resistance apparatus (35) limiting your chances of pattern overload to a bare minimum!

CONCLUSION

Pattern overload is a very common, but frequently overlooked source of musculoskeletal injury. To reduce chance of injury, care should be taken to periodize the use of machines and activities that require chronic exposure to any specific movement pattern. The stabilizer system of the body should always be cleared as sufficient and capable of handling the repetition and loading of any movement pattern before it is performed. Careful attention should be given to the selection of exercises and their order of execution. Any individual suffering from pattern overload will be well served to seek advice from a professional in the field of strength and conditioning and/or orthopedic rehabilitation. Those suffering from, or wanting to prevent pattern overload in themselves or their clients, will find studying programs teaching proper exercise technique very helpful (8, 11, 12, 13, 14, 15, 16, 33, 34, 35, 37).

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AUTHOR BIO

Paul Chek is a Holistic Health Practitioner and sought-after consultant worldwide in the areas of corrective exercise, athletic conditioning and holistic approaches to wellness He is the founder of the C.H.E.K Institute in California and has produced over 60 DVDs, 17 correspondence courses, and five books. For a free C.H.E.K Institute product catalog or information about seminars and Advanced Training Programs call (800) 552.8789 or visit www.chekinstitute.com.