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Unmasking Pain: A Look at the Latest Research

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Abstract
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Unmasking Pain

Recent research into the physical and psychological mechanisms of pain is revealing new ways to help ease the hurt without the use of medication.

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Whether it's dull or sharp, focused or diffused, acute or chronic, there's no doubt that pain matters a great deal in athletic training. It helps us detect and diagnose athletic injuries, and it serves as a gauge for monitoring progress in rehab. Athletes often have their own vocabulary for describing the pain they feel, and it's not always easy to interpret.

While you know that pain is important, you may not know exactly what's going on under the skin, and in the brain, to cause it. You also might not know about everything you can do to help relieve it.

Recent studies on the mechanisms of pain in athletes are providing new information in both these areas. Research is also shedding more light on a phenomenon called exercise-induced hypoalgesia, which--though not yet fully understood--could play a significant role in your approach to assessing and treating injuries.

WHAT IT IS & WHAT IT DOES

According to the International Association for the Study of Pain, pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage. This definition is broad, and it has to be. While the major physical mechanisms of pain are well understood, interpretations of pain can differ widely, so comparing one person's pain to another person's is a difficult and inexact process.

Biologically, pain results from the stimulation of nerve endings called nociceptors. In scientific terms, nociception is the division of the afferent central nervous system that responds to noxious stimuli. Put more simply, pain is a specific type of message that alerts the brain to potentially damaging or dangerous situations.

Pain fibers are distributed throughout the entire body and come in two basic forms. Type III fibers (also known as A-Delta fibers) are thick in diameter and have a thin myelin sheath. They respond primarily to structural deformation and mechanical pressure, and are therefore associated with sharp, piercing pain. Type IV fibers (also known as C-fibers) are thin and un-myelinated, so they transmit signals much more slowly than Type III fibers. They are associated primarily with dull, aching types of pain.

Both kinds of fibers have nerve endings that are dispersed in muscle tissue, tendons, and the skin. The nerve endings are well positioned to receive various noxious stimuli, which can depolarize or activate the nerve receptor, thereby triggering the sensation of pain. In addition, algesic (pain causing) substances within the body are released when a muscle is injured or damaged, and these substances, such as histamine, bradykinin, serotonin, and potassium, can activate the nearby nociceptors. Other substances, like hydrogen ions and prostaglandins, can heighten the sensitivity of nociceptors and make them more likely to fire.

Everyone knows what pain feels like, but by definition it's a subjective experience. This often presents a challenge to athletic trainers because a similar physical injury can be perceived very differently by different athletes. "Really hurts" to one individual might be the same as "kind of aches" to another and "throbs, but not badly" to a third.

Furthermore, pain does not necessarily increase or decrease depending on the amount of tissue damage. Although pain is an important factor when assessing an injury, it's not a completely reliable guide. You can never feel what the athlete feels, so you rely on them to communicate the type, location, and severity of their pain.

Rehab professionals are often curious about the extent to which pain is actually useful. Once an athlete is aware of his or her physical condition--a sprained knee, a bruise, a wound--it may seem like pain no longer serves a purpose. You could even argue that chronic pain can be counterproductive to the healing process.

When athletes and healthcare providers see pain as unnecessary, they often turn to analgesic drugs to reduce or eliminate it. While these medications can be very effective, particularly after an injury, they also have a key drawback--in some cases, they can mask functional pain, which provides necessary feedback for the recovery process. While the athlete is made more comfortable, the athletic trainer may be losing important information that's critical to a successful rehab.

MIND OVER MATTER?

Remember when Kerri Strug nailed her second vault at the 1996 Olympics to help secure the U.S. women's gymnastics team's first all-around gold medal? If so, you probably recall that she did so with two torn ligaments in her ankle, sticking her final landing in obvious pain with most of her weight on one leg. And if you've been in the profession long enough, you have probably witnessed a performance like it in your own setting--an athlete displaying remarkable focus and tenacity, finding the will to compete despite being hampered by a clearly painful injury or condition.

We often credit these athletes with Herculean courage and character, and wonder just how they do it. As it turns out, science is helping answer that question by shedding light on several key internal mechanisms--both physiological and psychological--that help athletes deal with pain. One of the most important is a phenomenon called exercise-induced hypoalgesia (EIH).

Early case studies of pain being diminished during physical effort date back to the American Civil War and World War I. Doctors in the field noticed and reported that while a soldier was engaged in battle, he felt less pain than when in the safety of a hospital. In more modern times, anecdotal evidence and scientific research have documented a similar effect during athletic competition.

So what is actually happening in these situations? How much is mental ("in the heat of battle") and how much is physiological? The exact mechanisms of EIH are not completely understood, but an exercise-induced decrease in the ability to transmit noxious stimuli has been observed through tests of the nervous system, suggesting that the best explanation involves a blend of both mental and physical elements.

Based on the information available now, it appears there are a number of contributing factors in EIH. One is an increase in endogenous circulating opioids (endorphins). Another is an increase in catecholamines (adrenaline and noradrenaline, also known as norepinephrine), leading to an increase in blood pressure, along with neurological gate-controlling from local muscular afferents. Untangling and isolating these factors is an area of intense study with important ramifications for athletes and anyone else who suffers from pain, and the research is ongoing.

But even if we're not yet sure exactly how it works, it's still important to recognize that it works. Research has shown that a key determining factor for the onset of EIH is the intensity of exercise.

The precise level of intensity needed to induce EIH is not known, and it almost certainly varies by individual. However, several researchers have reported that an intensity near 70 percent of maximal oxygen consumption (VO2 max) is sufficient to induce EIH. Running and cycling are the most common activities used to study aerobic exercise and pain perception, but other forms of aerobic work have also been found to be effective. Anaerobically, strength training, gripping exercises, and several types of isometric exercise have all produced a temporary decrease in pain perception as well, although not to the same degree as comparable aerobic exercise.

One of the most studied and controversial mechanisms of EIH centers on endogenous opioids--chemicals produced by the body that reduce pain. Beta-endorphins (a neurotransmitter) have been found to affect the peripheral and central portions of the nociceptive system, which essentially means they modulate pain sensation. While it's well established that the body's beta-endorphin levels increase during exercise, the relationship between beta-endorphins and decreased pain is not fully understood. Exercise-induced hypoalgesia occurs even when chemicals called opioid antagonists are used to block the body's opioid receptors, leading many researchers to conclude that there are several mechanisms (opioid and non-opioid) causing the analgesic effects.

Exercise is also a potent stimulus for increasing sympathetic activity. As part of the sympathetic response, catecholamines (epinephrine and norepinephrine) are secreted to prepare the body for exercise by increasing cardiac output and constricting peripheral blood vessels. Consequently, an increase in arterial blood volume increases systemic blood pressure, which may contribute to a temporary diminishing of pain perception.

Interestingly, there seems to be a neural link between the control of blood pressure and the modulation of pain perception. Studies have found that people with chronic untreated hypertension actually have a higher tolerance for pain than people with normal blood pressure. This relationship has led researchers to explore how elevated blood pressure might be involved in pain perception during exercise, but firm conclusions have not yet been reached.

PRACTICAL EFFECTS

Imagine an athlete (or anyone else, for that matter) who has just received a blow that results in a contusion. What's the first thing they do? They rub it. Everyone knows that rubbing an area after a hard impact seems to decrease pain--but have you ever wondered why?

The answer may help explain why all this research matters to you as a sports medicine professional. Pain can be diminished by rubbing an injured area because the un-myelinated C-fibers that transmit the pain messages must compete for access through the spinal cord with neuromuscular proprioceptors from the active muscles and pressure receptors in the skin. In what is called the Gate Control Theory, only a certain number of messages can be sent to the brain at any given time, and sending non-pain related stimuli ("this area is being rubbed") helps prevent more pain stimuli ("this area was just bumped and now it hurts!") from being processed by the nervous system. In short, the Gate Control Theory holds that the actual amount of painful impulses reaching the brain is reduced when multiple sources of sensory input are introduced simultaneously from different types of afferent fibers.

Many athletes believe the ability to tolerate pain is an important aspect of both training and competition. Whether they're "feeling the burn" in the weightroom or taking a punishing hit on the field, they accept that pain is part of athletics. But does pain tolerance really correlate well with performance?

Anecdotally, accomplished athletes like cyclist Lance Armstrong have credited their success in part to increasing their pain threshold through rigorous training and competition. At this point, however, there is very little clinical evidence suggesting that muscular pain tolerance actually contributes to athletic success. There is also little evidence that muscular pain tolerance can truly be trained or improved. For the most part, pain tolerance plays a minor role in determining athletic performance, but it's not surprising that the athletes most willing to endure pain would ascribe their success in part to their "toughness."

Even so, an understanding of pain and how to ameliorate it can help make rehab more effective. In terms of EIH, taking advantage of the analgesic effects of exercise may be a useful way to promote rehab compliance. For example, some athletes find soaking in an ice bath to be very painful. Stretching and other range of motion exercises are extremely uncomfortable after certain injuries. Even sustained muscle exercise can cause serious pain and discomfort. Athletic training and rehab are not just driven by science and rigid protocols--they're also grounded in the art of deciding how much pain an athlete can tolerate and knowing when to push them or pull back.

So let's say you have an athlete who dreads submerging their arm in an ice bath because it hurts. But if this treatment is necessary, to reduce inflammation for example, try having them perform moderate-intensity aerobic exercise beforehand to induce EIH. Or perhaps an athlete is recovering from a torn or strained muscle and finds strength and range of motion work excruciating. Warmup activities involving semi-vigorous aerobics will not only increase blood flow, but may also temporarily raise the athlete's pain tolerance.

In many ways, pain is fascinating. Everyone knows what it is, but we still haven't figured out all the positive and negative ways it affects the body. However, as we continue to learn more, the possible applications to sports medicine are numerous and exciting. Even without fully understanding all the mechanisms behind a phenomenon like exercise-induced hypoalgesia, we can take advantage of what we do know to make rehab and injury treatment more tolerable, and ultimately more successful.