Brain Reorganisation in Chronic Musculoskeletal Disorders

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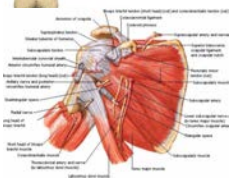
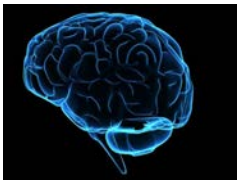
MSK disorders

Structural dysfunction

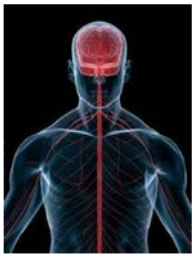


Nervous system reorganization



Why is looking at peripheral structural dysfunction ONLY may be not sufficient?

- **Failure to recognize the complexity of pain, by focusing only on the nociceptive signal arising from peripheral receptors**
  (Lewis et al. 2015, Nijs et al. 2016)
- **Neglect the fact that the CNS can rapidly adapt to changes occurring in the periphery**



Objectives

1. To gain knowledge on how the CNS go through reorganization in patients with chronic musculoskeletal disorders;
2. To discuss the challenge of objectifying the presence of central nervous system changes;
3. To explain how to rehabilitate chronic musculoskeletal disorders by using an approach that consider both peripheral (joint-level) and central (neurological-level) deficits.

2 case studies

- 36 year old woman
- Neck and shoulder pain for 1 month
- Sudden onset when shoulder-checking and reaching an object on the back seat of her car
- Pain at 1-2/10 at rest and 5/10 in right c-spine rotation, extension and shoulder abduction
- **Good general health**
- Mild degenerative changes at the C5C6 segment bilaterally

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Eur Spine J (2011) 20:585–591
DOI 10.1007/s00586-010-1644-y

ORIGINAL ARTICLE

Disc degeneration of cervical spine on MRI in patients with lumbar disc herniation: comparison study with asymptomatic volunteers

Eijiro Okada · Morio Matsumoto · Hirokazu Fujiwara · Yoshiaki Toyama

THE PERCENTAGE OF SUBJECTS WITH DEGENERATIVE CHANGES IN THE CERVICAL DISCS WAS 98.0% IN THE LUMBAR DISC HERNIATION GROUP AND 88.5% IN THE CONTROL GROUP
(p = 0.034) (Okada et AL. 2011)

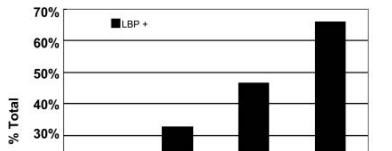

Figure 5. Relationship between total DDD score and low back pain (significant pain lasting more than 2 weeks).

(Cheung et coll. 2009)

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Structural dysfunction

- Decrease and painful global and segmental c-spine moblity testing (produce neck and shoulder pain)
- Aberrent and painful c-spine movement (extension and rotation)
- Painful scapular dyskinesis with arm elevation

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Physical impairment

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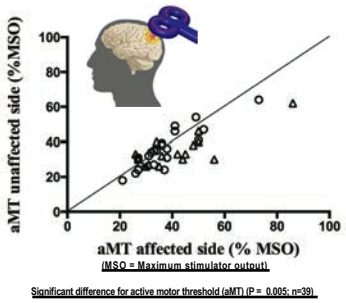
What nervous system reorganization occurs in MSK pain?

Motor control

CNS reorganization and MSK pain



Significant difference for active motor threshold (aMT) (P = 0.005; n=39)

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Decreased corticospinal excitability for the affected shoulder

Ngomo et al. 2015

CNS reorganization and MSK pain

- **CNS reorganization may disrupt** (Schabrun et al. 2015; Burns et al. 2016)
  - Facilitation of muscles needed to realize a motor task
  - Inhibition of other muscles for fine-tuning of movement
  - Altered intermuscle coordination
- **These changes might predispose individuals to**
  - Modify their motor strategies to control the joint that could in turn contribute to chronicity through maladaptive plasticity
  - Persistence of M1 reorganizations upon return to pain-free movement
    - Favouring recurrence of symptoms (Tsao et al. 2008)

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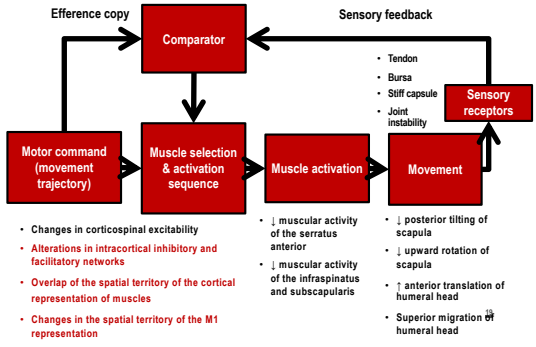
CNS reorganization and MSK pain



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Pain

Central sensitisation

IASP
International Association for the Study of Pain

« An unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage. »

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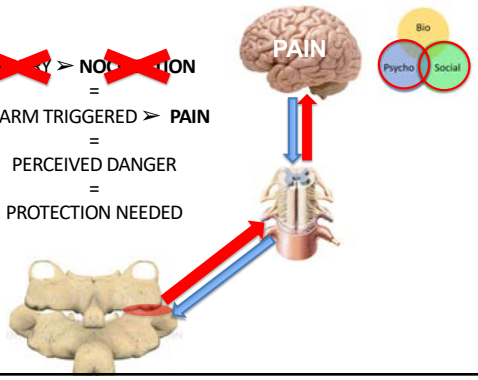
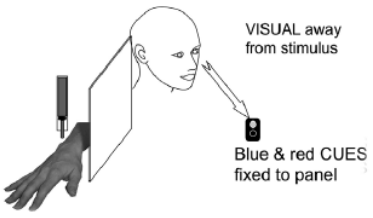
« An unpleasant sensory and **emotional** experience associated with actual or **potential** tissue damage, or described in terms of such damage. »

NOCICEPTION VS PAIN

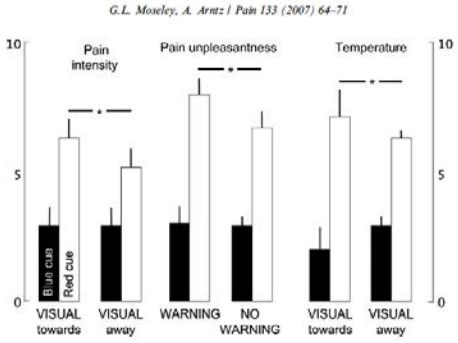
Pain neuroscience

~~NOCICEPTION~~
=
ALARM TRIGGERED ➢ **PAIN**
=
PERCEIVED DANGER
=
PROTECTION NEEDED





(Moseley et Arntz 2007)



(Moseley et Arntz 2007)

Pain neuroscience

INJURY ➢ **NOCICEPTION**
=
ALARM TRIGGERED ➢ **PAIN**
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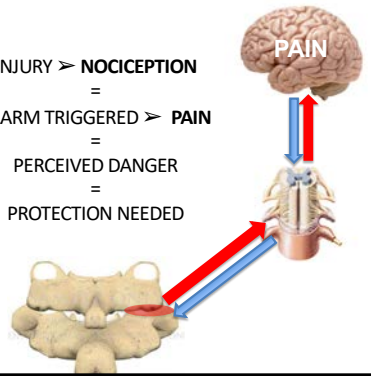


Psychosocial factors:
- Patient expectation
- Fear / Anxiety
- Catastrophism
- Kinesiophobia
- Painful history
- Beliefs
- Social environment
- Sleep
- Mood
- Fitness level

Clinical applicability

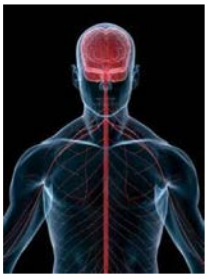
Important question:
- Painful history
- Sleep
- Stress (work, family, friends)
- Fear and belief
- Fitness level
- Mood
- Mental health
- Environment

Do some of these situations, personal or environmental factors modify YOUR pain level?

2 major changes in CNS

- Central changes in the motor cortex
  - associated with movement control deficits
- Central sensitization
  - distorted sensory processing

Need to consider the central (neural) and peripheral (joint-level) deficits in the evaluation procedures



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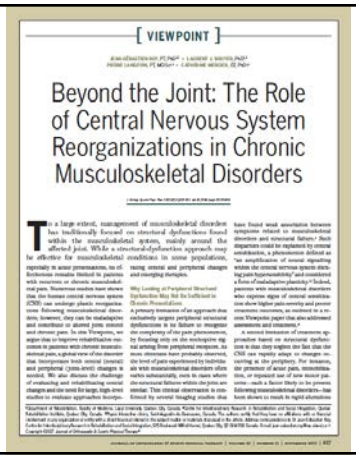
Is there nervous system reorganisation in both of these patients?

Are there tools to evaluate these CNS reorganization?


[VIEWPOINT]

Beyond the Joint: The Role of Central Nervous System Reorganizations in Chronic Musculoskeletal Disorders

Clinical Exam

TABLE 1 PRINCIPAL ELEMENTS OF THE CLINICAL ASSESSMENT OF CHRONIC MUSCULOSKELETAL DISORDERS

Structural-Dysfunction Approach	Global Approach
Structure(s) affected within the musculoskeletal system • Orthopaedic diagnostic tests Symptoms and functional limitations • Self-reported questionnaires • Clinical history taking and subjective examination Posture • Observation and objective measures Mobility • Active and passive range of motion • Muscular and capsuloligamentous flexibility tests • Joint mobility and stability (ie, gliding and translation) Neurodynamic • Neurodynamic tests Strength and endurance • Manual muscle testing, isometric muscle strength, or isokinetic peak torque • Endurance tests Biomechanics/motor control • Qualitative observation of movements to determine whether they are within normality (ie, away from normal motor pattern)	All of the elements included in the structural-dysfunction approach, plus the following: Motor control/biomechanics • Qualitative observation of limb movement to determine movement alterations and association with symptoms • Correction of altered movements and effect on pain Fear avoidance, pain catastrophizing, and anxiety • Self-reported questionnaires • Fear of movement, avoidance, or protective reactions during the evaluation of mobility and motor control Central sensitization • Disproportionate pain experience • Diffuse and widespread pain distribution • Sensory hypersensitivity Workplace and sport activities (or other leisure activities) • Assessment of work stations or work/sport gestures Other elements to consider • Activity level • Sleep • Mood • Stress management

[VIEWPOINT]

Beyond the Joint: The Role of Central Nervous System Reorganizations in Chronic Musculoskeletal Disorders

JOSPT 2017

Symptoms modification procedures

(Lewis et al. 2015)

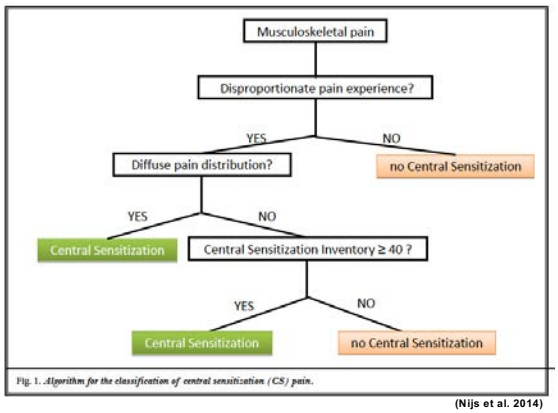


Fig. 1. *Algorithm for the classification of central sensitization (CS) pain.*

(Nijs et al. 2014)

More information gathering

- Stress level doesn't affect pain level
- Sleep well
- No pain elsewhere
- No history of neck and shoulder pain
- No pain with scapular repositioning while doing arm elevation

- Stress level affects pain level
- Doesn't sleep well
- Associated low back and thoracic pain
- History of low back, thoracic and cervical pain
- Scapular repositioning slightly improve pain

Diagnosis

- Neck pain with mobility deficit associated with an impingment syndrom with scapular dyskinesis
- Subacute
- Psycho-social factors doesn't influence pain response

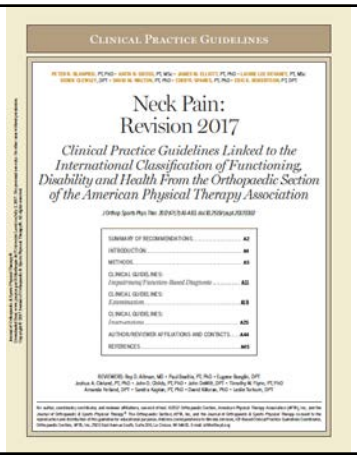
- Neck pain with mobility deficit associated with an impingement syndrome with scapular dyskinesis AND central sensitisation
- Chronic
- A lot of psychosocial factors influence pain response

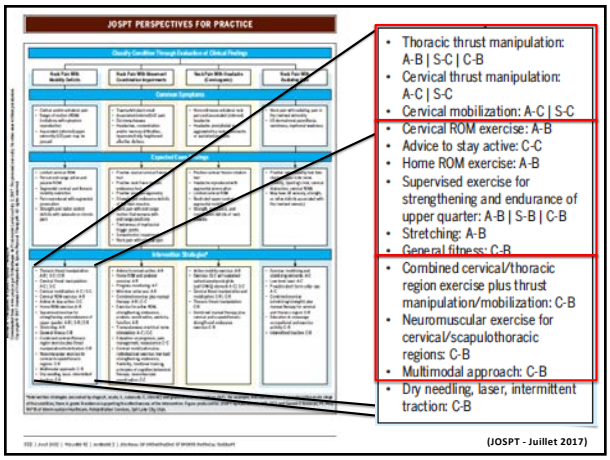
Intervention

CNS reorganization and MSK pain

- **Possible to reverse maladaptive reorganizations**
  - CNS has the capacity for adaptive plasticity
- **Changes in structural and functional brain organizations reversed in populations with chronic MSK disorders following**
  - Surgical or rehabilitation interventions (Seminiwicz et al. 2011; Tsao et al. 2010)
- **CNS reorganization therefore should be one of the main targets during rehabilitation of chronic MSK pain**

Rehabilitation interventions need to consider the central (neural) and peripheral (joint-level) deficits [39]



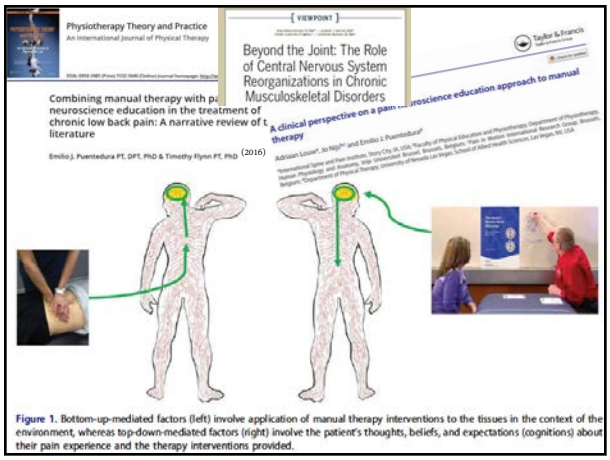


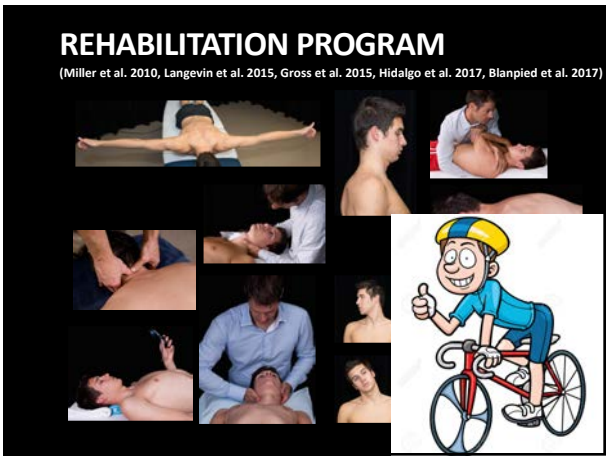
(JOSPT - Juillet 2017)

TABLE 2 PRINCIPAL ELEMENTS OF ACTIVE MANAGEMENT OF CHRONIC MUSCULOSKELETAL DISORDERS

Structural-Dysfunction Approach	Global Approach
Education on pain management, structures affected, and rehabilitation stages	All of the elements included in the structural dysfunction approach, except:
Postural exercises to realign limb/body segment	• Minimal use of passive techniques (if used, for goal-directed desensitizing)
Mobility exercises	• Normalization of posture and movement only if significant for the patient's painful condition
• Targeting muscular and capsuloligamentous structures	Education on motor control, pain neuroscience (ie, biopsychosocial pain mechanism), and graded exposure to exercise
Joint mobilization and manipulation	Sensorimotor training/graded exercises
Neurodynamic mobilization/desensitization maneuvers	• Using feedback to improve motor control by correcting movement alterations significant for patient's condition
Muscle strengthening exercises	• Emphasizing quality of movement control over quantity/speed/force
• Targeting strength and endurance	• Exercises of gradually increasing difficulty/graded activity
Exercises to normalize movement quality	• Work- or sport-specific re-education (goal-directed retraining)
• Normalization of movement	Building self-efficacy to self-manage symptoms
	• Education
	• Enhance intrinsic error-detection capabilities during sensorimotor training

(Roy et al. 2017)





Rehabilitation Program

- Relative Rest/ Activities modification
- Mobilization / stretching / manual therapy
- Education
- Posture
- Sensorimotor Training
- Strengthening (*controlled reloading with good shoulder control*)
  - Scapulothoracic
  - Glenohumeral
  - Core

ÉDUCATION +++

ÉDUCATION +++ (Rebbeck 2017)

- Stay active and return to usual activities
- Provide information about the nature of the injury
- Provide information about the course of recovery
- Provide information about coping strategies and address unhelpful beliefs
- Provide pain neuroscience education

PHYSIOTHERAPY THEORY AND PRACTICE
2016, VOL. 32, NO. 5, 332–355
http://dx.doi.org/10.1080/09593985.2016.1194646

Taylor & Francis

REVIEW

The efficacy of pain neuroscience education on musculoskeletal pain: A systematic review of the literature

Adriaan Louw, PT, PhD[a], Kory Zimney, PT, DPT[b], Emilio J. Puentedura, PT, DPT, PhD[c], and Ina Diener, PT, PhD[d]

[a]International Spine and Pain Institute, Story City, IA, USA; [b]Department of Physical Therapy, School of Health Sciences, University of South Dakota, Vermillion, SD, USA; [c]Department of Physical Therapy, School of Allied Health Sciences, University of Nevada, Las Vegas, Las Vegas, NV, USA; [d]Department of Physiotherapy, Stellenbosch University, Stellenbosch, South Africa

ABSTRACT

Objective: Systematic review of randomized control trials (RCTs) for the effectiveness of pain neuroscience education (PNE) on pain, function, disability, psychosocial factors, movement, and health-care utilization in individuals with chronic musculoskeletal (MSK) pain. ***Data Sources:*** Systematic searches were conducted on 11 databases. Secondary searching (PEARLing) was undertaken, whereby reference lists of the selected articles were reviewed for additional references not identified in the primary search. ***Study Selection:*** All experimental RCTs evaluating the effect of PNE on chronic MSK pain were considered for inclusion. ***Additional Limitations:*** Studies published in English, published within the last 20 years, and patients older than 18 years. No limitations were set on specific outcome measures. ***Data Extraction:*** Data were extracted using the participants, interventions, comparison, and outcomes (PICO) approach. ***Data Synthesis:*** Study quality of the 13 RCTs used in this review was assessed by 2 reviewers using the PEDro scale. Narrative summary of results is provided for each study in relation to outcomes measurements and effectiveness. ***Conclusions:*** Current evidence supports the use of PNE for chronic MSK disorders in reducing pain and improving patient knowledge of pain, improving function and lowering disability, reducing psychosocial factors, enhancing movement, and minimizing healthcare utilization.

ARTICLE HISTORY
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KEYWORDS
Chronic pain; explain pain; pain neuroscience education; therapeutic neuroscience education

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- 13 included studies
  - 398 patients did receive pain neuroscience education
  - 336 patients didn't receive pain neuroscience education

Significant improvement 1)pain, 2)fonction 3)pain knowledge 4)psychosocial factors 5)mobility and 6)reduced health care utilisation

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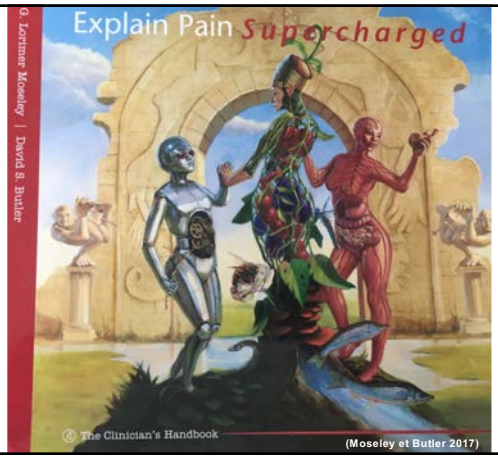
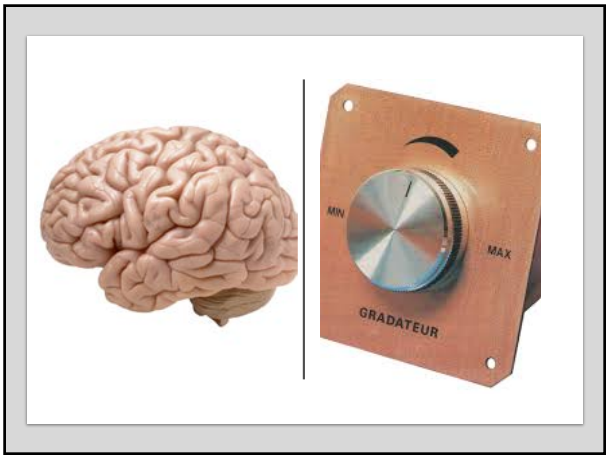
- 13 included studies:
  - 5 studies: education only

    No improvement of pain level
    Improvement of other variables
  - 8 studies: education and physical intervention (exercise and manual therapy)

    Pain improvement in 7/8 studies





Web sites suggestion

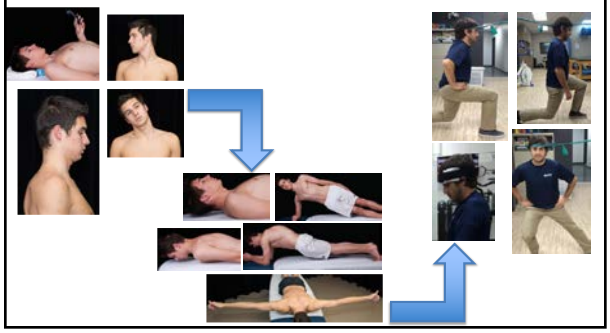
- You tube: Understanding pain in less than 5 minutes
- www.retrainpain.org
- www.noigroup.com
- www.painscience.com
- www.bodyinmind.org
- www.knowpain.co.uk
- www.pain-ed.com

MULTIMODAL APPROACH!

(Miller et al. 2010, Langevin et al. 2015, Gross et al. 2015, Hidalgo et al. 2017, Blanpied et al. 2017)

Graded exposure
- Peripheral and Neural adaptation -

(Roy et al. 2017, Gross et al. 2016, Langevin et al. 2015, Gross et al. 2009, Taylor et al. 2006)



LITERATURE REVIEW

The Effect of Different Exercise Programs on Size and Function of Deep Cervical Flexor Muscles in Patients With Chronic Nonspecific Neck Pain

A Systematic Review of Randomized Controlled Trials

Somayeh Amiri Arimi, PT, Mohammad Ali Mohseni Bandpei, PT, PhD, Khodabakhsh Javanshir, PT, PhD, Asghar Rezasoltani, PT, PhD, and Akbar Biglarian, PhD

(*Am J Phys Med Rehabil* 2017;96:582–588)

Les exercices à basse charge de flexion cranio cervicale sont hautement efficaces pour améliorer la fonction musculaire des fléchisseurs profonds du cou ainsi que la douleur et les incapacités

Sensorimotor Training

Goal of sensorimotor training

- Improve muscle recruitment (timing and activation)
  - Lead to pain-free movement
  - Avoid movement compensations
- Allow self-management
  - Use of external feedbacks
  - Improve intrinsic error-detection capabilities
- Symmetry during the movement
  - Not looking for a perfect movement

Muscular weakness VS Faulty muscle recruitment

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Strengthening / Recruitment of the painful shoulder

3 Steps (Tate et al. 2011)

- Step 1 – RC muscles with the arm below 45° of elevation
- Step 2 – Exercises in shoulder elevation above 45° and strengthening exercises for the scapulothoracic muscles
- Step 3 – Higher-level exercises that incorporated trunk strengthening and endurance training at multiple levels of elevation

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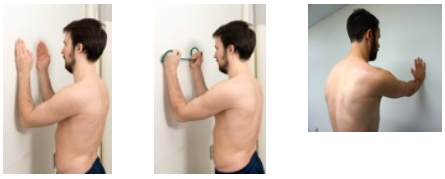
Step 1 - Exemples



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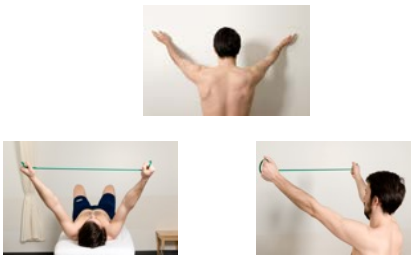
Step 2 - Exemples



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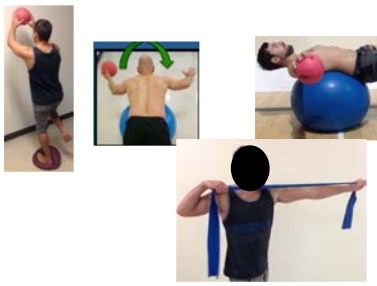

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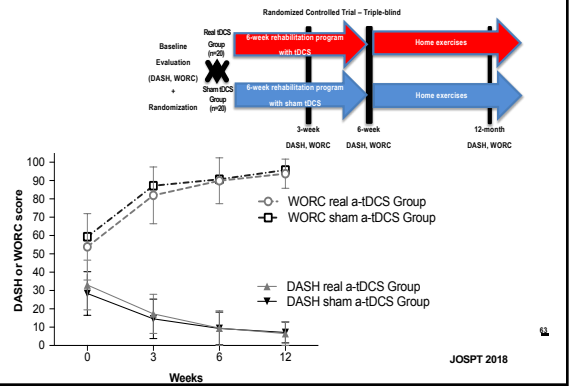
New therapies emerging?

- **New therapies are also emerging:**
  - To induce plasticity and normalize CNS organization
  - By modulating neuronal membrane potential and neuronal excitability
- **They include**
  - Non-invasive brain stimulations
    - Transcranial direct current stimulation (tDCS)
    - Repetitive transcranial magnetic stimulation (rTMS)
  - Peripheral neuromuscular stimulations
    - Peripheral electrical stimulations (PES)
    - Repetitive peripheral magnetic stimulation (RPMS)

tDCS for shoulder pain



REHABILITATION PROGRAM!

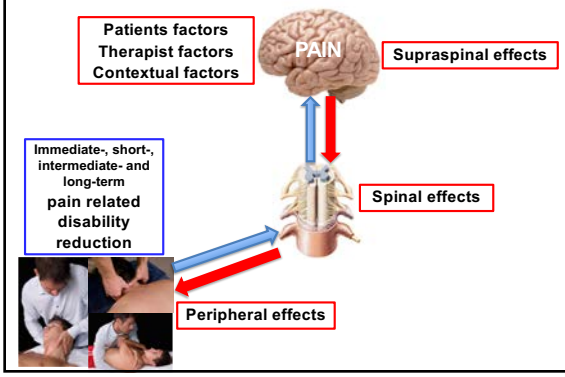
(Miller et al. 2010, Langevin et al. 2015, Gross et al. 2015, Hidalgo et al. 2017, Blanpied et al. 2017)

Mechanisms of manual therapy

(Sterling et al. 2001, Pickard 2002, Bialosky et al. 2009, Zusman 2011, Bialosky et al. 2012, Coronado et al. 2012, Castien et al. 2013, Gay et al. 2014, Bialosky et al. 2014, Bialosky et al. 2017)

Neurophysiological effect

(Sterling et al. 2001, Pickard 2002, Bialosky et al. 2009, Zusman 2011, Bialosky et al. 2012, Coronado et al. 2012, Castien et al. 2013, Gay et al. 2014, Bialosky et al. 2014, Bialosky et al. 2018)



In clinical practice… Should we mainly consider pain-response (contextualized pain-response…) instead of stiffness end-feel in our choice of technique?

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2 case studies

- **Structural-dysfunctional approach +++ AND educational/global psychosocial approach**
- Manual therapy + exercise to improve pain, c-spine mobility and shoulder control
- Graded exposure to create soft tissue and CNS adaptation

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- Exercise +/- manual therapy to improve pain, c-spine mobility and shoulder control
- Graded exposure to create soft tissue and CNS adaptation

Type of exercise, progression and dosage would be completely different from one patient to the other

Conclusion – « Take-home messages »

- Structural-dysfunctional and central nervous system approaches need to be considered
- Pain sensitisation and motor control are two aspects of CNS reorganization that need to be evaluated and treated
- If the condition is more chronic, the psychosocial
- Ask questions about the 3 aspects of patient painfull condition 1)bio 2)psycho 3)social and educate accordingly

Conclusion – « Take-home messages »

- Acute/subacute: Manual therapy, exercise and education
- Chronic: Education and exercise +++ and manual therapy to desensitize if pain-response is positive
- The Multimodal approach in a goal of desentisation and gradual adaptation is an approach of choice for chronic neck pain
- Consider pain-response in manual therapy techniques

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Merci !