EDITORIAL

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The Interplay of Pain and Motion

Das Zusammenspiel von Schmerz und Bewegung



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Pain represents one of the greatest human health challenges worldwide. The overall weighted age- and sex-standardised prevalence of pain has been estimated at approximately 27.5%, with relevant variation across various countries, ranging from 9.9% to 50.3% (11). Although pain is a common experience in humans, its nature remains very complex. A comprehensive definition of pain is difficult to obtain, though, reflecting this complexity, the International Association for the Study of Pain (IASP) has recently redefine pain as an "unpleasant sensory and emotional experience associated with, or resembling that associated with, actual or potential tissue damage" (4).

This revised definition includes that pain cannot be regarded as merely a pure physiological phenomenon. Rather, it is an inherently subjective experience formed by physiological, psychological and social factors. Consequently, the assessment of pain, as well as the investigations of the mechanism that modulate it, remains both challenging and difficult.

Among the different factors influencing pain, physical activity, exercise, training, and sports have different effects. They may induce pain under certain circumstances, but they are equally capable of reducing pain and bettering body function. This applies both to acute and chronic pain and extends across populations, from healthy individuals to patients. These seemingly contrasting observations, which at first glance appear contradictory, illustrate the varying interplay between pain and motion, and form the central theme of this invited special issue of this journal.

An acute bout of exercise may result in sport-related injuries, which go along with different types of pain, an experience familiar to nearly every physical active person as well as elite athletes. One particularly intriguing form of sport-induced pain is Exercise Induced Headache (ExIH), a condition that appears to be considerably more common than previously recognised. In the study of Tomschi et al., presented in this special issue, ExIH was demonstrated in 27.4% of more than thousand physical active participants.

Apart from this, exercise may also induce pain in the absence of injury and headache. Intensive exercise can trigger muscular or other structural pain through the release of noxious, chemical nociceptive stimuli. Responsible for this are for instance metabolites associated with anaerobic energy metabolism, substance P, histamines, prostaglandins, serotonin, bradykinin, and adenosine within the intramuscular space, which can stimulate free nerve endings of C-fibre, non-myelinated group IV afferents. This physiological response underlies the phenomena known as "Exercise Induced Pain", or (EIP) (3).

Pain associated with physical and mental strain is not limited to conventional sports. Professional and competitive digital gaming, also known as e-sports, notwithstanding the ongoing debate concerning its classification in the world of sports, places considerable mental, psychological and physiological demands on its players. High pain prevalence rates over a one-year period (73%) and over seven days (44%) have been reported among e-sports players. However, there is only a limited number of studies available, and these are highly heterogeneous (8). An examination of the causes of pain shows that the spine and the upper limbs – in particular the neck, lower back and wrist – are the most commonly affected areas. Whether there is such a thing as a typical 'gamer's neck' and whether this can lead to specific pain in this group is discussed by Soffner et al. in the present issue.

In contrast to exercise as a pain stimulus, exercise may also trigger endogenous hypoalgesia. A single bout of e.g. endurance exercise can induce Exercise Induced Hypoalgesia (EIH), an acute transient reduction in pain sensitivity. EIH is a robust and consistently observed phenomenon in healthy individuals, whereas responses in patients with pain are more variable, although EIH can also be observed in these populations (5, 10).

This EIH effect and its dose-response relationships have been comprehensively described by a recent systematic review and meta-analysis, including 13 studies with 23 exercises and 14 control interventions and a total of 498 participants (9). In healthy individuals, EIH occurred both locally (MD=3.1, Mean differences in Newton/cm^2), e.g. at the working leg, and remotely (MD=1.8), e.g. at forehead or sternum, with high-intensity endurance exercise (bicycling/running/rowing) having the largest effect (local: MD=7.5; remote: MD=3.0) followed by moderate intensity (local: MD=3.1; remote: MD=3.0). In contrast, low-intensity exercise even when extending the exercise duration, exerted only minimal hypoalgesic effects.

The pain reducing potential of regular exercise and training extends far beyond healthy persons. A recent umbrella review by Singh et al. synthesizing evidence from 157 systematic reviews encom- ›

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passing 2,736 RCT´s and more than 221,000 participants, demonstrated consistent and clinically meaningful pain relief via physical training across a broad spectrum of different chronic diseases. These include e.g. osteoarthritis, chronic low back pain, rheumatic arthritis, fibromyalgia, headache disorders and cancer, beside others. Larger treatment effects could be shown in lower intensity programs and shorter duration with <12 weeks (6). It seems that exercise intensity is an important factor and effects differ between healthy people and patients with chronic pain. This topic within this context is also addressed by Sluka and colleagues (7).

Despite the growing evidence supporting exercise as an effective hypoalgesic intervention, the mechanisms responsible for and behind the exercise-induced pain relief remain poorly understood. In this issue, Tomschi et al. (9) are describing mechanisms regarding chronic musculoskeletal pain, particularly in the context to knee osteoarthritis and chronic low back pain. They discuss the potential bio-physiological contributions of altered inflammation, changed tissue perfusion, neurophysiological adaptations, and neuromuscular mechanisms among others. Shedding light on these pathways is essential for developing more targeted and effective exercise treatment interventions.

For optimising rehabilitation, more than the mechanistic understanding of pain reducing effects caused by exercise is necessary. Successful exercise therapy also depends on identifying the factors that determine individual treatment responses. Determinants of treatment success in chronic low back pain are addressed by Niederer et al. (2) in this issue. In their narrative review, they point out that "functional restoration, motor control, stabilisation exercises, and Pilates" produce the most consistent reductions in pain intensity and disability". The conclusion made by the authors might also be applied to other diseases, that optimising rehabilitation requires "integrating evidence-based exercise prescription with individualised dosing, adherence management, and systematic consideration of treatment effect modifiers".

Finally, the practical relevance of the aforementioned findings depends critically on their successful translation into clinical and applied practice. Otherwise, they risk remaining little more than "smoke and mirrors". Bridging the gap between scientific evidence and its implementation in rehabilitation treatments, and everyday clinical care is, therefore, the focus of the concluding article by Fleckenstein et al. (1).

In summary, this special issue provides a comprehensive perspective on the complex interplay between pain and motion – ranging from fundamental physiological mechanisms, and epidemiological observations to realistic clinical applications, rehabilitations strategies and implementation into clinical practice. We hope that this issue will not only help to systematise the current state of knowledge but also stimulate further research in this fascinating field, thereby improving the assessment and management of pain through evidence-based exercise interventions for people who wish to avoid pain or for patients who are suffering from acute or chronic pain.

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