Pain and Its Control in Reptiles

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KEYWORDS

• Pain • Reptiles • Analgesia • Nociception • Multimodal analgesia • Opioid

KEY POINTS

- Reptiles have the anatomic and physiologic structures needed to detect and perceive pain.
- Reptiles are capable of demonstrating painful behaviors.
- Most of the available literature indicates pure μ-opioid receptor agonists are best to provide analgesia in reptiles.
- Multimodal analgesia should be practiced with every reptile patient when pain is anticipated.
- Further research is needed using different pain models to evaluate analgesic efficacy across reptile orders.

INTRODUCTION

Nociception is the processing of information by the peripheral and central nervous system (CNS) about internal or external stimuli to the body. Pain implies processing of this information at the level of the brain, specifically the cortex. In human terms, pain is the conscious perception of nociception as an unpleasant or adverse effect. Controversy has existed on whether nonmammalian species, such as reptiles, have the central and peripheral nervous system components to receive and process noxious stimuli as pain. Differentiating between a reptile "feeling" pain and having a "reflexive" response to noxious stimuli, or nociception, is at the crux of the pain debate in reptiles. Sound scientific data about the neuroanatomic, neurophysiologic, and behavioral pathways in reptiles are not as readily available as for other species and are often found in nonveterinary journals. Nonetheless, it has become a standard of practice to presume that reptiles are indeed capable of feeling pain and that analgesia should be an integral part of reptile medicine.

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NEUROANATOMY AND NEUROPHYSIOLOGY

The pathways required for pain processing include transduction, transmission, modulation, projection, and perception. All 5 categories are required components for the processing of pain by the brain.

Transduction

Transduction is the ability to detect innocuous to noxious stimuli within the environment by specialized or free nerve endings and transform them into action potentials. Like mammals, reptiles have cutaneous myelinated and unmyelinated afferent fibers running together in sensory nerves. Types of sensory nerves include myelinated A fibers (Aβ), small myelinated A fibers (Aδ), and small unmyelinated C fibers (C).[1,2] Additional documented peripheral receptors to aid in transduction have not been as well characterized compared with other vertebrates. Peripheral receptors may include intraepidermal mechanoreceptors, connective tissue mechanoreceptors without Schwann cell specializations, mechanoreceptors with Schwann cells, Merkel complexes, tactile sense organs, complex sensory organs, joint capsule endings, and sensory endings associated within the perichondrium, periosteum, tendons, and muscles. Reptiles, compared with other vertebrates, have relatively large terminal expansions of free nerve endings in the epithelial cells of the epidermis termed intraepidermal mechanoreceptors. Complex unencapsulated nerve endings occur in reptiles as in anamniotes, and they are characterized by an unmyelinated receptor axon in contact with surrounding connective tissue. A study in a pit viper species reported that Aβ fibers that respond to nonnoxious mechanical stimuli have a larger soma (cell body), whereas Aδ fibers that respond to noxious stimuli have a small soma, although there was no correlation with neuron function and soma size. Axon morphology was correlated with sensory neuronal function.[3] Substance P, a peptide neurotransmitter, documented within small afferent fibers, nerves, and dorsal and ventral horns of the spinal cord, is directly associated with painful stimuli in mammals. The substance P system is highly conserved across mammalian and nonmammalian species. In reptiles, substance P has been documented to occur within several turtle species.[4,5] Scant literature exists describing the required components to transduce painful or noxious stimuli in reptiles.

Transmission

Transmission occurs in the peripheral nervous system where action potentials occur and are transmitted to and from the spinal cord (CNS) and is then projected to the brain. Before being projected from the spinal cord to the brain, the signal in the form of action potentials can be modulated at the level of the spinal cord. Peripheral sensory nerve signals can be modulated, either amplified or suppressed, by interneurons present in the spinal cord. Specifically, the dorsal horn of the gray matter has interneurons that modulate the ascending neurons that receive, transmit, and project sensory information to the brain. Interneurons have been documented in the spinal cord of the red-eared slider (*Trachemys scripta elegans*) within the gray matter that assists in modulating movement and locomotion.[6,7] However, no studies have evaluated the role of interneurons and pain in reptiles.

Projection

Projection of sensory information from the periphery to the cerebral cortex within the spinal cord is a function of several ascending pathways originating from the spinal cord gray matter.[6,7] Axons of these pathways travel with the white matter of the spinal