# Mechanoreceptors of fascia
# Feed the brain


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Fascia is very important in your health and well-being. It connects all the structures and forms a big network that runs from the surface to the depths of our entire body. Fascia holds our body together and all the organs in place. According to the renomed fascia researcher - Robert Schleip, the average weight of fascia in our body is between 18 - 23 kilograms.

The term fascia is derived from the Latin word "fascia", which translated means band, bundle, band-aid or bandage.

For over 500 years, anatomy has been classically taught on the “isolated muscle” theory, focusing on individual muscle structure and function. Therapists of all disciplines typically learn origin, insertion, innervation and action of muscles in an isolated environment, with very little regard for their functional effect on movement as a whole. As a result, many sports and rehabilitation taping protocols are based on outdated concepts that muscles work in isolation, rather than applying what we now understand about movement, functional neurology, and the somatosensory system.

What is fascia?

- it’s alive
- fascia senses
- richest sensory organ
- fascia transmits force globally
- common myofascial pathways for transmitting
- stability, strain, and response
- distributes strain
- continuous interconnected web
- a GPS system of strain distribution

Fascia is a specialized system of the body that has an appearance similar to a spider’s web or a sweater. Fascia is very densely woven, covering and interpenetrating every muscle, bone, nerve, artery and vein, etc.

Fascia is an uninterrupted, three-dimensional web of tissue that extends from head to toe, front to back, from interior to exterior. Fascia is responsible for maintaining structural integrity; for providing support protection; acting as a force dampener. This interconnected nature of fascia means that everything in the body is structurally connected. fascia stabilises the body in static holding positions and dynamic movements against gravity - whether standing, sitting or lying down. It maintains their shape at all times and keeps all organs in place.

In other words, fascia is a thin layer of connective tissue found between the skin and the muscle - glue that holds us together. Fascia’s three-dimensional weave is principally oriented vertically in the body.

Fascia is not only connected mechanically but also neurologically. To show this statement I would like to use the sweater/shirt tug demonstration. Pulling on one corner of your shirt will show detectable lines (vectors) of strain that communicates how one part of the body is connected, mechanically, to the other. You can also communicate, that the manual manipulation of the local tissue will mechanically distort the receptors, neurologically, along the entire chain, sling, line.

Patient or athlete who presents either PAIN and/or PERFORMANCE limitation. The syndrome typically is evaluated via assessment of the muscular, articular, and movement system, with little regard  with the fascial system.

The anatomy of fascia is similar to other connective tissue. Fascia is made up of cells and what surrounds them, the extracellular matrix. In its physiological state, the extracellular matrix binds a lot of fluid, which is very important for its main function in the muscle, mobility. It keeps the muscle tissue supple and allows the individual muscle fibres to slide easily past each other.

The fascia consists mainly of two types of proteins: collagen fibres are 2-20 μm thick and give the tissue a high tensile strength. They are virtually impossible to stretch. The other fibres - Elastic, are only about 2 μm thick and have a strong extensibility. They can reach up to twice their length. Depending on this two types of proteins, fascia tissue has greater stability or greater flexibility.

The fascia of the body is divided into three layers - the superficial, deep and visceral layer.

**Superficial layer** - Is a thin layer of collagen just under (and integrated with) subcutaneous space. It is highly elastic and either allows or limits the skin slide on underlying tissue. This layer is Involved in thermoregulation. It defences, carries and protects neurovascular bundles, Lypmhatic vessels etc.

**Deep layer**- A layer of fascia which can surround individual muscles, and divide groups of muscles into compartments. It is dense fibrous connective tissue that interpenetrates and surrounds the muscles, bones, nerves and blood vessels of the body. It provides connection and communication in the form of aponeuroses, ligaments, tendons, retinacula, joint capsules, and septa. The deep layer has many receptors that are specialised for certain stimulation. It has more receptors than in muscles. This makes the fascial network the largest sensory organ in human body.

**Visceral layer** - The visceral fascia layer serves to suspend and embed internal organs. Like the deep layer, it is also less stretchable than the superficial layer, because in order to stabilise the organs, their tension must remain almost constant. The visceral layer encloses, for example, the brain and spinal cord with the meninges, the heart with the pericardium and the lungs with the pleura.

## Fascia as a sensory organ

Fascia contains an extremely high number of receptors that pick up different information and transmit it to the central nervous system. Before this realisation, the skin was called the largest sensory organ in humans. Now experts attribute this to the network of fasciae.
The fascia has different receptors, that maintain different functions:

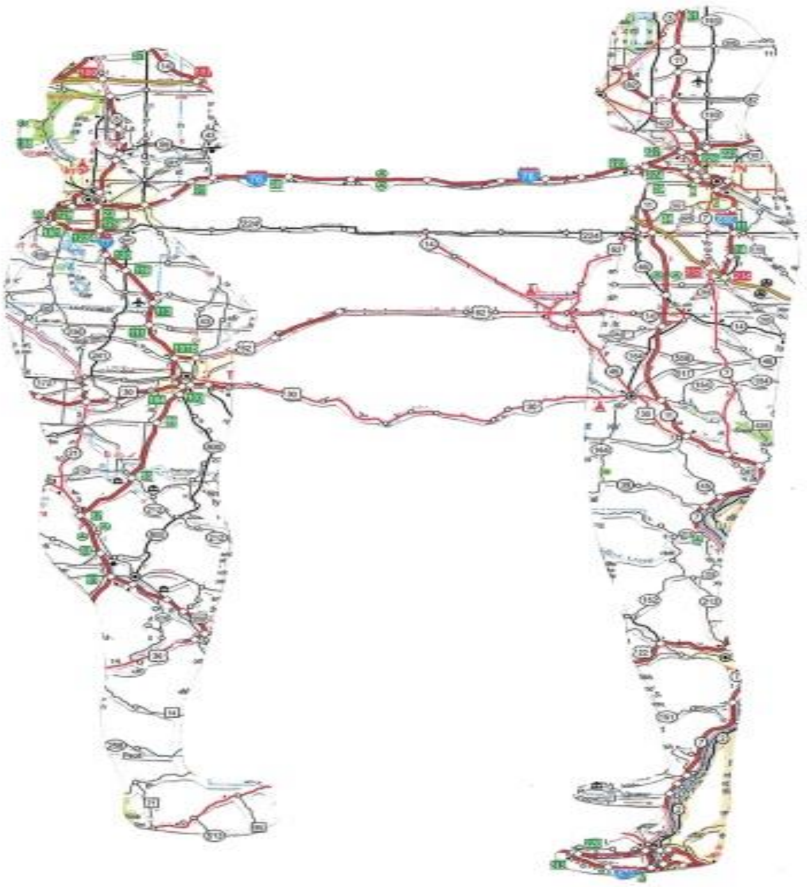
- Nociceptors: they register potential or actual tissue damage. Depending on several factors, pain is perceived through their activation in the brain.
- Proprioceptors: They help in the perception and coordination of conscious and unconscious body positions and movements.
- Mechanoreceptors: They perceive, for example, pressure, tension and vibration stimuli.

• Chemoreceptors: They detect changes in the chemical environment, as is the case with inflammation, for example.

Fascia is said to have an emotional memory function. This means that it can store experiences - and that includes pain. As a result, the fascia can shorten and stick together.

According to fascia mechanoreceptors, I have to mention about Hiltons Law: John Hilton (1860) - The same trunks of nerves whose branches supply groups of muscles also furnish a distribution of nerves to the skin over the insertion of the same muscles. It means that by stimulation of mechanoreceptors in fascia, we also stimulate the structures which fascia surroundes.

Body maps



Perhaps we should be rethinking what we are really doing when we put our hands on someone, treat with a tool, a roller, a piece of tape. By doing this, we are feeding the sensory system, via the collection of nerve branches innervating the skin, communicating to the parts of the brain (somatosensory cortex - neo cortex) that create the motor response that we ALL observe.

Body Mapping is the conscious correcting and refining of one's body map to produce efficient, graceful, and coordinated movement. The body map is one's self-representation in one's own brain. If our representation is accurate, movement is good**. If our representation is faulty, movement suffers. When our map is corrected, the movement improves.** Progress can be very rapid and a person can, over time, learn to move more naturally with greater pose.

By stimulating improved body mapping we are delivering improved motor control (a component of movement efficiency).

**Precision training -** Improving the Cortical map

Lorimer and Butler (NOI Group) said it best - " Modern Rehab will be via normalization of sensation, motor control and the congruence of these factors" - couldn't say it ANY better.

## Tactile acuity is disrupted in osteoarthritis but is unrelated to disruptions in motor imagery performance

**Tasha R. Stanton[1,2], Chung-Wei Christine Lin[3], Helen Bray[1], Rob J. E. M. Smeets[4], Deborah Taylor[5], Roberta Y. W. Law[5] and G. Lorimer Moseley[1,2]**

### Abstract

**Objective.** To determine whether tactile acuity is disrupted in people with knee OA and to determine whether tactile acuity, a clinical signature of primary sensory cortex representation, is related to motor imagery performance (MIP; evaluates working body schema) and pain.

**Methods.** Experiment 1: two-point discrimination (TPD) threshold at the knee was compared between 20 participants with painful knee OA, 20 participants with arm pain and 20 healthy controls. Experiment 2: TPD threshold, MIP (left/right judgements of body parts) and usual pain were assessed in 20 people with painful knee OA, 17 people with back pain and 38 healthy controls (20 knee TPD; 18 back TPD).

**Results.** People with painful knee OA had larger TPD thresholds than those with arm pain and healthy controls ($P < 0.05$). TPD and MIP were not related in people with knee OA ($P = 0.88$) but were related in people with back pain and in healthy controls ($P < 0.001$). Pain did not relate to TPD threshold or to MIP ($P > 0.15$ for all).

**Conclusion.** In painful knee OA, tactile acuity at the knee is decreased, implying disrupted representation of the knee in primary sensory cortex. That TPD and MIP were unrelated in knee OA, but related in back pain, suggests that the relationship between them may vary between chronic pain conditions. That pain was not related to TPD threshold nor MIP suggests against the idea that disrupted cortical representations contribute to the pain of either condition.

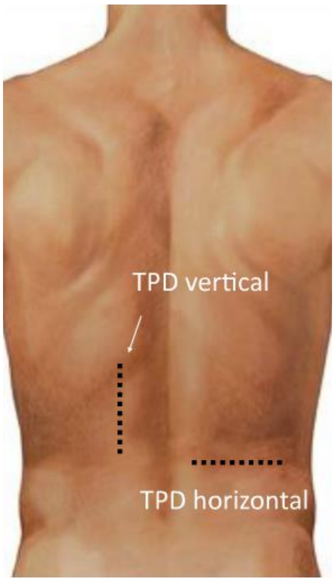
**Key words:** osteoarthritis, tactile acuity, two-point discrimination, motor imagery, left/right judgements, sensory-motor incongruence.

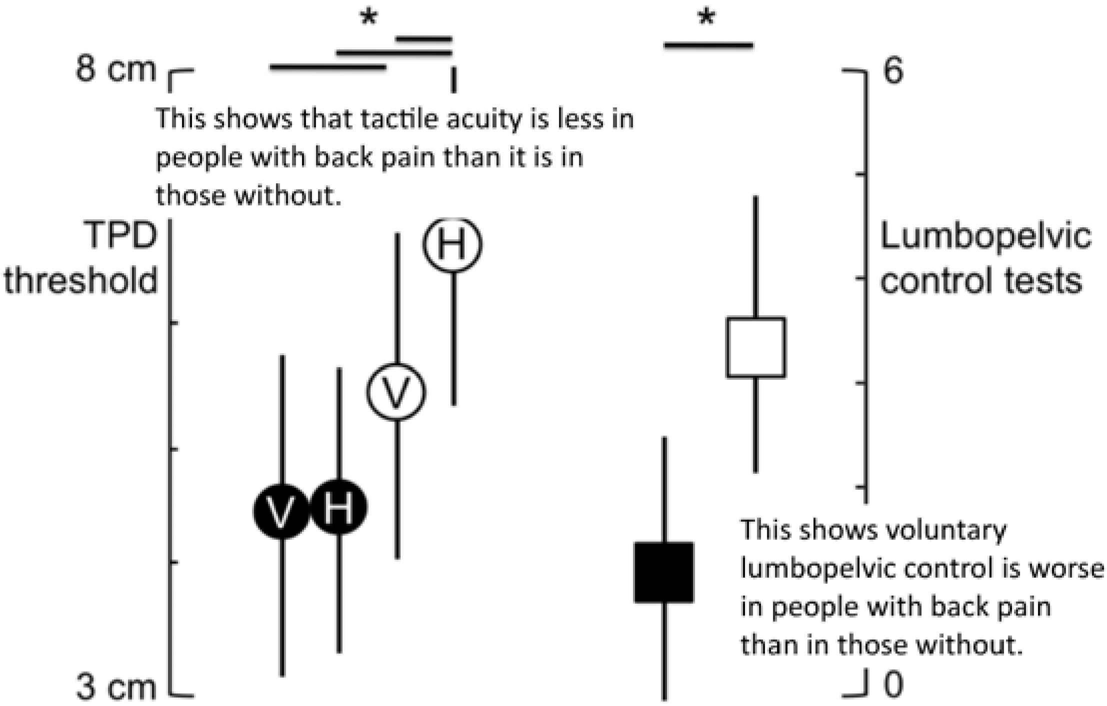
Tactile Threshold/Acuity studies - from the NOI group (http://www.noigroup.com/en/Home)

Demonstrating how those in chronic pain (low back, knee in particular) have decreased awareness (aka tactile acuity) of said area. They also found that by stimulating the sensory system (via touch receptors) they can improve the body map/cortical map of the region leading to improve motor control + pain mitigation.

We are extrapolating the evidence provided by the NOI group to suggest that tooling, taping, and movement also stimulate the sensory system providing similar, if not better, results in pain and position sense (tactile acuity).

**Tactile Acuity and Pain**


TPD vertical
TPD horizontal


*
*
8 cm
This shows that tactile acuity is less in people with back pain than it is in those without.
TPD threshold
H
V
V
H
3 cm
6
Lumbopelvic control tests
This shows voluntary lumbopelvic control is worse in people with back pain than in those without.
0

The importance to touch – how it can create presynaptic inhibition of pain

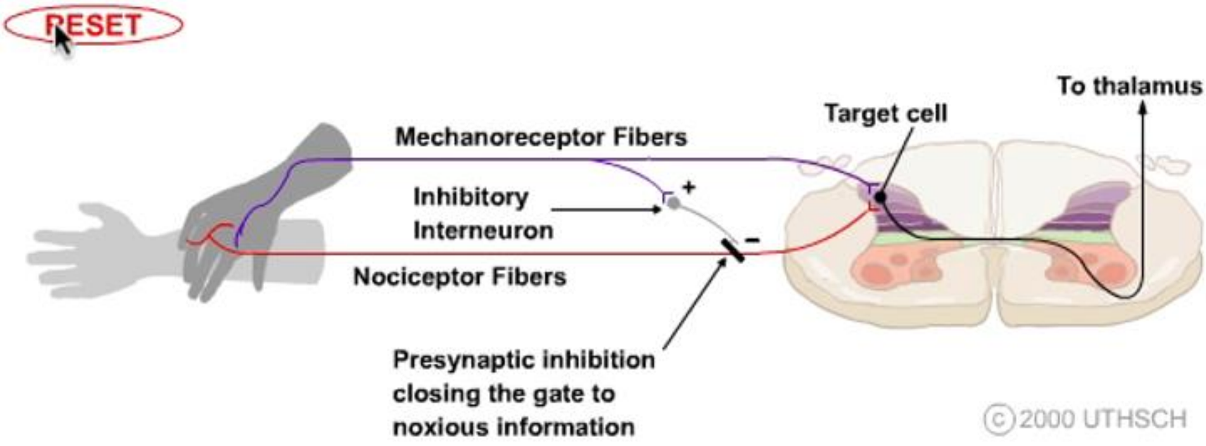



**Figure 8.1**
**The gate control theory of pain modulation. The gate control theory is based on presynaptic inhibition of pain information produced by mechanical stimulation, and provides the basic rationale for the TENS.**

## Feed the Brain - using the sensory system (tactile mechanoreceptors)

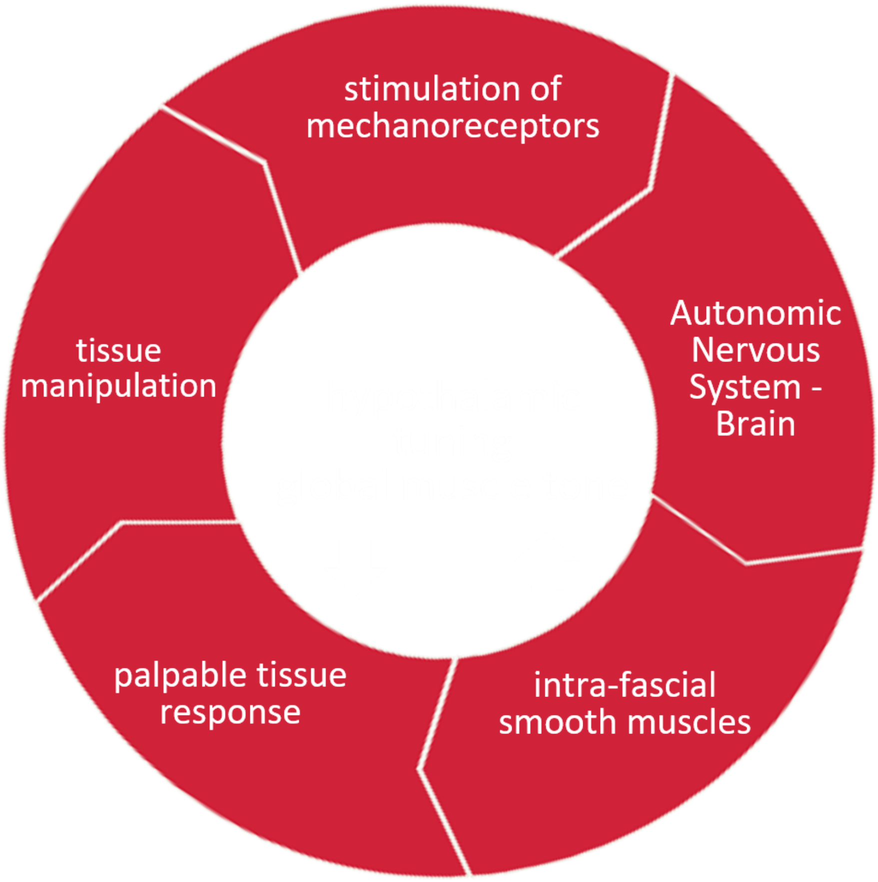
The Brain as the governor - it provides the motor response we observe. When we treat a patient with instruments (IASTM), it's the nervous system that we have influenced. It is unlikely that any changes in the mechanical properties of tissues have occurred.

By this treatment, we have convinced the nervous system to let us move farther, with greater ease or with greater strength.

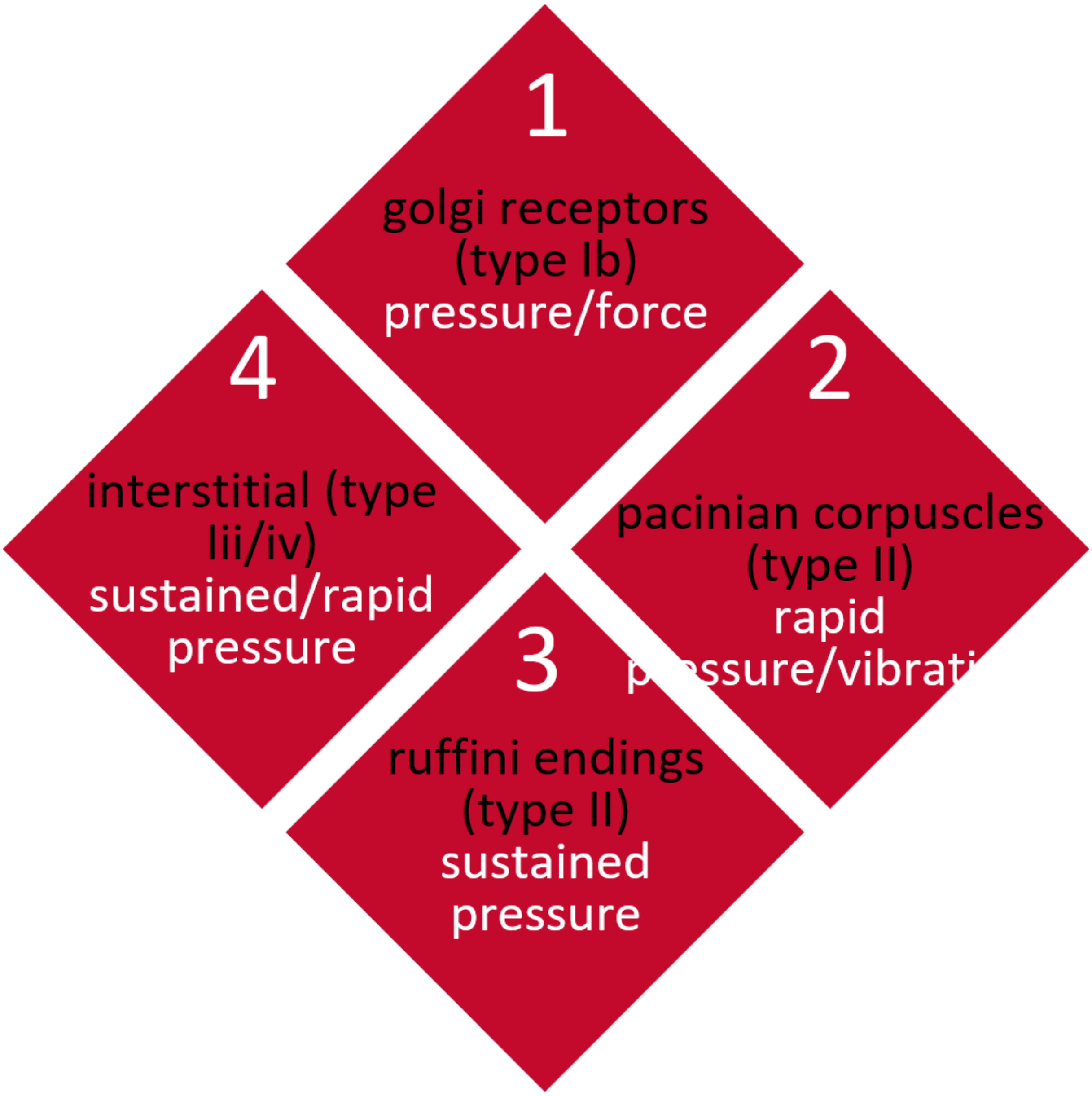
### MECHANORECEPTION

Our outer bag (skin, superficial fascia) is highly innervated by mechanoreceptors. The mechanoreceptors are 10 times more sensory rich than muscles receptors - mechanical stimulation of the fascial system will create a nervous system effect on fascial, muscle tone (Schleip R. (2003). Fascial Plasticity – A new neurobiological explanation: Part 2. J. of Bodywork and Movement Therapies, 7 (2), 104- 116. )

We can manipulate tissue by stimulating mechanoreceptors (with soft touch or sheer). It effects the brain. The manipulation can create a down or up regulation of tone in intra fascia (within fascia) smooth muscles and also, it can create motor response - palpable tissue response (relaxation, priming).


stimulation of mechanoreceptors
Autonomic Nervous System - Brain
intra-fascial smooth muscles
palpable tissue response
tissue manipulation

We have 4 types of fascial receptors (Big four)




I like to consider the fascial system as our roadmap (internal GPS system). It has discernible lines/chains/slings that connect different regions of the body (similar to a roadmap). They are thoroughly connected, both mechanically and neurologically, so having a better understanding of this system can provide some direction when a treatment regiment is not effective in one particular portion of the chain.

Structures that maintain their integrity due primarily to a balance of continuous tensile forces through the structure

What does tensegrity have to do with the human body? The principles of tensegrity apply at essentially every detectable size scale in the body. At the macroscopic level, the 206 bones that constitute our skeleton are pulled up against the force of gravity and stabilized in a vertical form by the pull of tensile muscles, tendons and ligaments (similar to the cables in Snelson's sculptures). In other words, in the complex tensegrity structure inside every one of us, bones are the compression struts, and muscles, tendons and ligaments are the tension-bearing members. At the other end of the scale, proteins and other key molecules in the body also stabilize themselves through the principles of tensegrity.

What can we achieve by mechanoreceptors  intervention:

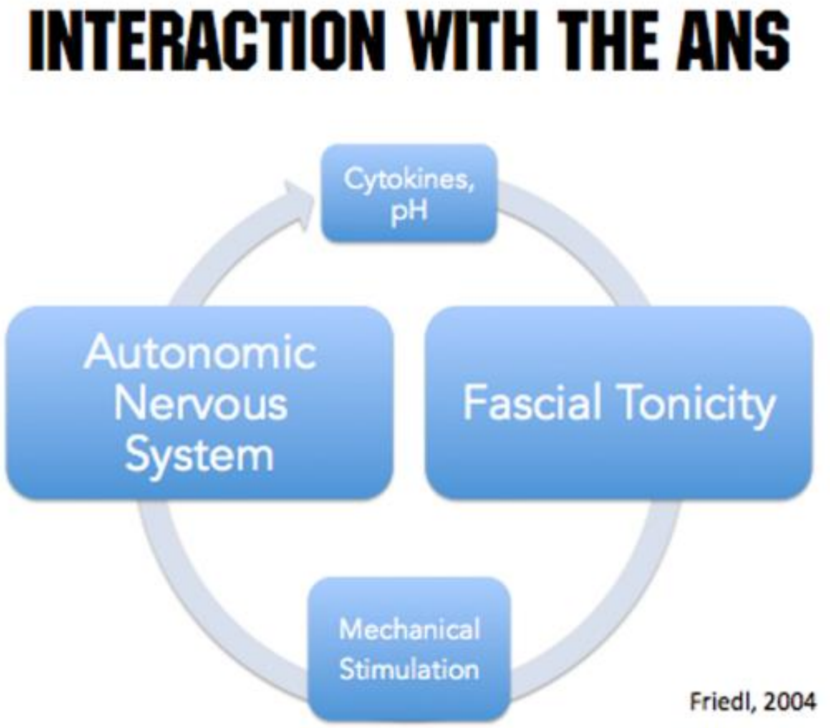
1. Pain mitigation
2. Relaxation effect (decrease tone)
3. Tactile Acuity - precision training
4. Activation (increase tone)

**INTERSTITIAN STIMULATIONS**

Interstitial fibers (free nerve endings) are most abundant receptor in the fascial system and skin. They respond to feather like mechanical pressure = feeling of wellbeing/pain relief

We can name fascia as an Interoceptive Organ.

- Only a minority of the sensory nerve endings in MSK fascia are myelinated mechanoreceptors  concerned with proprioception
    - Golgi Receptors, Paccini Corpuscles, or Ruffini Endings.
- Located in fascial tissues
- Higher concentration in hairy skin
- Stimulation of these Fibers result in activation of an area of the brain (Insula) associated with pain relief and sense of well being
- 40% of these fibers are low threshold receptors which are responsive to light touch
    - Painter's Brush (EG)
    - Cotton Ball (EG)
- Responsive to light (feather like) touch - painters brush effect




**Pacinian Stimulation**

Pacinian Corpuscles – respond to rapid/oscillating mechanical pressure = improved tactile acuity/representation

Pacinian corpuscle stimulation don't specifically activate nor inhibit motor output but they do improve cortical representation of local area being treated. This is an important factor when dealing with a chronic population that is experiencing a "smudging effect" where they lose perception of the effected body part. These receptors are primarily responsive to rapid pressure changes. Stimulating these receptors can result in improved proprioceptive feedback and controlled motor movement.

Pacinian response to mechanical stimulation = Tactile Acuity

**Ruffini Stimulation**

Rufini ending mechanoreceptors have increased sensitivity to slow, more passive manipulation. This said, deep pressure is not needed to generate a reduction in tissue tone while applying manual therapy. Rufini mechanoreceptors are inhibitory receptors. BY stimulating them we result in a lowering of sympathetic nervous system activity (van den Berg & Capri 1999). Slow deep tissue techniques tend to have a relaxing effect on local tissues as well as on the whole organism. It therefore appears that deep manual pressure – specifically if it is slow or steady- stimulates interstitial and Ruffini resulting in global muscle relaxation, as well as a more peaceful mind and less emotional arousal.

# CONTRACTILE PROPERTIES OF FASCIA

- FASCIA HAS BOTH A SENSORY AND MOTOR DIMENSION
- FASCIA HAS THE ABILITY TO CHANGE ITS TONUS AUTONOMOUSLY, INDEPENDENT OF OUTSIDE MUSCULAR FORCES.
- DR. JOCHEN STAUBESAND FOUND, USING ELECTRON PHOTOMICROSCOPY, SMOOTH MUSCLE-LIKE CELLS EMBEDDED WITHIN THIS FASCIA'S COLLAGEN FIBERS (MYOFIBROBLASTS)
- STAUBESAND ALSO FOUND A RICH INTRAFASCIAL SUPPLY OF SYMPATHETIC NERVE TISSUE AND SENSORY NERVE ENDINGS. BASED ON THESE FINDINGS HE CONCLUDED THAT IT IS LIKELY THAT THESE FASCIAL SMOOTH MUSCLE CELLS ENABLE THE SYMPATHETIC NS TO REGULATE A FASCIAL PRE-TENSION INDEPENDENT OF THE MUSCULAR TONUS.

STAUBESAND, J., & LI, Y. (1996). ZUM FEINBAU DER FASCIA CRURIS MIT BESONDER BERUCKSICHTIGUNG EPI – UND INTRAFASZIALER NERVEN. MANUELLE MEDIZIN, 34, 196-200.

Staubesand study indicates that fascia has the ability to change its tone - smooth like cells within fascia (myofibroblasts) . Fascia has rich intrafascial network of sympathetic nerves that can be manipulated - Regulate fascial tone independent of muscular tonus

# TGF BETA 1

- STIMULATION OF SYMPATHETIC NS SENDS OUT THE CYTOKINE TGF-BETA-1 TO ELICIT AN IMMUNE SYSTEM RESPONSE
- TGF BETA 1 IS ALSO KNOWN AS THE MOST RELIABLE AND MOST POTENT PHYSIOLOGICAL STIMULATOR OF MYOFIBROBLAST CONTRACTION.

BHOWMICK, S., SINGH, A., FLAVELL, R.A., CLARK, R.B., O'ROURKE, J., & CONE, R.E. (2009). THE SYMPATHETIC NERVOUS SYSTEM MODULATES CD4(+) FOXP3(+) REGULATORY T CELLS VIA A TGF-BETA-DEPENDENT MECHANISM. J LEUKOC BIOL, 86(6), 1275 – 1283.

The stimulation of said parasympathetic nervous system can limit the delivery of TGF Beta 1 thus decreasing fascial tone

**VIBRATION**

- Merkel/Pacinian Stimulation
- Respond to **sustained**/**high velocity** thrust manipulations and vibratory or oscillatory techniques

- Triggers **heightened local proprioceptive attention** of the central nervous system to the stimulated fascial region.

- Such stimulation may thus have beneficial effects and may result in a **refined cortical body representation** and **improved local neuromuscular coordination.**

This study showed that vibration can be a promising means of increasing range of motion beyond that obtained with static stretching in highly trained male gymnasts

*APPLIED SCIENCES*

*Biodynamics*

# Flexibility Enhancement with Vibration: Acute and Long-Term

WILLIAM A. SANDS[1], JENI R. MCNEAL[2], MICHAEL H. STONE[3], ELIZABETH M. RUSSELL[1], and MONEM JEMNI[4]

[1]*Sport Science, U.S. Olympic Committee, Colorado Springs, CO;* [2]*Department PEHR, Eastern Washington University, Cheney, WA;* [3]*Physical Education, Exercise and Sport Sciences, East Tennessee State University, Johnson City, TN; and* [4]*Leeds Metropolitan University, Carnegie Faculty of Sport and Education, Leeds, UNITED KINGDOM*

**ABSTRACT**

SANDS, W. A., J. R. MCNEAL, M. H. STONE, E. M. RUSSELL, and M. JEMNI. Flexibility Enhancement with Vibration: Acute and Long-Term. *Med. Sci. Sports Exerc.*, Vol. 38, No. 4, pp. 720–725, 2006. **Introduction:** The most popular method of stretching is static stretching. Vibration may provide a means of enhancing range of motion beyond that of static stretching alone. **Purpose:** This study sought to observe the effects of vibration on static stretching to determine whether vibration-aided static stretching could enhance range of motion acquisition more than static stretching alone in the forward split position. **Methods:** Ten highly trained male volunteer gymnasts were randomly assigned to experimental ($N = 5$) and control ($N = 5$) groups. The test was a forward split with the rear knee flexed to prevent pelvic misalignment. Height of the anterior iliac spine of the pelvis was measured at the lowest split position. Athletes stretched forward and rearward legs to the point of discomfort for 10 s followed by 5 s of rest, repeated four times on each leg and split position (4 min total). The experimental group stretched with the device turned on; the control group stretched with the device turned off. A pretest was followed by an acute phase posttest, then a second posttest measurement was performed following 4 wk of treatment. Difference scores were analyzed. **Results:** The acute phase showed dramatic increases in forward split flexibility for both legs ($P < 0.05$), whereas the long-term test showed a statistically significant increase in range of motion on the right rear leg split only ($P < 0.05$). Effect sizes indicated large effects in all cases. **Conclusion:** This study showed that vibration can be a promising means of increasing range of motion beyond that obtained with static stretching in highly trained male gymnasts. **Key Words:** STRETCHING, SPLITS, GYMNASTICS, CHILDREN

Although flexibility has been considered one of the pillars of fitness characteristics, the actual role of flexibility in determining or enhancing performance in sports has been difficult to characterize (11). Some sports that require the athlete to achieve relatively large ranges of motion, and often the athlete's opportunity to win, are based on this ability. Sports such as artistic gymnastics, rhythmic gymnastics, trampoline, diving, synchronized swimming, figure skating, martial arts, and others rely heavily on the athlete's ability to achieve limb positions that are beyond the norm. Achieving these positions can be problematic for some young athletes, and the time required to accomplish them has been shown to be extensive (20).

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Flexibility has been defined as the range of motion about a joint or a related series of joints (20). Simple static stretching is the most popular means of enhancing flexibility (4). Stretching is categorized based on whether the stretching motion is performed statically or dynamically. Stretching has also been categorized based on how the range of motion is achieved, "active" or "passive" referring to whether the motion is achieved by agonist muscle tension or by inertia, gravity, or both (11). Flexibility has received recent attention based on a more modern understanding of the role of stretching and flexibility in injury prevention (22). Stretching has also been associated with an acute loss of maximal strength and power (16,21). This effect, however, may be ameliorated by activities following stretching that involve more rapid movements (24). Methods of enhancing range of motion beyond static and ballistic stretching, and more recently proprioceptive neuromuscular facilitation, have scarcely been addressed. Settings such as sport and physical therapy may benefit from methods that can enhance range of motion relatively quickly and easily.

Whole body vibration and local vibration have been investigated for some time in the context of the tonic

Simultaneous vibration and stretching may greatly increase flexibility while not altering explosive strength

# Vibration and Stretching Effects on Flexibility and Explosive Strength in Young Gymnasts

ANN M. KINSER[1], MICHAEL W. RAMSEY[1], HAROLD S. O'BRYANT[2], CHRISTOPHER A. AYRES[1], WILLIAM A. SANDS[3], and MICHAEL H. STONE[1]

*[1]Sports Performance Enhancement Consortium, Kinesiology, Leisure, and Sports Science, East Tennessee State University, Johnson City, TN; [2]Biomechanics Laboratory, Appalachian State University, Boone, NC; and [3]Head, Biomechanics and Engineering, United States Olympic Committee, Colorado Springs, CO*

ABSTRACT

KINSER, A. M., M. W. RAMSEY, H. S. O'BRYANT, C. A. AYRES, W. A. SANDS, and M. H. STONE. Vibration and Stretching Effects on Flexibility and Explosive Strength in Young Gymnasts. *Med. Sci. Sports Exerc.*, Vol. 40, No. 1, pp. 133–140, 2008. **Purpose:** Effects of simultaneous vibration–stretching on flexibility and explosive strength in competitive female gymnasts were examined. **Methods:** Twenty-two female athletes (age = 11.3 ± 2.6 yr; body mass = 35.3 ± 11.6 kg; competitive levels = 3–9) composed the simultaneous vibration–stretching (VS) group, which performed both tests. Flexibility testing control groups were stretching-only (SF) ($N = 7$) and vibration-only (VF) ($N = 8$). Explosive strength-control groups were stretching-only (SES) ($N = 8$) and vibration-only (VES) ($N = 7$). Vibration (30 Hz, 2-mm displacement) was applied to four sites, four times for 10 s, with 5 s of rest in between. Right and left forward-split (RFS and LFS) flexibility was measured by the distance between the ground and the anterior suprailiac spine. A force plate (sampling rate, 1000 Hz) recorded countermovement and static jump characteristics. Explosive strength variables included flight time, jump height, peak force, instantaneous forces, and rates of force development. Data were analyzed using Bonferroni adjusted paired *t*-tests. **Results:** VS had statistically increased flexibility ($P$) and large effect sizes ($d$) in both the RFS ($P = 1.28 \times 10^{-7}$, $d = 0.67$) and LFS ($P = 2.35 \times 10^{-7}$, $d = 0.72$). VS had statistically different results of favored (FL) ($P = 4.67 \times 10^{-8}$, $d = 0.78$) and nonfavored (NFL) ($P = 7.97 \times 10^{-10}$, $d = 0.65$) legs. VF resulted in statistical increases in flexibility and medium $d$ on RFS ($P = 6.98 \times 10^{-3}$, $d = 0.25$) and statistically increased flexibility on VF NFL flexibility ($P = 0.002$, $d = 0.31$). SF had no statistical difference between measures and small $d$. For explosive strength, there were no statistical differences in variables in the VS, SES, and VES for the pre- versus posttreatment tests. **Conclusions:** Simultaneous vibration and stretching may greatly increase flexibility while not altering explosive strength. **Key Words:** VERTICAL JUMP, GYMNASTICS, RATE OF FORCE DEVELOPMENT, PEAK FORCE

There is little doubt that range of motion (ROM)/flexibility is an important component of fitness for development of many athletes, particularly gymnasts. Stretching is a common and useful method for increasing flexibility. Although stretching is an integral part of gymnastics and many other sports, there can be some drawbacks to its use (12,24).

Acute stretching as part of a warm-up, particularly slow and static stretching, can cause a loss of maximum strength, rate of force development, power, and explosive performance (24). This creates a dilemma for gymnasts in that stretching during warm-up is not only a tradition, but it may help the athlete achieve difficult positions during subsequent performance. However, the potential stretching-induced decrease in explosiveness could reduce performance capabilities. Thus, a warm-up method that would allow ROM enhancement while enhancing or at least not limiting explosiveness would be quite applicable.

Recent research dealing with the use of vibration as part of warm-up has indicated that forward-split flexibility among male gymnasts can be markedly enhanced (20). Vibration–stretching has also been shown to increase ROM in the shoulder joint of male gymnasts (15). There are some data indicating that vibration may enhance measures of explosiveness (18). Furthermore, muscles with increased muscle length or tension are most affected by vibration (17). Therefore, it may be advantageous to use a combination of vibration and stretching as part of the warm-up for gymnasts, thus enhancing ROM and preserving or enhancing explosive performance (24).

The forward-split (one leg is flexed forward at the hip while the other leg is hyperextended rearward at the hip) is a movement/position commonly assumed by gymnasts during various portions of their routines. Enhancing ROM for this position would be advantageous to gymnastic performance. Additionally, various types of jumping movements are regularly performed during gymnastic routines. These jumps largely depend on the ability of the athlete to express

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These findings suggest that 30 Hz LMV may elicit an improvement in quadriceps activation and could be used to treat quadriceps dysfunction resulting from knee pathologies.

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# The acute effects of local muscle vibration frequency on peak torque, rate of torque development, and EMG activity

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ABSTRACT

*Purpose:* Vibratory stimuli enhance muscle activity and may be used for rehabilitation and performance enhancement. Efficacy of vibration varies with the frequency of stimulation, but the optimal frequency is unclear. The purpose of this study was to examine the effects of 30 Hz and 60 Hz local muscle vibration (LMV) on quadriceps function.
*Methods:* Twenty healthy volunteers (age = 20.4 ± 1.4 years, mass = 68.1 ± 11.0 kg, height = 170.1 ± 8.8 cm, males = 9) participated. Isometric knee extensor peak torque (PT), rate of torque development (RTD), and electromyography (EMG) of the quadriceps were assessed followed by one of the three LMV treatments (30 Hz, 60 Hz, control) applied under voluntary contraction, and again immediately, 5, 15, and 30 min post-treatment in three counterbalanced sessions. Dependent variables were analyzed using condition by time repeated-measures ANOVA.
*Results:* The condition × time interaction was significant for EMG amplitude ($p = 0.001$), but not for PT ($p = 0.324$) or RTD ($p = 0.425$). The increase in EMG amplitude following 30 Hz LMV was significantly greater than 60 Hz LMV and control.
*Conclusions:* These findings suggest that 30 Hz LMV may elicit an improvement in quadriceps activation and could be used to treat quadriceps dysfunction resulting from knee pathologies.
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## 1. Introduction

Vibratory stimuli may have practical uses in exercise performance and rehabilitation. Early work suggests enhancement of reflexive activity via stimulation of muscle spindles causing the tonic vibratory reflex (Burke et al., 1976; Eklund and Hagbarth, 1966a,b). Other mechanisms of improved muscle function following vibration include elevated muscle temperature (Cochrane et al., 2008) and enhanced corticospinal excitability and intracortical processes (Mileva et al., 2009; Siggelkow et al., 1999). Despite studies reporting enhanced muscle function following vibration (Bosco et al., 1999; Tihanyi et al., 2007) there are also studies that report detrimental or equivocal (de Ruiter et al., 2003; Herda et al., 2009) effects.

These ambiguous findings could be the result of heterogeneous stimulation parameters, particularly frequency. Greater damping of the stimulus occurs when the vibration frequency is close to the natural frequency of soft tissue (10–50 Hz in lower extremity musculature) (Wakeling and Nigg, 2001). Therefore, a muscle's electrical and mechanical responses could vary with frequency of vibration. Greater gains have been reported in one-repetition-maximum during a half squat following whole body vibration (WBV) at 50 Hz, but not at 20 Hz or 35 Hz (Ronnestad, 2009). However, Moran et al. (2007) reported no improvement in peak power or EMG during a maximal biceps curl following 65 Hz LMV. Additionally, greater EMG amplitudes in the vastus lateralis have been observed during 30 Hz WBV compared to 40 Hz and 50 Hz (Cardinale and Lim, 2003). Overall, it remains unclear what frequency is ideal for enhancing muscle function.

Much of the current literature has evaluated the effects of indirect vibration on muscle function using WBV. However, commercially available WBV platforms are cost prohibitive and provide limited portability. Local muscle vibration (LMV) applied directly to the muscle–tendon unit also influences muscle function (Bongiovanni and Hagbarth, 1990; Couto et al., 2013; Iodice et al., 2011; Mischi and Cardinale, 2009; Ribot-Ciscar et al., 2003), and may provide a cost effective and portable alternative to WBV. For example, Couto et al. (2013), found that maximal

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**We can use three major vibration rates such as:**

**Low** Vibration Rate can:

- Recovery/Mobility
- Motor Control

**Medium** Vibration Rate can:

- Recovery/Preparation
- Motor Control

**High** Vibration Rate can:

- Preparation
- Motor Control

**Conclusion**

This thesis applies to my work as a physiotherapist. I wanted to explain how many more possibilities we have in our treatment by stimulating mechanoreceptors. Nowadays, we have a huge choice of tools and techniques we can use to treat the patient. For example, we can use the IASTM (Instrummment assist  soft tissue manipulation) to maximise effects of the therapy. The newest research shows, that the optimal time of mechanoreceptor stimulation is only four minutes. It is enough to achieve expected effects on tissue. Longer stimulation can often overstimulate the system, and there is no further effects of stimulation.

In theraphy the most important thing is to define the goal. For example, you can treat tissue spasma by stimulating Ruffini receptors. By deep and slow impulse we can relax the tissue. To performe a better motor control we can use Paccini stimulation by rapid and fast impulse.

In my everyday work, I educate my patients how to roll themselves. I give them directions based on the above mentioned stimulation techniques.

I also use a vibration impulse to stimulate the tissue. We have a great choise of different vibration tools ( rollers, massage guns, balls, vibration plate, even pods). First, we define the goal of the therapy, and then we can start to manipulate the tissue. To release the tension we must apply the low ( or medium) vibration rate. To activate the motor control we have to *use high vibration rate.*

*"The successful use of manual therapy depends on a comprehensive understanding of the complex interplay between multiple inputs, including the **patient**, the **provider**, and the **environment**. Relying simply on biomechanical mechanisms is a recipe for failure."*

*Mintken*

**We have to remember that by stimulating fascia mechanoreceptors we stimulate the brain.**

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