A safe “opioid” – is dry needling an efficacious alternative to opioids?

Abstract

Traditional Chinese medicine has used acupuncture for more than 2,000 years as a method to effectively treat numerous illnesses and diseases. It is in the Western model of medicine that acupuncture is considered ‘alternative’ medicine. The practice of this Western model of acupuncture, known as dry needling (DN), requires a technique that uses a monofilament without an injectate that is inserted into the soft tissue at varying depths—from superficial to deep—triggering a physiological response. Certain physicians and physical therapists have adopted this westernized version of the Chinese medicine modality by using the same technique for acupuncture to perform DN and electric dry needling (EDN). DN and EDN are administered to mediate analgesia peripherally, spinally, and supraspinally via multiple pathways by arousing the hypothalamic-pituitary-adrenal axis, provoking immune cells, and prompting the supraoptic nucleus. Stimulating these sites initiates the opioid interneuron mechanism resulting in opioid-based pain reduction that is mediated by the sympathetic nervous system and endogenous cannabinoids. Although EDN is further correlated with the spinal to supraspinal mechanisms of anti-nociception, both DN and EDN have shown to be components of a comprehensive analgesia pathway that acts like opioids opioids in the human body. When comparing DN and EDN to opioid usage for analgesia, the adverse reactions and the significance of higher adverse reactions in the patient are essential factors to consider; DN and EDN have markedly less adverse effects that opioid use. The literature shows that DN or EDN have a high efficacy for analgesia, and operate via similar mechanism of action as opioids. Therefore, the medical community should consider and utilize DN and EDN as an alternative to opioids in certain conditions.

Keywords: acupuncture, analgesia, dry needling, electric dry needling, hyperalgesia, morphine, opioid receptors, opioids

Abbreviations: ACTH, adrenocorticotropic hormone; AMPA, a-amino-3-hydroxy-5-methyl-4-isoxazolepropionic acid; ADP, adenosine diphosphate; ATP, adenosine triphosphate; COX-2, cyclooxygenase-2; CRH, corticotropin-releasing hormone; DN, dry needling; DRG, dorsal root ganglia; EDN, electric dry needling; NK1, neurokinin 1; NMDA, N-methyl-D-aspartate; OIH, opioid-induced hyperalgesia; ORL1, opioid receptor-like; SP, substance P; TRPV1, transient receptor potential vanilloid receptor subfamily 1

Introduction

Opioids are some of the earliest known drugs used to treat pain, depression, insomnia, and anxiety. Opioids act on opioid receptors to produce morphine-like effects in the human body. However, the side effects of opioid use can include nausea, constipation, vomiting, itching, respiratory depression, addiction, tolerance, and opioid-induced hyperalgesia (OIH). Although most side effects of prescribed opioid use are considered mild, a dangerous side effect is respiratory depression.

Opioid receptors are found throughout the spine, central nervous system, and gastrointestinal tract that mediate morphine-like effects. In the 1960s, the mechanisms of opiates were found to be mediated by multiple types of molecular receptors throughout the body. The three classic opioid receptors that mediate analgesia are nociception receptors, Toll-like receptor 4, and sigma receptors. Sigma receptors are no longer considered opioid receptors in that they are not reversible when opioid antagonists, such as Naloxone or Naltrexone, are given.1

The opioid receptor classes mu, kappa, and delta are the top classes of opioid receptors that are used due to their high affinity for binding to the opioid binding sites and are stereoselective for levorotatory isomers. The mu opioid receptor (which has three subtypes) and the opioid receptor-like (ORL1) receptors are clinically relevant in pain analgesia. These opioid receptors are G-protein coupled receptors involved in GABA-ergic neurotransmission.

The pharmacodynamics of opioids correlate with the class of receptors they bind to, the affinity they have for the receptors, and whether they are antagonist or agonist. Various opioid receptors will stimulate a variety of opioid effects; for instance, the mu-1 subtype will result in supraspinal analgesia, the mu-2 subtype will result in respiratory depression and dependence, and the kappa will result in spinal analgesia and sedation.

It is via these same mechanisms of action that DN and EDN influence analgesia. DN and EDN affect supraspinal and spinal analgesia by the stimulation of the opioid receptors without using an injectate. With DN and EDN, eliciting analgesia is not limited to the periphery; and in decreasing the second-order neuron hyperalgesia, perception of pain at the central nervous system is decreased. Thus, an opioid-like mechanism is recognized. This opioid-like mechanism of action allows DN and EDN to be considered as a substitute for opioid use with the benefit of decreasing opioid addiction.
Discussion

Addressing the pathways of anti-nociception that utilize opioid mechanisms of analgesia is the focus of this discussion. Centrally mediating pain is accomplished by nociceptors that are bipolar: starting with the cell body at the dorsal root ganglion (DRG), one nerve ending ending going toward the periphery, the other end going into the dorsal column to communicate with second order neurons. The C-fibers initiate the communication in the DRG and trigger the release of glutamate and Substance P (SP). This release of SP, in turn, triggers the second-order α-amino-3-hydroxy-5-methyl-4-isoxazolepropionic acid (AMPA) receptor via phosphorylation as the glutamate release is sustained. It requires activation of neurokinin-1 (NK1) second-order receptors via SP to cause phosphorylation of N-methyl-D-aspartate (NMDA) second-order receptors. The phosphorylation of NMDA receptors creates an influx of calcium ions (Ca2+) across the membrane leading to the up-regulation, awakening, and sensitization of NMDA receptors, and the up-regulation of cyclooxygenase-2 (COX-2) enzyme that increases the production of prostaglandins. Furthermore, the repeated channel use of NMDA and AMPA receptors causes cell death at the postsynaptic neuron and a cytotoxic environment that triggers interneuron apoptosis of the dorsal horn.1

The dorsal horn interneurons inhibit the afferent receptive field. When the dorsal horn is disinhibited, the nociceptive afferents that were dormant or silent can stimulate the dorsal horn using synapsis that were previously not used.1 This process results in an increased receptive field peripherally and is the basis of referred pain in which the communication of pain in the spinothalamic tract is termed hyperalgesia. The release of glutamate, SP, and adenosine triphosphate (ATP) also stimulate glial cells and astrocytes in the dorsal horn creating spinal hyperalgesia. Central sensitization is the result of hyperalgesia peripherally and spinally. Multiple studies describe central sensitization with low back and shoulder fibromyalgia with increased sensitivity to mechanical stimulation and receptor field expansion in the dorsal horn regarding pain threshold.1

Goldman et al. (2010)2 found a significant release of ATP, adenosine diphosphate (ADP), and adenosine in the interstitial fluid after DN 30 minutes at acupuncture point ST36 location; most likely due to stimulation of the transient receptor potential vanilloid receptor subfamily 1 (TRPV1) receptors and following calcium wave propagation.2,3 ATP is then catalyzed to adenosine, in turn activating A1 adenosine receptors.3 Research revealed that mice experiencing inflammatory or neuropathic pain had normal A1 adenosine receptors showing less activation of the cingulate gyrus versus mice that had A1 adenosine receptors blocked; the cingulate gyrus is the emotional center in the brain for pain experience.4 A1 receptors, which are G-coupled protein receptors, are found on the afferent DRG; and, the nerve endings possibly function by blocking adenylyl cyclase. Thus, the stimulation of A1 receptors via DN-mediated analgesia is comparable to opioids blocking adenylyl cyclase in opioid analgesia.

Studies have indicated that EDN only affects the purinergic receptors P2X2 and P2X3 in neuropathic pain.5 Mice that were inflicted, bilaterally, with hind leg injuries showed an elevation of these purinergic receptors, increased notably at the DRG L4/L5.6 Application of EDN, bilaterally, at acupuncture points ST36 and GB34 for seven days at 30 minutes per day, significantly decreased purinergic receptors, increased ATP, and improved mechanical pain threshold.6,7 Although direct opioid analgesic pathway mechanisms were not in play, desensitization of spinal pain, lessened supraspinal communication, and diminished perception centrally of pain did result (as occurs with opioids).

In the neuroendocrine system, there was an increase in the activity of the hypothalamic-pituitary-adrenal axis with inflammation in humans and animals. There was a significant increase with all the hormones in that pathway, from corticotropin-releasing hormone (CRH) to adrenocorticotropic hormone (ACTH) to cortisol, in mice as inflammation occurred; but not so when void of inflammation.5 Treated with EDN, the same mice with inflammation did not express pain analgesia; however, the beta-endorphins were increased in production at the paraventricular nucleus.6,8 The released endogenous opioids attach to opioid receptors resulting in analgesia. This pathway may have an attenuated effect in humans on the opioid receptors. Again, it was shown that opioid pathways were stimulated with DN and EDN.

The CRH–POMC–corticosterone axis is also triggered by mechanical stress via human dermal fibroblasts.5 Dermal fibroblasts can produce CRH and express CRH receptors.9,10 When inflammation occurs, CRH influences opioid release from immune cells enhancing EDN-mediated analgesia. Conversely, EDN-mediated analgesia is inhibited and decreased when CRH antagonists are used.9 There is a descending pain modulation system that increases the concentration of opioids, norepinephrine, and serotonin in the spine due to EDN, while it decreases the concentration of norepinephrine in the brain due to stimulation of the arcuate nucleus and periaqueductal gray with EDN.3 When the arcuate nucleus and periaqueductal gray are stimulated, enkephalins and dynorphins are released down the spine. Use of an opioid antagonist, such as Naloxone, limits the EDN-mediated analgesia.10 The decrease of norepinephrine in the brain is a result of norepinephrine-inhibiting analgesia in the brain. Furthermore, there are A2-adrenergic receptors and 5-HT receptors on enkephalinergic interneurons in the dorsal column which encourage the release of enkephalins. Enkephalins recognize three classes of opioid receptors (mu, kappa, and delta receptors) which are presynaptic and postsynaptic. Thus, enkephalins affect pathways altering the transmission of pain through the spinothalamic tract and decreasing the supraspinal perception of pain. All three receptors are stimulated during acute pain, via the enkephalins, but only two receptors with chronic pain.11 These tracts, as mentioned above, are a direct indication of DN-mediated analgesia. DN, as an alternative to opioids, helps mitigate opioid addiction and other unwanted opioid side effects.

Conclusion

Opioids can alleviate various levels of discomfort caused by injury, illness or surgery; but opioid addiction and abuse has become an epidemic, perhaps doing more harm than good. Use of an alternative method of treatment in some cases can aid in significantly decreasing the use of opioids. Acupuncture is a time-tested method that has influenced the development of DN and EDN to stimulate a morphine-like effect without the harmful side effects of using a narcotic. DN and EDN seem to be effective methods that allow patients to return to activities rather than stay sidelined by chronic pain and adverse effects of opioids. DN and EDN are cost-effective and less harmful to the patient in that they allow the body to provide its pain relief. Dry needling appears to be a safe and efficacious alternative to opioids.

Acknowledgments

None.

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Conflicts of interest
The authors declare that the research was conducted in the absence of any commercial or financial relationship that could be construed as a conflict of interest.

References