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PAIN PERCEPTION IN THE HORSE AND ITS CONTROL BY MEDICATION: AN OVERVIEW

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The decision to initiate a study on pain perception in horses comes from the practical importance to racing of medications which affect pain perception. On the one hand, the racing industry has long had to cope with the use of narcotic analgesics. Although illegal in all racing states, these medications are not infrequently used by horsemen and their control is a constant challenge to racing chemists. On the other hand, there are the non-steroidal anti-inflammatory drugs such as phenylbutazone. While these agents reduce the inflammatory component of pain, their actions are different from those of the narcotic analgesics. This has led to their approval for use in racing animals in some jurisdictions. One of the goals of our pain studies is to more accurately describe the actions of both of these groups of agents in horses and to clearly distinguish between the pharmacological effects of these two very different types of medications.[1]

Studies on pain perception in horses are few and their interpretation is highly dependent on experiments and experience with pain perception in humans. The basic thinking in pain perception is that it starts with "nociception", or the perception of something noxious at the peripheral location. Such a perception is usually localized to a particular site which can usually be identified by the subject. The information generated locally as nociception is then transmitted to the CNS. In the central nervous system, it may be perceived and interpreted in a variety of ways. Pain itself is commonly but not invariably aversive. On the other hand, pain perception in settings associated with discomfort or pain whose ultimate significance is known and feared can be extremely aversive.[2] However, all these central interpretations of the perception of pain in the CNS are subjective and are largely based on subjective experiments with humans. We know little about pain perception in equines, although it is probably reasonable to extrapolate from what we know about pain perception in humans and assume that similar principles apply in the horse.[3]

Pain perception or nociception originates when cells are damaged by chemical or physical means. This gives rise to the local release of chemical mediators of pain like bradykinin, histamine, prostaglandins, serotonin and SRSA (slow reacting substance of anaphylaxis). These are the local chemical mediators of pain and injection of these agents will give rise to acute local pain. Release of these chemicals is the primary event in pain perception and when these local events are transmitted to the CNS, they are perceived as pain.[4]

The precise pathways followed by nociceptive impulses on their journey through the CNS is not clear. The specific pathway theory held that specific, discrete and relatively fixed pathways exist for the transmission of pain to the CNS. By this view, the pain pathways in the central nervous system were thought of as "hard wired". If indeed "pain pathways" in the CNS are "hard wired", surgical section of these pathways should block these pathways and give rise to good pain control. Unfortunately, however, clinical experience with surgical section as a method of pain control suggests that pain perception almost always recurs. Based on surgical experience and other work, at least five distinct spinal cord pathways are involved in the transmission of nociceptive impulses to the CNS.[5]

This inability to block transmission to the CNS gave rise to what is called the pattern theory of pain perception. Pattern theory holds that rather than stimulation of specific pathways giving rise to pain, pain results from stimulation of many pathways in a particular pattern. For example, while light and sound perception are not, per se, painful, and neither are heat and cold, they can, when very intense, be perceived as painful. By this theory impulses can arrive at the CNS by any route, and it is the specific pattern of impulses arriving in the CNS which gives rise to the perception of pain in the CNS.[5]

While the specific pathway theory is not satisfactory from the clinical and experimental point of view, the pattern theory is so diffuse and vague that it has been difficult to experimentally test. A more useful and workable hypothesis has resulted from the marriage of the specific and pattern theories. This theory is called the gate theory of pain perception. The gate control theory of pain perception was introduced in 1965 by Melzak and Wall.[6] In its simplest form it may be considered a hybrid of the specific and pattern theories. It turns out that information reaches the CNS by at least two distinct types of nerve pathways. Information on touch, proprioception, pressure, and so forth comes to the CNS on fast fibers, which carry these neutral or bland impulses. On the other hand, nociceptive impulses come to the CNS on slow fibers, which predominantly carry pain impulses. These pathways are thought of as converging on "gates" in the CNS, where the incoming information is processed. If a wealth of information is coming in on the fast fibers, the slow fibers are blocked out at the gate and the nociceptive impulses do not get through and are not perceived in the CNS. This mechanism can help to explain the success of counterirritants, acupuncture, and transcutaneous electrical stimulation in treating pain. The gate theory has therefore been a very useful experimental tool.

The processes just outlined show how the perception of pain may be interfered with at a number of points along this sequence of events. The agents with which we are all most familiar in the control of nociception are the nonsteroidal anti-inflammatory drugs (NSAID). While aspirin is the prototype of members of this group, phenylbutazone is the member of this group most widely used in horses. These agents act by inhibiting the cyclo-oxygenase enzyme which is a central step in prostaglandin biosynthesis. By virtue of this inhibition,

prostaglandin levels in inflamed tissues drop to normal and their local nociceptive effect is lost. However, it is important to remember that the nonsteroidal anti-inflammatory drugs are primarily active against inflammatory pain, and have little or no effect on pain perception in normal tissue. These agents are generally considered to be mild analgesics, active against pain of low to moderate intensity. They have little or no effects on normal pain perception and proprioception. The central nervous system is essentially unaffected by the aspirin-like drugs.[1,7]

A second method of blockade of nociceptive transmission often used in veterinary medicine is local anesthesia. Local anesthetics are basic, lipid-soluble drugs which act to reversibly inhibit nerve impulse conduction in both the peripheral and the central nervous system. To be effective, a local ansthetic must be lipid-soluble, for they all act on the inner surface of the neuronal membrane. At this surface they block the increase in sodium conductance associated with the nerve impulse and in this way block nerve conduction. The local anesthetics block both sensory and motor nerves and also block impulse transmission in the CNS. When administered locally, their onset of action is fast, usually occurring within about three to fifteen minutes. The duration of action is variable, with procaine's effects lasting about 30 minutes. On the other hand, the duration of action of lidocaine is longer, about 60-120 minutes, and that of tetracaine much longer, about 400 minutes.[1,7]

One contention often heard about local anesthetics is that they become sequestered when injected into a joint or nerve and therefore do not enter the general circulation of the animal. This is almost certainly incorrect, for as relatively lipid-soluble substances, the local anesthetics can diffuse almost anywhere in the body. Further, as basic, lipid-soluble drugs, these agents are likely to accumulate in an acidic urine and under some circumstances attain quite high concentrations in urine.

The last mechanism which we will be discussing in this overview of the peripheral blockade of nociception is transcuteneous electrical stimulation. This technique was introduced by Wall and Street in 1969, and has been used with some success in both human and veterinary medicine. Transcutaneous electrical stimulation functions by providing a wealth of sensory information in the fast fiber pathways, effectively blocking out the slow or pain fiber pathways at the gate in the central nervous system. Data from human investigators suggest that transcutaneous electrical stimulation in human studies is effective in the treatment of chronic pain. Interestingly, the persistence of this effect is variable, lasting for up to several hours after treatment is withdrawn.

In summary, pain or nociceptive impulses arising at the periphery can be blocked in a variety of ways. The most commonly used drugs in both human and veterinary medicine are the prostaglandin inhibitors. These agents act to reduce the generation of nociceptive impulses at the sites of inflammation. Transmission of nociceptive impulses to the CNS may be prevented by local anesthetic blocks, which are quite specific and effective. More recently, the technique of tanscutaneous electrical stimulation has been developed, which blocks pain centrally even though applied locally.

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FOOTNOTE

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