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Editorial comment

Exercising non-painful muscles can induce hypoalgesia in individuals with chronic pain

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1. What is exercise-induced hypoalgesia (EIH)?

Almost 40 years ago, Black et al. [1] published the first article on the effect of physical exercise on pain sensitivity in humans illustrating that a period of running significantly reduced the pain sensitivity. This phenomenon also known as *'exercise-induced hypoalgesia (EIH)'* is now well established in pain-free subjects, and it is typically demonstrated as reduced pain sensitivity in response to exercise [2]. Recently, the influence of different types of exercises [3] as well as the mechanisms underlying EIH [4] has been investigated. However, the effect of acute exercise on the pain sensitivity in subjects with different chronic pain conditions is still controversial, since both hypoalgesia, as well as no change in pain sensitivity, or even hyperalgesia (i.e. impaired EIH) has been reported following exercise.

2. Isometric exercise differs from aerobic exercise in effect on pain sensitivity

In this issue of the *Scandinavian Journal of Pain*, Smith et al. [5] investigated the effect of two different types of exercises on pressure pain thresholds (PPTs) in 21 subjects with chronic whiplash-associated disorder (WAD) and in 19 pain-free controls. PPT at the neck and leg were recorded before and after isometric (3 min wall squat; leg muscle contraction without joint movement) and aerobic (30 min bicycling) exercises. In addition, conditioned pain modulation (CPM), heat and cold pain threshold, and psychological distress were assessed. The study showed increases in PPT at exercising (leg) and non-exercising (neck) body parts in subjects with WAD and pain-free controls after the isometric exercise condition, but not after the aerobic bicycling exercise. Surprisingly, no significant difference in EIH was found between subjects with WAD and pain-free controls. The magnitude of EIH was not associated with CPM, thermal pain sensitivity, or measures of psychological distress (pain catastrophization, fear of movement, and symptoms of posttraumatic stress).

3. Isometric exercises of pain-free muscles can induce EIH in chronic pain conditions

One interesting aspect of this study is certainly the hypoalgesic effect of just 3 min of isometric exercise. The induction of multi-segmental hypoalgesia after isometric exercise in subjects with WAD is consistent with previous studies on subjects with chronic pain [6], and EIH after isometric exercises appear to be less dependent on exercise intensity [3] than aerobic exercises which may increase its applicability in subjects with chronic pain. In addition, isometric exercise may reduce temporal summation of pain [7,8], which is often facilitated in subjects with chronic pain [9,10], illustrating the potential for isometric exercise as a rehabilitation procedure also targeting the central mechanisms of pain. A limitation to the interpretation of the current results is that aerobic exercise did not induce hypoalgesia in the pain-free controls questioning whether the exercise protocol used to induce hypoalgesia was sufficient. It should be mentioned that aerobic exercise at similar intensity as used in the current study did not significantly affect temporal summation of pain in pain-free subjects [7] and further facilitated temporal summation of pain in subjects with chronic musculoskeletal pain and high pain sensitivity [11]. Temporal summation was not evaluated by Smith et al. [5] and this is obviously an area requiring further investigations.

4. Exercising pain-full muscles may increase central pain-facilitatory mechanisms

In Smith et al. [5], PPTs were investigated before and after exercises performed at extra-segmental sites to the clinical pain region. EIH after exercises performed at non-painful body parts has previously been observed in subjects with different chronic pain conditions [6,12–14]. One question that the current study cannot answer is how exercises performed at sites within the clinical pain region would have affected the pain sensitivity. There is a hint of comparative effects from another study investigating EIH in 20 subjects with trapezius myalgia showing increased PPTs at painful

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and non-painful body parts only during contractions of non-painful muscles but not during contractions of painful muscles [6]. Similar results were reported in subjects with chronic knee osteoarthritis where only upper body exercise, and not lower body exercises, significantly increased PPTs at upper and lower body parts. Impaired EIH is often demonstrated in subjects with fibromyalgia [15,16] and chronic fatigue syndrome [13,17], which are pain conditions characterized by more widespread pain distributions reducing the likelihood of exercising non-painful body parts. Exercising painful body areas may activate local, spinal or supraspinal pain facilitatory mechanisms [18] and over-ride the pain inhibitory effects of exercise.

5. Activated central descending inhibitory mechanisms facilitate exercise-induced hypoalgesia

Can the results be generalized to other subjects with chronic pain? Similar to other subjects with chronic pain conditions [19], the subjects with WAD investigated by Smith et al. [5] demonstrated reduced pain threshold for pressure and cold at painful and non-painful assessment sites indicating generalized hyperalgesia. However, the included subjects were also characterized by relatively low levels of clinical pain intensity and disability, and showed no sign of dysfunctional CPM compared with pain-free controls. Although no association between EIH and CPM was found in this study, impaired EIH has been demonstrated in subjects with impaired CPM [11,20] indicating that subjects who demonstrate a greater ability to activate the descending inhibitory systems, report greater hypoalgesia following exercise.

6. Exercise may activate endogenous opioid and cannabinoid systems

How does exercise reduce the pain sensitivity? To date, the mechanisms underlying EIH is not clear but based on previous findings, hypoalgesia after exercise is related to activation of systemic pain inhibitory mechanisms with widespread anti-nociceptive effects in concert with local or segmental pain inhibitory mechanisms [3]. Previous findings have implicated that several mechanisms are involved in the widespread anti-nociceptive effects of exercise including activation of the endogenous opioid system [21], the endocannabinoid system [4], and the cardiovascular system [22], but further research into the underlying mechanisms is warranted to optimize the clinical utility of exercise as a method of pain management.

7. Conclusion and implications for research and management of chronic pain

Hypoalgesia after exercise in subjects with chronic pain seems to be influenced by type of exercise and whether the muscles performing the exercises are painful or not. This study by Smith et al. [5] adds to the current literature regarding the effect of exercise on pain sensitivity in subjects with chronic pain, and the results have implications for research and clinical management in this important area.

Conflict of interest

The author has no conflict of interest to declare.

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