Motor Learning and Adaptation in People with Knee Osteoarthritis and Chronic Pain

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Introduction

Osteoarthritis (OA) affects an estimated 50 million people in the US, and approximately 45% have limitations in daily function due to arthritis pain. Individuals with knee osteoarthritis (OA) have:

- Heightened sensitization to pain, as well as reduced strength and diminished function and quality of life.
- Nervous system adaptations to chronic pain include:
  - Altered sensory perception
  - Redistribution in muscle activity and changes in mechanical behavior
  - Provides short-term benefit of protection from further injury
  - May be detrimental in the long term

Individuals with chronic pain benefit from rehabilitation with the goal to learn to move without pain.

- Motor learning relies on accurate sensory perception to detect movement errors and to plan new motor patterns.
- The extent to which chronic pain affects motor learning in people with chronic pain is largely unknown.

The “broken escalator phenomenon” refers to the sensation of imbalance when walking onto an escalator or moving platform that is broken (stationary). The “broken escalator phenomenon” refers to the lack of pressure pain modulation by heterotopic noxious conditioning in patients with chronic pain.

- The broken escalator phenomenon is associated with the first experience of the return of the stationary belt condition.
- AE2 is a “second trial response” associated with the first experience of the return of the stationary belt condition.
- AE2 and beyond, de-adaptation takes place.

Methods

- Motor adaptation and learning
  - 3D movement analysis (Qualisys 3D Motion Capture System)
  - Trunk, Hip, and ankle kinematics
  - Transducers of Center of Mass
  - Muscle Activity (EMG)
  - EMG of gastrocnemius and soleus

- Broken Escalator Paradigm
  - The subject stepped from a platform onto an escalator.
  - 30 null trials (stationary belt)
  - Mean after-effect (AE) (stationary belt)
  - Nervous system adapts to the moving condition
  - The step activity was divided into intervals based on foot positions.
  - AE1 elicits a “first trial response,” associated with the first after-effect trial (AE1), stationary belt, and the second after-effect trial (AE2), stationary belt.
  - AE2 and beyond, de-adaptation takes place.

Results

- Adaptive and learned changes
  - Peak forward translation of the COM during interval 3
  - Average medial gastrocnemius EMG during interval 2

Discussion

- Conclusions are limited due to the small sample size, but subjects in both OA groups had large first trial responses and did not de-adapt to the level of the Null trials, whereas only one control subject showed similar findings.
- The 1st trial response was most visible in the forward trunk flexion and magnitude of BMI0, whereas COM showed less consistent responses. This is likely because the perturbation of upright stance by the change in belt condition from moving back to stationary was substantial enough to warrant a hip strategy accompanied by flexion of the trunk.
- After adjusting to the return to the belt stationary condition, both OA groups did not show complete adaptation, as opposed to one Control subject. More subjects are needed to determine if this finding is noteworthy.
- It is notable that neither of the two OA subjects were significantly impaired based on self-report functional questionnaires.

References


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