

Harmonic technique

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Contents of course

- The lumbar spine
- Cervical spine & CD junction
- Lower ribs
- Thorax & ribs
- Shoulder
- Hips
- Biomechanics
- Physiology of repair & adaptation
- Clinical application

Definition of Harmonic Motion

The rhythmic and cyclical motion of an object between two spatial positions

Definition of Harmonic Technique

A manual technique which brings on a state of resonance within the body

Harmonic vs. Rhythmic

Harmonic



Rhythmic



Mechanics of harmonics

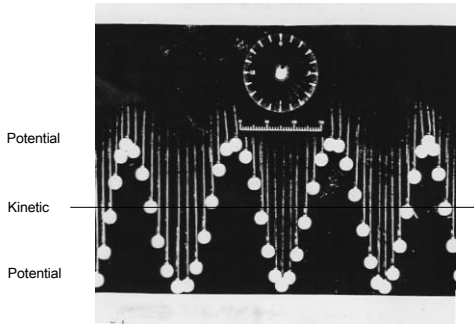
Pendulums



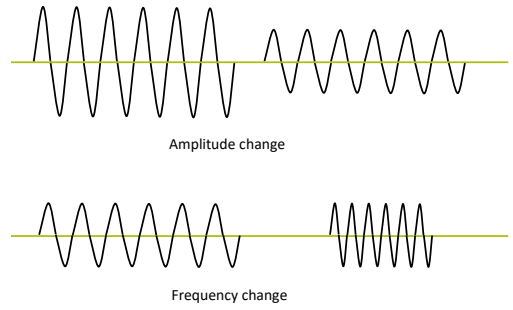
Springs



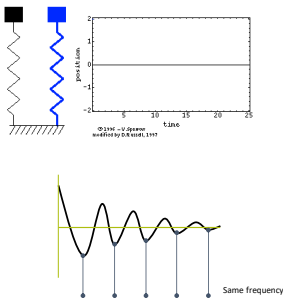
Spring- energy



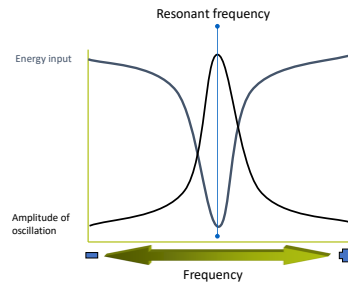
Amplitude & frequency



Dampened oscillation



Resonant frequency

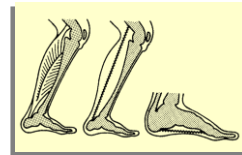
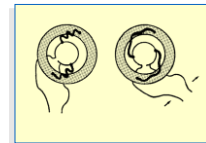


Springs and pendulums in the body

	Frequency determined by:	Where in the body	Affected by:
Spring	Mass Stiffness	Antagonistic tissue (as elastic strain energy) Tissues under compression (e.g discs)	Oedema Scarring Adhesions Increase in muscle tension* Weight gains
Pendulum	Length of the arm	Limbs Counter-motion of masses	All masses are combinations of spring and pendulums, affected by above

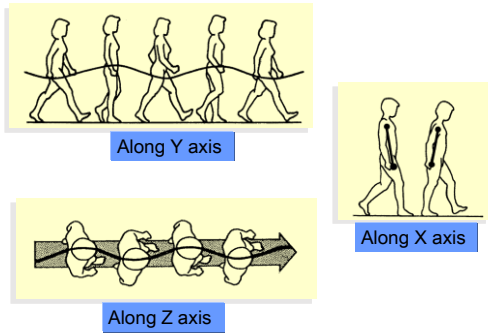
* Can be diagnostic

Springs in the body

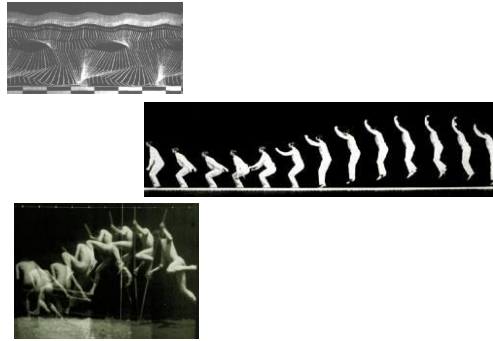


Tetsuo Fukunaga, Kojiro Kubo, Yasu Kozuka, Senji Fukuhara, Hiroaki Kaneko, Constantinos N. Maganaris 2003 In vivo behaviour of human muscle tendon during walking. Proceedings of the Royal Society B: Biological Sciences, 270:1643-1651

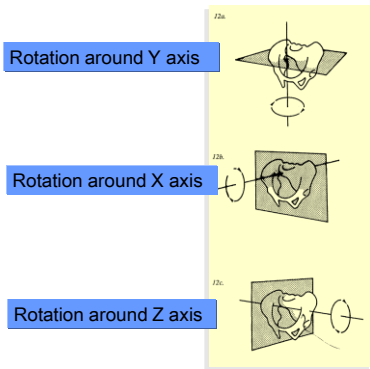
Pendulums in the body



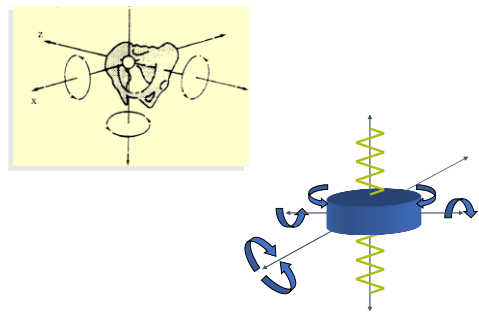
Harmonic in motion



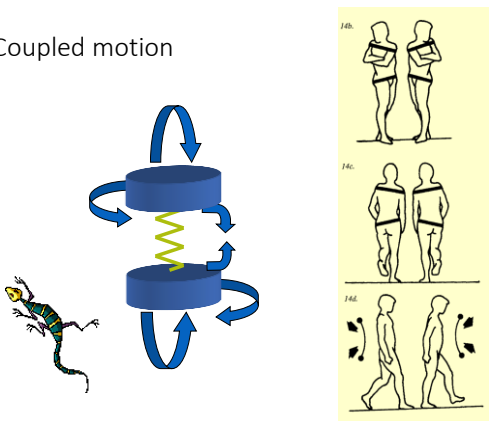
Rotational pendulums



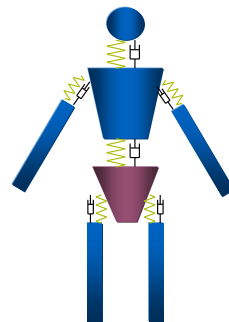
Free vibrating mass



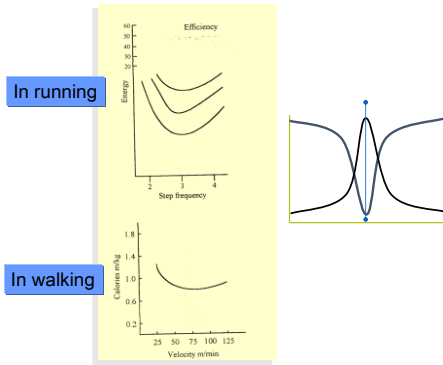
Coupled motion



Free vibrating humans



Resonant frequency in human movement



Resonant frequency in human movement

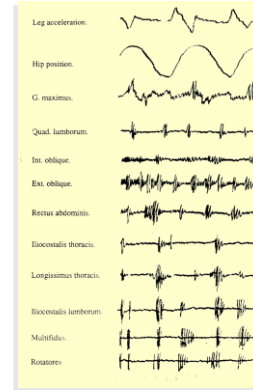
Resonance in rhythmic movement is associated with metabolic minima and stability of movement patterns compared to other frequencies

GA Cavagna, M Montoye, PA Williams, G Murch - Pflüger. 1997 The resonant step frequency in human running. *Archiv European Journal of Physiology*, 678: 684
 C. T. Farley, R. Biksham, L. Saha and C. B. Taylor 1991 Hopping frequency in humans: a test of how springs set stride frequency in bouncing gaits. *Journal of Applied Physiology*, 71: 6, 2127-2132
[Sofianos, M, Mita, S, Tuncel, M.](#) Advantages of rhythmic movements at resonance: minimal active degrees of freedom, minimal noise, and maximal predictability. *J Mot Behav*, 2009;41(3):123-9

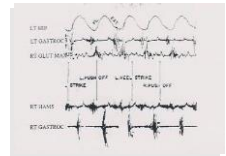
Resonant frequency in human movement

"Pendular oscillations of a limb or limb segment, attunement of the central nervous system to the resonant frequency minimizes the variables to be controlled and maximizes the predictability of the rhythmic movement's chaotic dynamics"

[Sofianos, M, Mita, S, Tuncel, M.](#) Advantages of rhythmic movements at resonance: minimal active degrees of freedom, minimal noise, and maximal predictability. *J Mot Behav*, 2009;41(3):123-9
[Sofianos, M, Mita, S, Tuncel, M.](#) Resonance Tuning in Rhythmic Arm Movements. *J Mot Behav*, 1998;30(2):13-14.



Neural control



Getting it right

- The body masses have individual resonant frequency
- Each mass has up to six different patterns of oscillation
- Harmonic Technique is about amplifying these patterns
- If its not easy it can't be Harmonic

Therapeutic role of Harmonic Techniques

The pathology



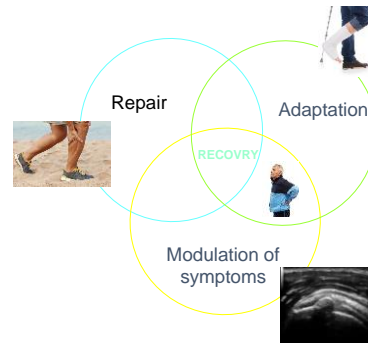
6 weeks after injury.....



Process Approach

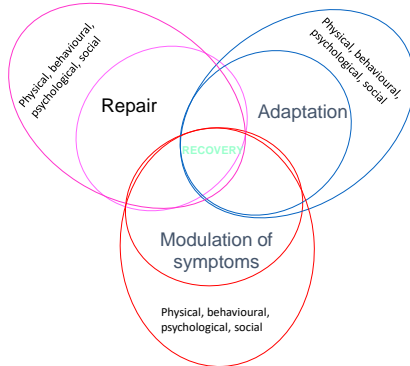
Co-create with the patient environments in which their recovery can be optimised.

Recovery processes



Lederman E 2013 Therapeutic stretching: towards a functional approach. Elsevier

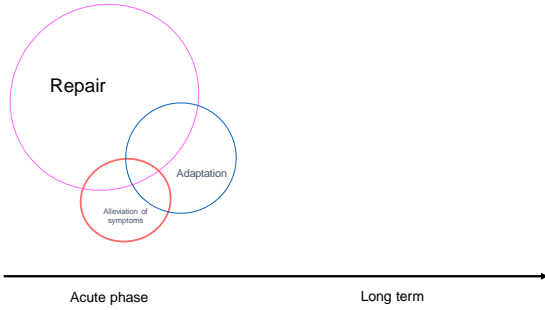
Recovery environments



Recovery environments: management considerations

Process	Condition	Specific management	Shared management
Repair	All acute conditions, max 8 weeks: All tissue damage, Joint & muscle sprains, post surgery, blunt trauma, first phase of frozen shoulder,	Moderate cyclical and repetitive loading Applied locally to affected area Gradual loading Pain-free / tolerable movement Can be either active or passive Any movement pattern but preferably functional. Extra-functional is OK	Psychological Ease movement pain related anxieties, catastrophising, support, reassurance, comfort, Sooth and calm Therapeutic relationship - trust, non-judgmental, empathic... Contextual factors Cognitive Inform Plan Set goals Provide choice Behavioural Support recovery behaviour Raise awareness to avoidance behaviour
Adaptation	All chronic conditions: Post immobilisation contracture, ROM rehab, postural and movement re-education/rehab, CNS damage/rehab, structural/biomechanical change, enhance/recover human performance	Active Task specific whole and goal movement Functional Repetition Overloading Discomfort likely and generally OK	Physical Functional movement Frequent exposure to activity
Alleviation of symptoms	Acute/Chronic pain/discomfort Acute/chronic stiffness	Many treatment modalities may be beneficial depending on patient expectations... Sleep & relaxation Physically: Active may be better than passive movement Cyclical movement may be better than static approaches Functional or extra-functional	

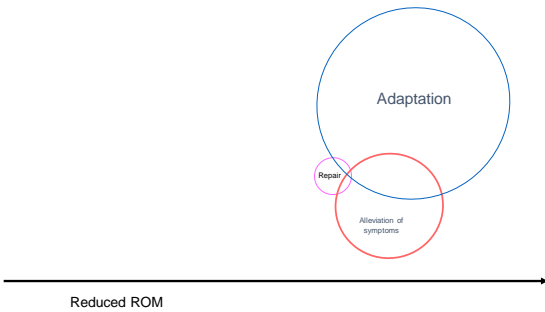
Treatment strategy acute injuries



Consider this management

Process	Condition	Specific management	Shared management
Repair	All acute conditions, max 8 weeks: All tissue damage, Joint & muscle sprains, post surgery blunt trauma, first phase of frozen shoulder,	Moderate cyclical and repetitive loading Applied locally to affected area Gradual loading Pain-free / tolerable movement Can be either active or passive Any movement pattern but preferably functional. Extra-functional is OK	Psychological Ease movement pain related anxieties, catastrophising, support, reassurance, comfort, Sooth and calm Therapeutic relationship - trust, non-judgmental, empathic... Contextual factors Cognitive Inform Plan Set goals Provide choice Behavioural Support recovery behaviour Raise awareness to avoidance behaviour Physical Functional movement Frequent exposure to activity
Adaptation			
Alleviation of symptoms			

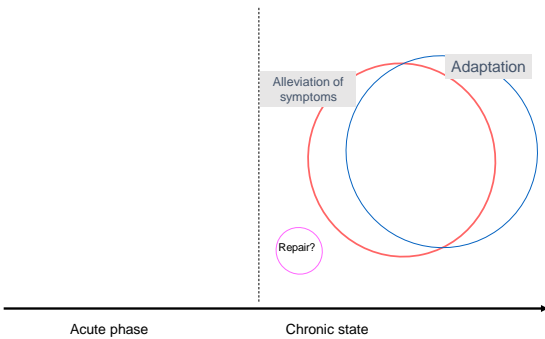
Post immobilisation / contractures



Consider this management

Process	Condition	Specific management	Shared management
Repair			Psychological Ease movement pain related anxieties, catastrophising, support, reassurance, comfort, Sooth and calm Therapeutic relationship - trust, non-judgmental, empathic... Contextual factors Cognitive Inform Plan Set goals Provide choice Behavioural Support recovery behaviour Raise awareness to avoidance behaviour Physical Functional movement Frequent exposure to activity
Adaptation	All chronic conditions: Post immobilisation contracture, ROM rehab, postural and movement re-education/rehab, CNS damage/rehab, structural/biomechanical change, enhance/recover human performance	Active Task specific wide and goal movement Functional Repetition Overloading Discomfort likely and generally OK	
Alleviation of symptoms			

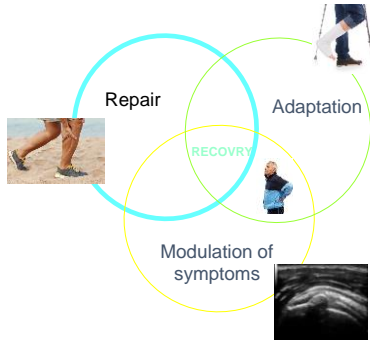
Chronic pain conditions



Consider this management

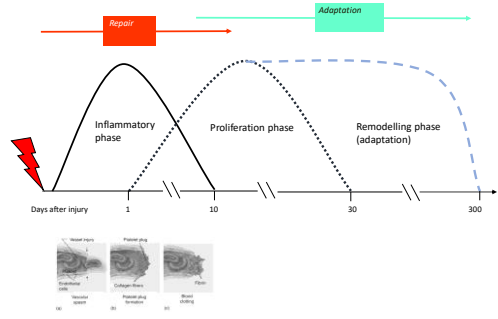
Process	Condition	Specific management	Shared management
Repair			Psychological Ease movement pain related anxieties, catastrophising, support, reassurance, comfort, Sooth and calm Therapeutic relationship - trust, non-judgmental, empathic... Contextual factors Cognitive Inform Plan Set goals Provide choice Behavioural Support recovery behaviour Raise awareness to avoidance behaviour Physical Functional movement Frequent exposure to activity
Adaptation			
Alleviation of symptoms	Acute/Chronic pain/discomfort Acute/chronic stiffness	Depending on patient expectations... Physiologically: Active may be better than passive movement Cyclical movement may be better than static approaches Functional or extra-functional	

Recovery processes



Lederman © 2013 Therapeutic stretching: towards a functional approach. Elsevier

Repair phases



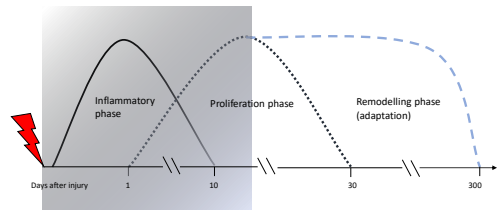
Saleidin, K. Anatomy and Physiology, McGraw-Hill, 2004

Role of mobilisation and pumping

Tissue	Events during inflammation and proliferation	Effects of movement	Immobility
Interstitial space (oedema)	Medium for repair Transport of nutrients and drainage metabolic by-products and removal of debris Medium for cell migration Medium for cell communication	Regulate extent of oedema Facilitate flow and supply of nutrients Facilitate drainage Guide migration and movement of interstitial and immune cells	If excessive interfere with repair
Vascular	Supply route nutrients + energy Oxygen for fibroblast + synthesis of collagen	Facilitate flow Direct angiogenesis along force vectors	Reduced flow, affect repair rate and quality Disorganised vascular architecture
Lymphatic	Drainage of interstitium: Metabolic by-products and cell debris	Facilitate drainage Direct lymphangiogenesis by directing flow dynamics	Lymphoedema, poor repair Disorganised lymphangiogenesis
Connective tissue	Building materials for damaged tissues (by fibroblasts), including the interstitial matrix itself	Effect synthesis by fibroblast Effect of normal deposition in extracellular space Restores biomechanical properties of tissue (tensile strength, stiffness) Reduces potential for abnormal cross-links and adhesions	Opposite effects
Muscle	As in connective tissue + regeneration and proliferation by satellite cells	Better myofibril regeneration and orientation. Helps formation of attachments between the myofibrils and extracellular collagen matrix. Helps satellite cells differentiation (to myoblasts) Direct formation and alignment of the myofibrils along the force transmission vectors within the muscle	Increased potential for scarring Reduced contractile and passive properties of muscle Longer recovery
Joints	As in interstitial space	As in interstitial space Support transport to cartilage & intracapsular structures, e.g. meniscus	Longer recovery Joint contract adhesions Reducing biomechanical properties of intra- and extra-capsular structures

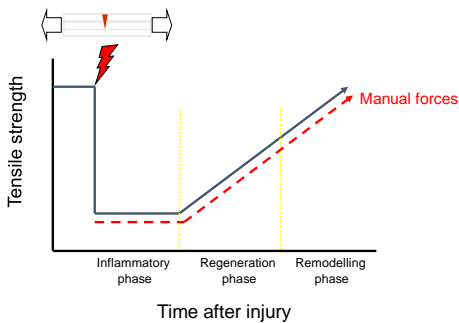
Lederman E (to be published) Functional Exercise Prescription in Movement and Sports Rehabilitation, HandSpring, London.

Management during inflammation and proliferation phases

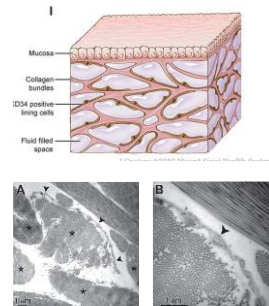


Saleidin, K. Anatomy and Physiology, McGraw-Hill, 2004

Tissue tensile strength following injury

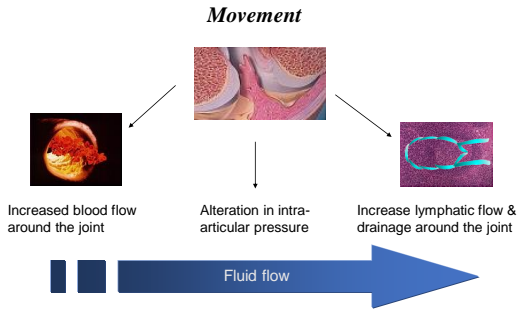


Interstitial and transinterstitial pump

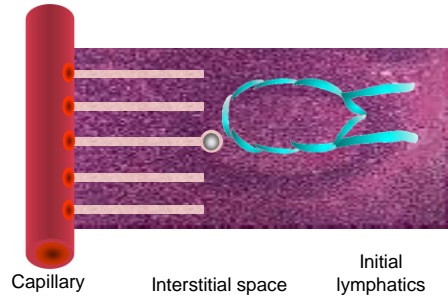


Petos C, Benias et al Structure and Distribution of an Unrecognized Interstitium in Human Tissues. Sci Rep. 2018; 8: 4947. Published online 2018 Mar 27

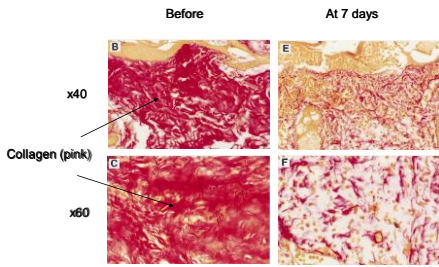
The transsynovial pump



Flow through the interstitium

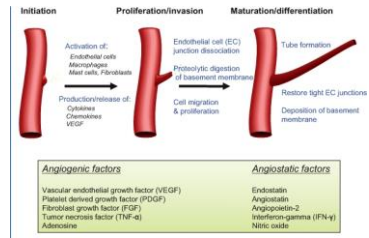


Oedema formation



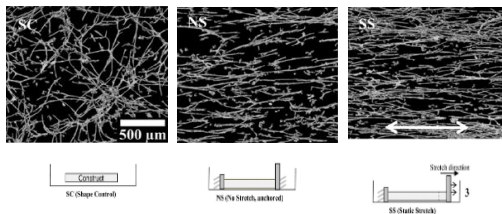
Kendrick C. Boardman and Melody A. Swartz. *Interstitial Flow as a Guide for Lymphangiogenesis*. *Circ. Res.* 2003;92:801-808.

Inflammation and angiogenesis



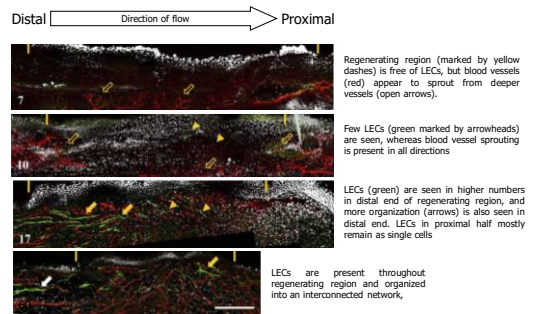
<https://www.ncbi.nlm.nih.gov/books/NBK53377/>

Tension and angiogenesis



Koblan L, Underwood CJ, Steve Maas S et al Effect of Mechanical Boundary Conditions on Orientation of Angiogenic Microvessels. *Cardiovasc Res.* 2008 May 1; 79(2): 324-332.

Lymphatic regeneration occurs in direction of interstitial flow

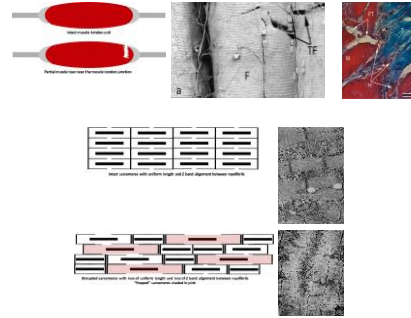


Boardman KC, Swartz MA 2003 *Interstitial flow as a guide for lymphangiogenesis*. *Circ. Res.* 2003 Apr 18;92(7):801-8.

Muscle tissue

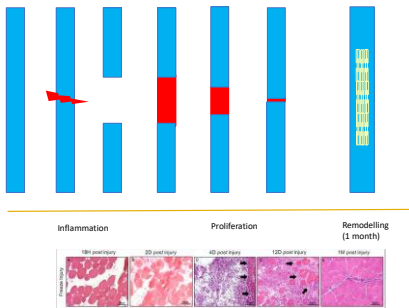


Degrees of muscle damage



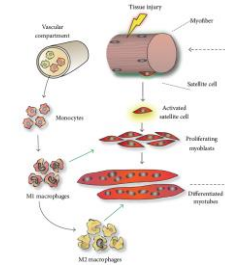
Translational Sports Medicine, Volume 2, Issue 3, Pages: 102-106, First published: 13 January 2019, DOI: (10.1002/tms2.86)

Muscle repair

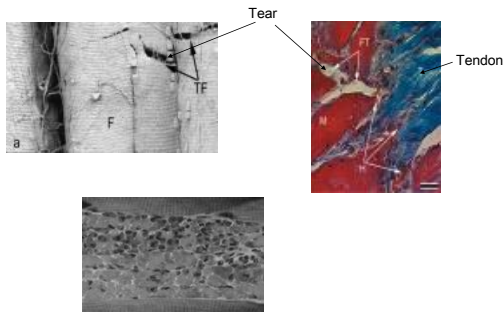


Lederman E (to be published) Functional Exercise Prescription in Movement and Sports Rehabilitation. Handspring, London.
David Hardy et al 2016 Comparative Study of Injury Models for Studying Muscle Regeneration in Mice. PLoS One. 2016; 11(1): e0147158.

Muscle repair: satellite cells

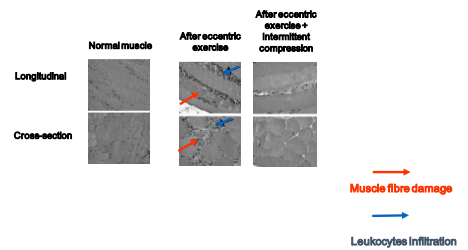


Varying degrees of damage



Zhuo, H., Espinosa, L., Gao, S. The role of neuromuscular injury and repair following muscle stretch. J Anat. 2008 Apr;208(4):450-70.

Effect of intermittent compression on repair



Butterfield TA et al 2008 Cyclic compressive loading facilitates recovery after eccentric exercise. Med Sci Sports Exerc. 2008 Jul;40(7):1289-96

Massage and DOMS

Active recovery, massage, compression garments, immersion, contrast water therapy, and cryotherapy induced a small to large decrease (-2.26 < g < -0.40) in the magnitude of DOMS, while there was no change for the other methods, such as stretching. Massage was found to be the most powerful technique for recovering from DOMS and fatigue

Dupuy O, Douzi W, Theurot D, Bosquet L, Dugail B 2018 An Evidence-Based Approach for Choosing Post-exercise Recovery Techniques to Reduce Markers of Muscle Damage, Soreness, Fatigue, and Inflammation: A Systematic Review With Meta-Analysis. *Front Physiol*. 2018 Apr; 9:403. doi: 10.3389/fphys.2018.00403. eCollection 2018.

Muscle: Movement vs. immobility

- Faster resolution of repair
- Increase capillary ingrowth
- Better muscle fibre orientation
- Improved tensile strength

Järvinen M Healing of a crush injury in rat striated muscle. 4. Effect of early mobilization and immobilization on the tensile properties of gastrocnemius muscle. *Acta Chir Scand*. 1976;142(1):47-56.
 Järvinen M Healing of a crush injury in rat striated muscle. 3. A micro-angiographical study of the effect of early mobilization and immobilization on capillary ingrowth. *Acta Pathol Microbiol Scand A*. 1976;84(4):351-364.
 Järvinen M, Laitinen M. Healing of a crush injury in rat striated muscle. 2. A histological study of the effect of early mobilization and immobilization on the repair processes. *Acta Pathol Microbiol Scand A*. 1975; May;83(3):269-82.
 Järvinen M The effects of early mobilization and immobilization on the healing process following muscle injuries. *Sports Med*. 1993 Feb;15(2):79-83.

Clearance rate studies

- Clearance in septic arthritis (Salter et al 1981)
- Clearance of haemarthrosis (O'Driscoll et al 1983)
- Reduce joint effusion (Giovanelli et al 1985)
- Clearance of injected dye (Skyhar et al 1985)

Joints



Continuous passive motion after repair of the rotator cuff. A prospective outcome study

Continuous passive (n=17) motion vs. manual passive range-of-motion exercises (n=15)

The treatment was extremely successful in both groups. Excellent score for twenty-seven shoulders (84 per cent), good for two (6 per cent), fair for two (7 per cent), and poor for one (3 per cent). With the numbers available No significant differences ($p > 0.05$) between the two groups Manual passive range-of-motion exercises were more cost-effective than continuous passive motion.

Group CPM (n=29) Continuous passive motion (CPM) 1 h / day
 Group CPT (n=28) daily active stretching and pendulum exercises for 1 h / day
 20 days X 4 weeks.

All patients in both groups were also instructed in a standardized home exercise programme consisting of passive range of motion and pendulum exercises to be performed every day. In both groups, statistically significant improvements were detected in all outcome measures compared with baseline.

Pain reduction, at rest, at movement and at night was better in CPM group. In addition the CPM group showed better shoulder pain index scores than the CPT group

[Lastayo PC](#)

Dundar U, Toktas H, Cakir T, Evcik D, Kavuncu V. 2009 Continuous passive motion provides good pain control in patients with adhesivecapsulitis. *Int J Rehabil Res*. 2009; 32:193-8.

Effects of CPM on pain following joint surgery

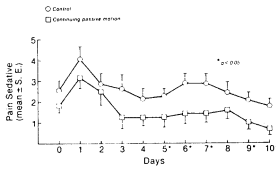


FIG. 3. Pain medication taken by patients following total knee arthroplasty with immediate passive mobilization versus control subjects (bed rest). From Coutts *et al.*¹⁴

Some evidence for manual drainage

Lymph flow in instrumented dogs varies with exercise intensity.
Desai P, Williams AG Jr, Prajapati P, Downey HF.
Lymphat Res Biol. 2010 Sep;8(3):143-8. doi: 10.1089/lrb.2009.0029.

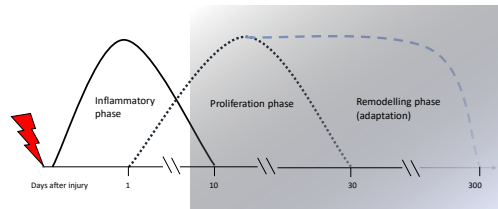
Lymphatic pump treatment enhances the lymphatic and immune systems.
Hodge LM, Downey HF.
Exp Biol Med (Maywood). 2011 Oct 1;236(10):1109-15. doi: 10.1258/ebm.2011.011057. Epub 2011 Aug 24.

Lymphatic pump treatment increases thoracic duct lymph flow in conscious dogs with edema due to constriction of the inferior vena cava.
Prajapati P, Shah P, King HH, Williams AG Jr, Desai P, Downey HF.
Lymphat Res Biol. 2010 Sep;8(3):149-54. doi: 10.1089/lrb.2009.0032.

Lymphatic pump manipulation mobilizes inflammatory mediators into lymphatic circulation.
Schander A, Downey HF, Hodge LM.
Exp Biol Med (Maywood). 2012 Jan 1;237(1):58-63. doi: 10.1258/ebm.2011.011220. Epub 2011 Dec 14.

Passive motion is the only form of passive physical therapy known to stimulate repair / recovery

Management in the latter repair phases



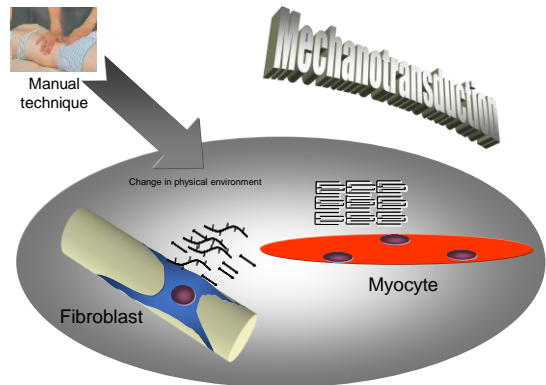
Harvey LA, Grossi LA, Herbert RD. Continuous passive motion following total knee arthroplasty in people with arthritis. *Cochrane Database Syst Rev.* 2010 Mar 17(3):CD004260.
Boudreau L, et al. Efficacy of continuous passive motion following total knee arthroplasty: a metaanalysis. *J Rheumatol.* 2004 Nov;31(11):2251-64

Saleidin, K. *Anatomy and Physiology*, McGraw-Hill, 2004

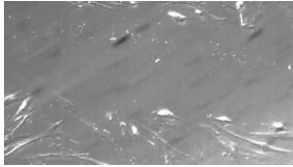
Movement and repair

Importance of movement:

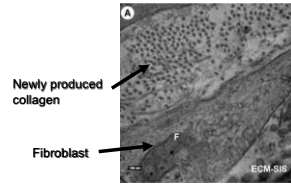
- Help resolution of inflammation
- Reduces swelling / oedema
- Directs activity of fibroblasts
- Influence recovery of structural and biomechanical properties of tissues
- Aids physiological recovery



Fibroblasts proliferation



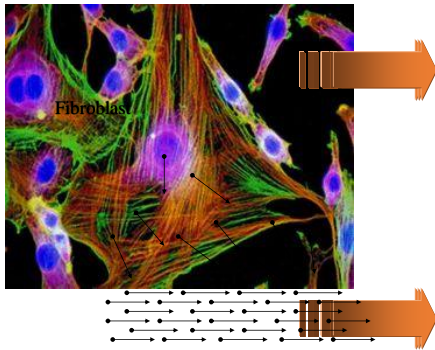
Cyclical loading



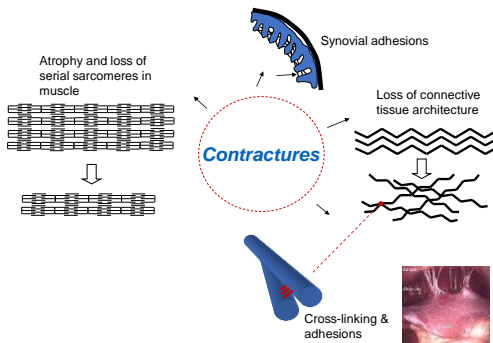
Effects of Cell Seeding and Cyclic Stretch on the Fiber Remodeling in an Extracellular Matrix-Derived Bioscaffold. *Tissue Eng Part A*. 2020 April;15(4):957-963.

Benefits of movement on connective tissue

- Alignment of collagen fibres
- Improve tissue strength
- Reduce cross-linking (adhesions)

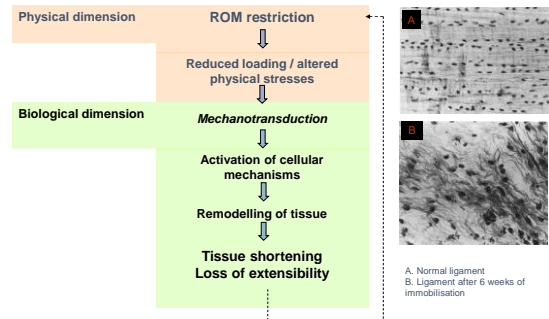


Adaptive changes associated with immobilization and contracture



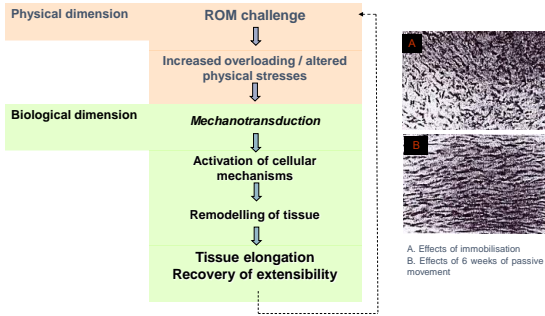
Lederman E 2013 Therapeutic stretching: towards a functional approach. Elsevier

From the physical to the biological dimension



Lederman E 2013 Therapeutic stretching: towards a functional approach. Elsevier

Recovery: from the physical to the biological dimension



Lederman E 2013 Therapeutic stretching: towards a functional approach. Elsevier

Effects on tensile strength

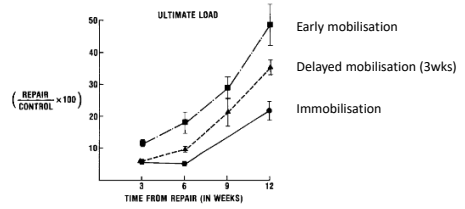
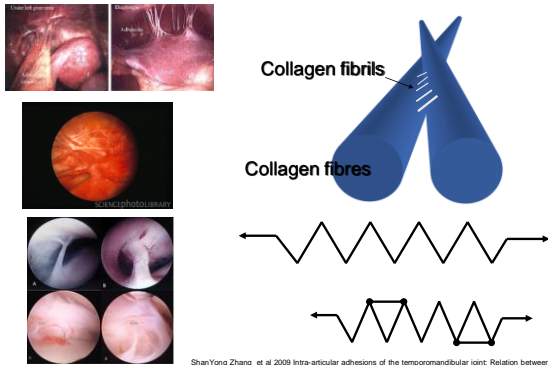


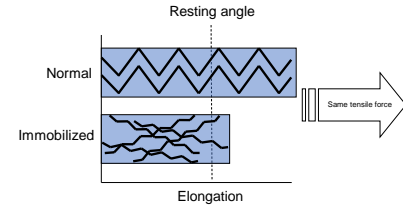
Fig. 4. Comparison of ultimate tensile load values of repaired tendons of all experimental groups. Higher values were seen at each interval with early mobilization.

Gelberman R H, Woo S L-Y, Loehrer K, Akeson WH, Amiel D 1982 Effects of early intermittent passive mobilization on healing canine flexor tendons. Journal of Hand Surgery 7(2):170-175

Mobilisation effects on movement range



Immobilization and connective tissue extensibility



Lederman E 2013 Therapeutic stretching: towards a functional approach. Elsevier

Mobilisation and ROM

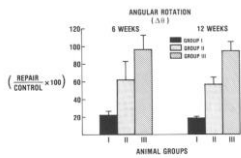
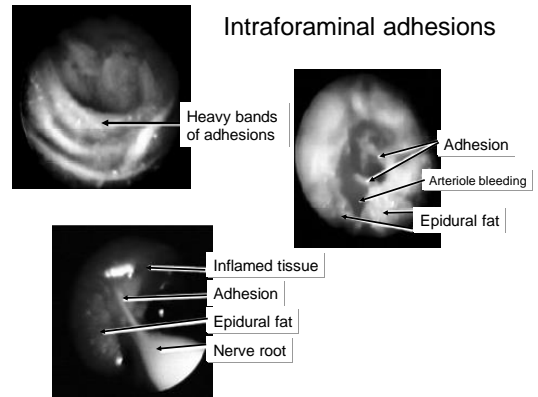


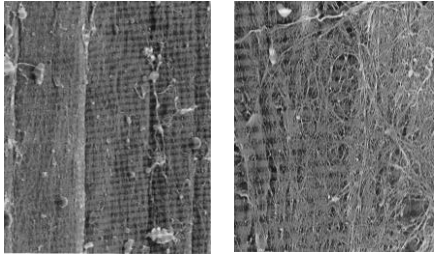
Fig. 6. Histogram showing differences in angular rotation ($\Delta\theta$) of repaired tendons from immobilization, delayed mobilization, and early mobilization groups.

GROUP I - Immobilisation
GROUP II - Delayed mobilisation
GROUP III - Early mobilisation

Gelberman R H, Woo S L-Y, Loehrer K, Akeson WH, Amiel D 1982 Effects of early intermittent passive mobilization on healing canine flexor tendons. Journal of Hand Surgery 7(2):170-175

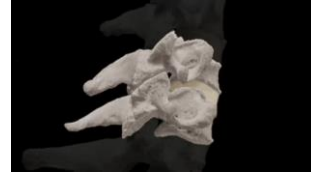
Intraforaminal adhesions





Williams P et al. 1998 The morphological basis of increased stiffness of rabbit tibials anterior during surgical limb-lengthening'. J Anat 193 131-138

Foraminal pump (& disc imbibition?)



Aggressive vs. Gentle

Group A: Aggressive early passive rehabilitation (manual therapy [2 times per day] and unlimited self-passive stretching exercise

Group B: limited continuous passive motion exercise and limited self-passive exercise

RESULTS:

ROM: group A > B until 3 months postoperatively. A=B at 1-year follow-up

MRI scan at 6 to 12 post op: Retears - Group A, 7 of 30 cases (23.3%) / Group B 3 of 34 cases (8.8%)

CONCLUSIONS:

A gentle rehabilitation protocol with limits in range of motion and exercise times after arthroscopic rotator cuff repair would be better for tendon healing without taking any substantial risks.

N=64

Lee BS, Cho NS, Shim YG 2012 Effect of two rehabilitation protocols on range of motion and healing rates after arthroscopic rotator cuff repair: aggressive versus limited early passive exercises. [Arthroscopy](#). Jan;28(1):34-42.

The short of it..

Tolerable/comfortable, cyclical, repetitive movement

Why pump tissues?

Assisting fluid flow

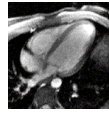
- Inflammation
- Ischaemia
- Impediment to flow

Gross fluid flow

Muscle pump



Heart pump



Breathing



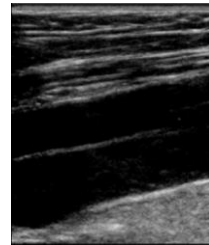
Gravity



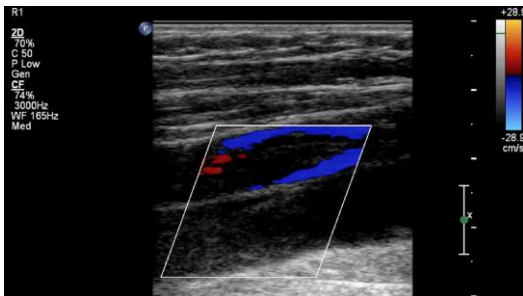
The mechanical code for pumping

- Adequate compression
 - Intermittent
 - Rhythmic
 - Repetitive
- (Either passive or active)

External compression and venous flow



External compression and venous flow



Methods: Three different interventions:

Passive range of motion (stretching)

Active assisted harmonics

Passive harmonic therapy

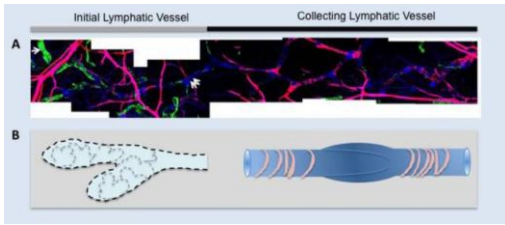
Applied to participants' dominant upper extremity shoulder joint (10 minutes).

Primary Outcome Measures: Superficial palmar branch of the radial artery blood flow volume was evaluated with color Doppler ultrasound before and immediately after the intervention.

Results: Blood flow volume was significantly increase with active assisted and passive harmonics. No change in blood flow volume with passive range of motion intervention.

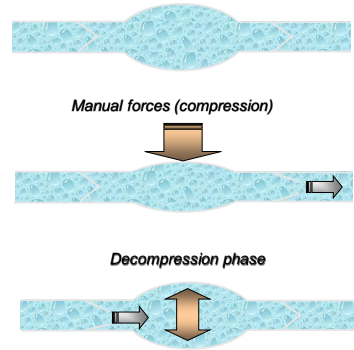
To be published. The effect of harmonic therapy on acute peripheral blood circulation in young males.

Initial and collecting lymphatics



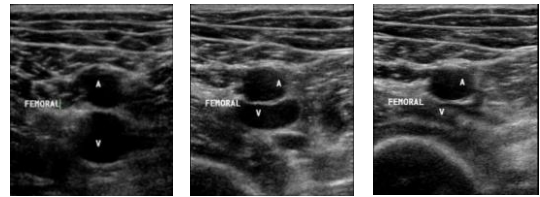
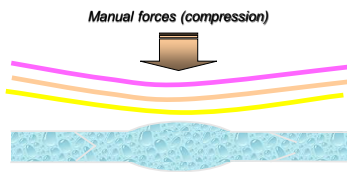
Shan Liao, Pierre-Yves von der Weid 2014 Inflammation-induced lymphangiogenesis and lymphatic dysfunction. *Angiogenesis*. 2014 Apr; 17(2): 325-334

The siphon effect

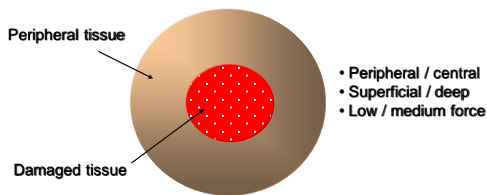


Force of compression

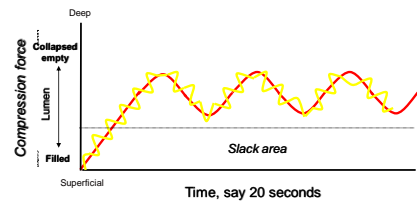
Compression force



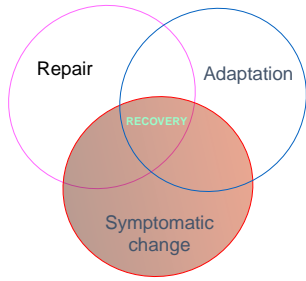
Pattern of drainage



Pattern of oscillation



Recovery processes

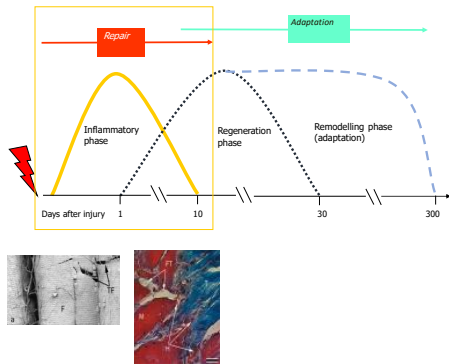


Lederman E 2013 Therapeutic stretching: towards a functional approach. Elsevier

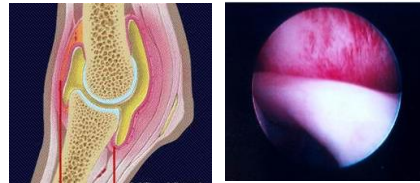
Two pain-stiffness conditions

- Injury
- Sensitivity (sensitisation)

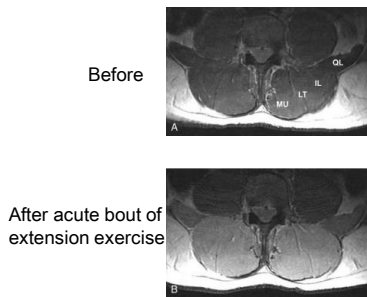
Injury related stiffness



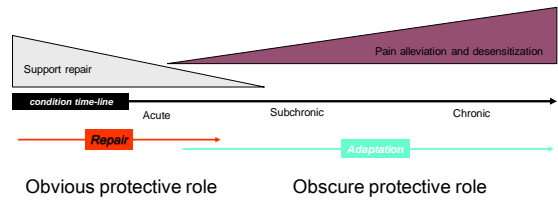
Pain-stiffness after injury: tissue swelling and sensitivity



Pain stiffness of DOMS

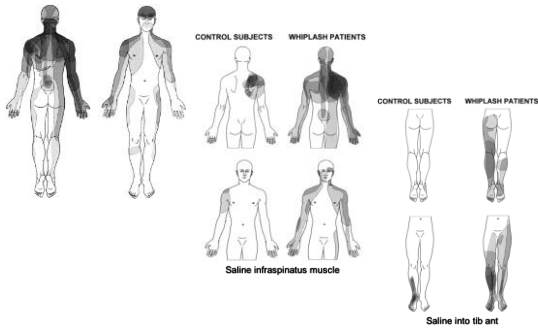


Pain/stiffness of injury and pain/stiffness of sensitivity



Mayer J et al. The Use of Magnetic Resonance Imaging to Evaluate Lumbar Muscle Activity During Trunk Extension Exercise at Varying Intensities. SPINE Volume 30, Number 22, pp2556-2563

Sensitisation:

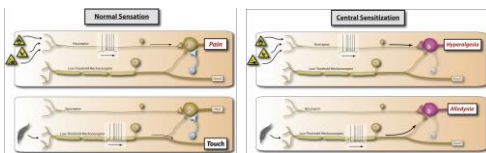


Koebnik-Johansen M. Generalised muscle hyperalgesia in chronic whiplash syndrome. *Pain*. 2009;140(2):229-34.

Tender points at site of pain: central rather than peripheral generators

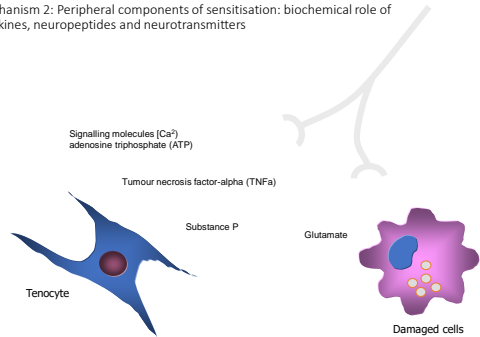
Leffler AS, Hansson P, Kossek E. Somatosensory perception in patients suffering from long-term trapezius myalgia at the site overlying the most painful part of the muscle and in an area of pain referral. *Eur J Pain*. 2003;7(3):267-76.

Mechanism 1: normal & central sensitisation



Woolf CJ 2011 Central sensitization: implications for the diagnosis and treatment of pain. *Pain*. Mar; 152(3 Suppl):S2-15.

Mechanism 2: Peripheral components of sensitisation: biochemical role of cytokines, neuropeptides and neurotransmitters



Shibata S, et al of The Pain of Tendinopathy: Physiological or Pathophysiological? *Sports Medicine*. Sept 2019
 Goyal M, et al Increased substance P in subacromial bursa and shoulder pain in rotator cuff diseases. *J Orthop Res* 1998; 16(5):614-621
 Grant M, et al Increased 1-norethanol subacromial synovial and shoulder pain in rotator cuff diseases. *Rheumatology* (Oxford) 2001; 40(3):395-1001.
 Zou Y, Balleu J. Neuropeptides in tendinopathy. *Front Biosci*. 2009 Jan 14; 2023-11.
 Anderson DJ et al Presence of substance P and the neurokinin-1 receptor in tenocytes of the human Achilles tendon. *Regul Pept*. 2008 Oct 9; 150(1-3):81-7. Epub 2008 Mar 4.
 Allreadson H, Lorenzian R. Chronic tendon pain: no signs of chemical inflammation but high concentrations of the neurotransmitter glutamate. Implications for treatment? *Curr Drug Targets*. 2002 Feb;3(1):45-54.

Peripheral vs central pain generators

	Peripheral (recovery by repair)	Central sensitisation
Onset	History of trauma	Often unknown cause Can be a sequelae to trauma/ops
Duration	Any pain within 1-6 weeks of injury	Ongoing pain over 12 weeks
Observation	Protective movement strategies Antalgic postures / gait	Movement fears Absence of protective movement strategies
Symptomatic area	Local related to injury Neurological symptoms along clear peripheral pathway	Diffuse non-anatomical Fleeting aches & pains different areas Presence of other unrelated areas of chronic pain conditions
Pattern	Clear onset, a peak and gradual attenuation	Ongoing or intermittent
Palpation	Local to injury Along nerve distribution	Diffuse allodynia and hypersensitivity Sensitivity in diffuse anatomical structures
Neuropathic	Altered sensation and motor control	Often absent

See also: Smart KM, Blake C, Staines A, Duddy C 2011 The Discriminative validity of "nociceptive," "peripheral neuropathic," and "central sensitization" as mechanism-based classifications of musculoskeletal pain. *Clin J Pain*. 2011 Oct;27(8):655-63. doi: 10.1097/AJP.0b013e318219f16a.

Loss of spinal ROM: Biomechanical restriction or stretch sensitivity?

Spontaneous biomechanical stiffening
 very rare
 More likely to be stretch sensitivity

Loss of spinal ROM: Biomechanical restriction or stretch sensitivity?

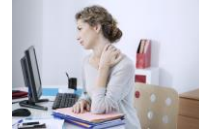
Same spinal stiffness in CLBP and normal individuals



Overs EF Jr, DeVocht JW, Gudavalli MR, Wilder DG, Mestek WC. Comparison of posterolateral spinal stiffness measures to clinical and demographic findings at baseline in patients enrolled in a clinical study of spinal manipulation for low back pain. *J Manipulative Physiol Ther.* 2007 Sep;30(7):493-500.
 Tashir R, Stanton G, Lorimer Moseley, Arnold Y, L Wong, Gregory N, Kawchuk 2017 Feeling stiffness in the back: a protective perceptual inference in chronic back pain. *Sci Rep.* 2017; 7: 9681. Published online 2017 Aug 29. doi: 10.1038/s41598-017-09429-1

Stretch sensitivity in the neck

NP patients showed an overall stiffer and more rigid neck motor control pattern compared to HC, indicated by lower neck flexibility, slower movement velocity, increased head steadiness and more rigid trajectory head motion patterns.



Ingebrigt Meisingset, et al 2015 Evidence for a general stiffening motor control pattern in neck pain: a cross sectional study. *BMC Musculoskeletal Disord.* 2015; 16: 56.

Stretch sensitivity vs. biomechanical stiffness



By Telegraph Reporters
 7 AUGUST 2016 - 10:38PM

Scientists have discovered why we wake up stiff in the morning - because our body's natural ibuprofen has not kicked in yet.

Researchers revealed the reason our limbs can feel rigid and achy when we rise is because the body's biological clock suppresses anti-inflammatory proteins during sleep.

When we start moving around each morning our body is playing catch up as the effects of the proteins wear off.

L. E. Hand, T. W. Hopwood, S. H. Dickson, et al. 2016 The circadian clock regulates inflammatory arthritis. *The FASEB Journal*, 2016;
 Chata A, D'Agostino J, Taniguchi B, Mazzoccoli G 2014 Rheumatoid arthritis and the biological clock *May*10(5):687-95. *Expert Rev Clin Immunol*

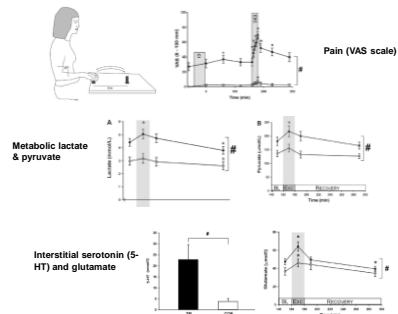
Pain /stiffness (Painiff?) of task exertion/fatigue

Pain /stiffness of fatigue

Pain alleviated by (short) rest

Metabolites normally produced by exercise act in combination to activate sensory neurons that signal sensations of fatigue and muscle pain

Pain-stiffness of fatigue / exertion



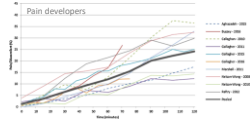
Pullin KA et al (Exposures) Applied Muscle Metabolites Synergistically Evoke Sensations of Muscle Fatigue and Pain in Human Subjects. *Eur J Appl Physiol.* 2014 Feb; 107(2): 300-309. Published online 2013 Oct 18.
 Gregor JL, et al 2013 Fatigue-enhanced hyperalgesia in response to muscle stretch: induction and development occur in a use-dependent manner. *Exp Brain Res.* 2013 Dec; 224(2): 268-275.

Linn Rosenthal et al. Increase in muscle nociceptive substances and anaerobic metabolism in patients with trapezius myalgia: microdialysis in rest and during exercise. *Pain* 112 (2004) 224-234
 Sjogaard G et al 2010 Muscle oxygenation and glycogen in humans with trapezius myalgia during stress and repetitive work using microdialysis and NIRS. *Eur J Appl Physiol.* Mar;108(4):657-69. Epub 2009 Nov 9.

(Benign) Standing pain

40–71% of back-healthy people develop symptoms in prolong standing
 CLBP describe the same location and quality but higher pain intensity than back-healthy
 Both groups return to baseline following day

	Max VAS (at anytime)		Change in VAS (from onset of standing)	
	Mean	St Dev	Mean	St Dev
PDs	21.84	10.00	20.53	9.11
LBP	40.57	18.32	30.50	12.64



Not associated with:
 Mechanisms at the neuromuscular level -

- Muscle fatigue
- Muscle stiffness
- Lack of muscle strength or endurance
- Increased co-contraction

Postural:

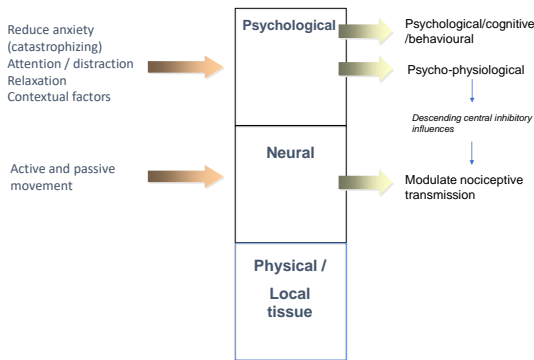
- Body sway
- Shifting of body weight
- Fidgeting

Is associated with:
 increased in stance using flexion and rotation
 (and lumbar lordosis)

Gregory DE, Callaghan SP. Prolonged standing as a precursor for the development of low back discomfort: an investigation of possible mechanisms. *Gait Posture*. 2008;28:86-92.
 Sorensen C. Risk factors for low back pain: development during prolonged standing. *Spine*. 1991;16:1000-1004.
 Coenen P. 2017 Associations of prolonged standing with musculoskeletal symptoms-A systematic review of laboratory studies. [doi:10.1016/j.jchp.2017.07.001](https://doi.org/10.1016/j.jchp.2017.07.001) Aug 24;58:310-318.

Coenen P. 2017 Associations of prolonged standing with musculoskeletal symptoms-A systematic review of laboratory studies. [doi:10.1016/j.jchp.2017.07.001](https://doi.org/10.1016/j.jchp.2017.07.001) Aug 24;58:310-318.

Promoting desensitization



Harmonic and CLBP

Supported LEX oscillation (HT) vs. back extension / flexion exercise (ERL)
 10 sessions of treatment for 5 sessions per week.

Pain intensity and the RMQ score decreased in the HT technique but not in ERL group.
 The effect size for HT was .6 for pain and .3 for RMQ

This preliminary study showed that pain intensity and disability improved in subjects with chronic LBP in the HT group.
 N=14

Arabi AM et al 2016 The Effect of Harmonic Techniques End Range Loading Exercises on Pain and Disability in Patients With Non-Specific Chronic Low Back Pain: A Preliminary Study. *J Chiropr Med*. 2016 Mar; 15(1): 3-8. Published online 2016 Mar 25. doi: 10.1016/j.jchp.2016.02.007

Use of Harmonic in pain conditions & message to the patient

Pain condition	Role of Harmonic	Message to patient
Puff of injury	Support repair Movement no stretching Harmonic pump techniques	Pain is useful part of recovery. Active movement is beneficial for tissue repair Reduce loading / intensity
Puff of sensitisation	Modulate symptoms Sooth-calm Movement	Unlikely to be injured or damaged Sooth and calm the area Activities / exercise cause no damage

Biomechanical limitation or stretch sensitivity?

Condition	Swelling	Stretch sensitivity	Loss of extensibility	Management
Injury				Movement (within tolerable discomfort)
Sensitisation	✓	✓		
Fatigue & exertion		✓		
DOMS		✓		
Immobilisation			✓	End-range functional activities
Advanced age	✓	✓	✓	("within uncomfortable stretch": "Achy but painful but safe")
Autoimmune (scleroderma)			✓	?
Other (Dupuytren's)			✓	

Leahman J. To be published 2022 Functional exercise prescription in movement and sports rehabilitation. Harpenden, London.
 *Smith BJ, Wankler P, Smith TO, et al Should exercise be painful in the management of chronic musculoskeletal pain? A systematic review and meta-analysis. *British Journal of Sports Medicine* 2017;51:1679-1683.

Caring-soothing behaviour

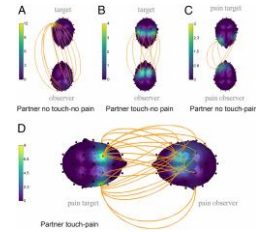


Psychological
 Reassurance
 Calming-soothing anxieties
 Distraction (away from pain/external focus)
 Cognitions – nothing bad happened
 Compassion/empathy



Physical
 Holding
 Rocking
 Rubbing over the painful area
 Distraction (using touch / movement)

Touch and coupling analgesia



Brain-to-brain coupling may be involved in touch-related analgesia
 + when a partner held the hand of a woman during labour, the couple would begin to synchronize their breathing and heart rate patterns, otherwise known as physiological coupling

Powell Goldberg, J.H. Williams-Fogel, Guillaume Dumas, Simone G. Shamay-Tsoory. Brain-to-brain coupling during handholding is associated with pain reduction. Proceedings of the National Academy of Sciences, 2018; 115(16):8141-8146. doi:10.1073/pnas.1711061115

Harmonic and the brain: soothing and calming

Continuous rocking motion helps to synchronize neural activity in the thalamo-cortical networks of the brain, which play an **important** role in both sleep and memory consolidation.

Harmonic and the brain: soothing and calming

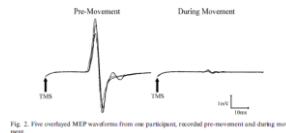


Fig. 2. Five overlaid MEP waveforms from one participant, recorded pre-movement and during movement.

MEP= motor evoked potential

During 1 Hz cyclic passive movement of the index finger there was a 60% reduction in the amplitude of the motor evoked response from the first dorsal interosseous muscle.

The results of the present study demonstrate that passive movement can have a profound effect on the excitability of the corticomotor pathway.

Eskandar, D.J., Thibaut, C.W., Byrnes, M.L., Ghosh, S. and Metzger, J.L., 2002. Reduced corticomotor excitability with cyclic passive movement: a study using transcranial magnetic stimulation. Human movement science, 21(5-6), pp.533-540.

Perrault et al. Whole Night Continuous Rocking Entrain Spontaneous Neural Oscillations with Benefits for Sleep and Memory. Current Biology, DOI: 10.1016/j.cub.2018.12.058

Kompotis et al. Rocking Promotes Sleep in Mice through Rhythmic Stimulation of the Vestibular System. Current Biology, 2019 DOI: 10.1016/j.cub.2018.12.007

Touch effects

Touch intent

Instrumental touch / manipulation:

Aim to mechanically cure or prevent the progression of the patient's condition through focusing on the body.

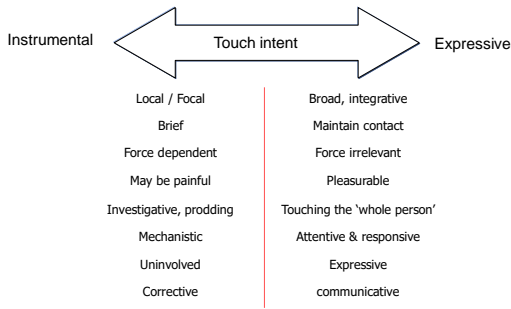


Expressive touch / manipulation:

Accepting the patient as a whole – body and mind. Treatment is aimed at improving the patient's condition by supporting the body-mind processes.



Characteristics of instrumental & expressive touch



Importance of touch

In premature & newly born	In children	In adults	In elderly
Promote self-regulation Reduce arousal Increase weight gain Infants more active & alert Fewer episodes of apnoea Need less oxygen Higher red blood cell count Improved frequency of stooling Reduced episodes of bradycardia Less jerky movement More mature motor behaviour Less irritable & less hypertonicity	Promote self-regulation Reduce arousal Higher scores on intelligence and development testing Cry less Smile more Retarded physical development (psychological dwarfism) Child resigned and still Possible contribution to mental illness in adulthood Under-weight More prone to recurrent infection and accidents Higher mortality rate (children in orphanages)	Support Comfort Emotional well being De-stressor	Support Comfort Emotional well being De-stressor Premature death after loss of partner
Touch & movement stimulation			Touch & movement deprivation

Pedro VC, Mazzareppa MA 2015 Application of tactile/kinesthetic stimulation in preterm infants: a systematic review. *J Pediatr (Rio J)*. May-Jun;31(3):213-33. doi: 10.1016/j.jped.2014.10.005. Epub 2015 Feb 9.

Chemistry of touch (and well being)

	Function	Touch effects
Cortisol	Associated with stress responses	Reduced in variety of conditions by touch
Dopamine	Neurotransmitter Good feelings Positive emotion Increase motivation	Increase during massage
Serotonin	Vital for attention and sense of well being (+ other chem) Low serotonin + cortisol = + aggression Imbalances found in depression, anxiety and schizophrenia	Increase during massage
Oxytocin +opoids and prolactin systems	Bonding hormone (love hormone) Acceptance Nurture Social solidity and warmth	Increased during touch (also for the therapist!)

Psychological influences of massage & MT

Reduce anxiety	Individuals suffering anxiety. 35-37 Women PMT sufferers. 207 Office workers. 176,177 During labour. 34,178 Hospitalisation. 179 / surgery 187 / burns 180,181 / cardiac surgery 182 / cancer surgery 183, 184 / HIV 185, 186. Teenage mothers. 188 Sexual and physical abuse. 189 ME sufferers. 192
Reduce depression	Office workers. 176,177 Teenage mothers. 188 Individuals suffering depression. 35-37 Sexual and physical abuse. 189 ME sufferers. 192
Reduce stress	Office workers. 176,177
Promote relaxation	During labour. 34,178
Improve overall mood	Women PMT sufferers.207
Reduce aggression	Preschool and adolescent children with behavioural problems. 193-195