Brain Reorganisation in Chronic Musculoskeletal Disorders

Pierre Langevin, pht, M.CI.Sc., FCAMPT, Professeur de clinique, Université Laval
Jean-Sébastien Roy, pht, PhD, Associate professor, Université Laval
Centre interdisciplinaire de recherche en réadaptation et en intégration sociale (CIRRIS)

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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• Neck and shoulder pain for 1 year
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Disc degeneration of cervical spine on MRI in patients with lumbar disc herniation: comparison study with asymptomatic volunteers

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)

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Structural dysfunction

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

Physical impairment

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

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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)
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)

Decreased corticospinal excitability for the affected shoulder

Ngama et al. 2015

CNS reorganization and MSK pain

• CNS reorganization may disrupt
  – 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
    • Favoring recurrence of symptoms

CNS reorganization and MSK pain

Motor command
  (movement trajectory)
Muscle selection & activation sequence
Muscle activation
Effence copy
Comparator
Motor command
Sensory feedback

Muscle activity of the infraspinatus
Muscle activity of the latissimus dorsi
Muscle activity of the serratus anterior

↓ muscular activity of the serratus anterior
↓ posterior tipping of acromion
↓ upward rotation of acromion
↓ posterior translation of humeral head
\[ \text{Superior migration of humeral head} \]

↓ muscular activity of the infraspinatus and subscapularis

↓ posterior tipping of scapula
↓ upward rotation of scapula

↓ anterior translation of humeral head

Central sensitisation

Pain
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

VISUAL away from stimulus
Blue & red CUES fused to panel

(Wiseley et Arntz 2007)
INJURY ➞ NOCICEPTION ➞ PAIN ➞ PERCEIVED DANGER ➞ PROTECTION NEEDED

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

Is there nervous system reorganisation in both of these patients?
Are there tools to evaluate these CNS reorganization?
Clinical Exam

TABLE I

| Principal Elements of the Clinical Assessment of Chronic Musculoskeletal Disorders |
|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| Subjective Symptoms | Symptomatic Signs | Objective Assessment | Treatment Plan |
| Neck pain with mobility deficit associated with an impingement syndrome with scapular dyskinesis | Subacute | Psycho-social factors don’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 |

Diagnosis

- 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

Intervention

- 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
Rehabilitation interventions need to consider the central (neural) and peripheral (joint-level) deficits.
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 +++ (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

The efficacy of pain neuroscience education on musculoskeletal pain: A systematic review of the literature
AdrianLouw,PT,PhD,KoryZimney,PT,DDFT,EmilioJ.Puenteduras,PT,DDFT,PhD,andIssiDemer,PT,PhD
InstituteforSpineandSportsInstitute,MayoClinic,Scottsdale,AR,UnitedStates

OBJECTIVE: Systematic review of randomized control trials (RCTs) for the efficacy of pain neuroscience education (PNE) on pain function, disability, psychosocial factors, recovery, and health care utilization in individuals with chronic musculoskeletal (MSK) pain. Systematic searches were conducted in 11 databases. Forty-four RCTs were conducted among 2,094 participants, of which 398 patients did receive pain neuroscience education (PNE) and 1,696 patients did not receive PNE. Pain intensity, disability, psychosocial factors, recovery, and health care utilization were evaluated using pain disability index (PDI), pain interference index (PII), fear avoidance beliefs questionnaire (FABQ), catastrophizing (CSQ), and pain catastrophizing scale (PCS). A Cochrane approach, data synthesis (Qualitative data synthesis of 13 RCTs used in this review was performed by 3 random-effects models for categorical and continuous variables), was used to analyze the data. A meta-analysis and meta-regression analyses were conducted to assess the efficacy of pain neuroscience education (PNE) on pain function, disability, psychosocial factors, recovery, and health care utilization.

RESULTS: Significant improvement in pain, function, pain knowledge, psychosocial factors, mobility, and reduced healthcare utilization. No improvement of pain level.

13 included studies:
- 5 studies: education only
- 8 studies: education and physical intervention (exercise and manual therapy)

Pain improvement in 7/8 studies

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!

Graded exposure
- Peripheral and Neural adaptation -

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

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

Step 1 - Exemples

Step 2 - Exemples

Step 1 - Exemples

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)
Mechanisms of manual therapy

Mechanical effect
Neurophysiological effect

Immediate-, short-, intermediate- and long-term pain-related disability reduction

Spinal effects
Supraspinal effects
Peripheral effects

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

- Educational/global psychosocial approach AND structural-dysfunctional approach
- 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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