Mechanisms of Acupuncture Analgesia

Ali Khorsand
M.D, Ph.D
The concept of the gate control theory is that non-painful input, closes the gates to painful input, which results in prevention of the pain sensation from traveling to the CNS.
The projection neuron (P) carries both nociceptive stimulation from small fibers (S) and non-nociceptive stimulation from large fibers (L) on the way to the brain. 

With no stimulation, the inhibitory neuron (I) keeps the gate "closed," and there is no painful sensation.

With painful stimulation, the small fiber (S) blocks the inhibitory neuron (I), "opening" the gate for the projection neuron (P) to send on the painful stimulus.

With the addition of non-painful stimulation, the large fiber (L) activates the inhibitory neuron (I), partially or completely closing the gate depending on the strength of the stimulus, and competes with the painful stimulation for access to the projection neuron (P).
Pain stimuli reach the brain via A-delta and C fibers. Areas of the dorsal horn of the spinal cord receive input from large-diameter A-beta fibres as well as receiving connections from A-delta and C fibres; these A-beta fibres are non-nociceptive and regulate transmission of pressure and touch signals. The larger diameter of the A-beta fibres means that the signals they carry travel faster than those in A-delta fibres. Like a highway, the ‘nerve gates’ can handle only a limited number of nerve signals at one time.
Pain stimuli in A-delta and C fibres travel slowly, while the A-beta nerve signals travel much faster. The faster signals crowd out the slower ones because of the limited capacity of the nerves. This effectively blocks the pain stimuli from reaching the brain and therefore pain is not experienced. It has been postulated that the insertion of needles in acupuncture points stimulates large numbers of A-beta fibres, therefore preventing the brain from perceiving the pain stimulus due to engagement of the synapses by A-beta nerve signals.
Pert et al., showed that auricular electrical stimulation through needles of the rat ear produced an elevation of hot plate threshold that was reversed by administering naloxone.

The behavioral analgesia to auricular electroacupuncture was accompanied by a 60% increase in radioreceptor activity in cerebrospinal fluid levels of endorphins, a level that was significantly greater than that found in a control group.
The impulses of Needle stimulation are transmitted via the spinal cord anterolateral tract to the hypothalamo-pituitary system (HPS), which releases beta-endorphin (βE) into blood, cerebrospinal fluid and periaqueductal grey matter (PAG), which release met-enkephalin (MEK) and βE to suppress the transmission of nociceptive information and to activate the raphe nuclei, leading to the activation of the descending inhibitory system. This results in an inhibition of the dorsal horn cells receiving the nociceptive impulses using the neurotransmitters serotonin (5HT) and noradrenalin.
Neurotransmitters:

The role of endogenous opiates and other neurotransmitters in acupuncture analgesia was first demonstrated in the 1970s when cerebrospinal fluid (CSF) was removed from animals in which acupuncture analgesia had been induced. The donor CSF was transfused into a recipient animal, which subsequently developed analgesia too.

**Serotonin**
**Opioids, endorphin,**
**Adenosine**
**Cortisol**
**TNF-alpha, IL-1 and IL-4, IL-8**
**(Glu), (Asp), (Gln), (GABA), (Gly) and (Tau)**
Plasma serotonin (5-HT) contents before and after the treatment were detected by fluorescence spectrophotometry.

After the treatment, plasma 5-HT content of the acupuncture group was remarkably higher than that of the medication group (P < 0.05).
When the acupuncture needle is inserted, it stimulates the pain receptors (nerve endings) and causes the secretion of endogenous opioids.

These play a role in pain control. These indigenous opiates are so called because of their similarity in pharmacological action with external opiates such as morphine. They produce similar effects, including the desired analgesia, the only difference being that they are not addictive like morphine.
an endogenous substance is unlikely to cause addiction within the host body. Interestingly, the analgesic effect of endogenous opiates is extremely powerful and many times stronger than that of morphine.

Beta-endorphin has been administered both within and outside the spinal cord resulting in prolonged analgesia, with few or none of the side-effects commonly associated with external opiates.
Adenosine

it released during acupuncture and its anti-nociceptive actions required adenosine A1 receptor expression. These observations indicate that adenosine mediates the effects of acupuncture and that interfering with adenosine metabolism may prolong the clinical benefit of acupuncture.
Effects of electroacupuncture at "Futu" (LI 18), etc. on expression of spinal 5-HT 1 AR mRNA, 5-HT 2 AR mRNA and protein in rats with neck incision pain. Qiao LN, Yang YS, Wang JY, Gao YH, Han YJ, Chen SP, Ji CF, Liu JL

Acupuncture can significantly suppress pain reaction of neck incision in the rat, which is closely associated with its effects in up-regulating 5-HT 2 AR mRNA.
Effects of electroacupuncture of unilateral and bilateral "zusanli" (ST 36) on serum TNF-alpha, IL-1 and IL-4 levels in rats with chronic inflammatory pain

Wang WJ, Lu J, Niu CS, Huang YR, Ma Q, A YG, Hao HW, Li LM, Tu Y.

they observe the effect of electroacupuncture (EA) on TNF-alpha, IL-1 and IL-4 in rats with chronic inflammatory pain, so as to investigate its underlying mechanism in relieving pain.

Acupuncture can effectively lower serum TNF-alpha, IL-1 and IL-4 levels in inflammatory pain rats, which may contribute to its effect in relieving inflammatory pain.
Acupuncture for chronic pelvic pain syndromes (CPPS) and its effect on cytokines in prostatic fluid.

Yuan SY, Qin Z, Liu DS, Yin WQ, Zhang ZL, Li SG.

the levels of Interleukin-8 (IL-8), Interleukin-10 (IL-10) and Tumor necrosis factor-alpha (TNF-alpha) in prostate fluid were detected and the correlation between those changes and pain score was analyzed.

Acupuncture has significant reducing the levels of IL-8 and TNF-alpha to relieve inflammatory reaction.
(Glu), (Asp), (Gln), (GABA), (Gly) and (Tau)

Effect of electroacupuncture on the levels of amino acid neurotransmitters in the spinal cord in rats with chronic constrictive injury

Concentrations of glutamate (Glu), aspartate (Asp), glutamine (Gln), gamma-aminobutyric acid (GABA), Glycine (Gly) and taurine (Tau) in the lumbar spinal cord (L4-6) were detected.

Spinal Glu, Asp, and Gin contents were downregulated significantly in the EA group (P < 0.01) while Gly, GABA and Tau levels were upregulated obviously (P < 0.01, P < 0.05).

effects in reducing the release of excitatory amino acids and promoting the release of inhibitory amino acid neurotransmitters.
How does Chinese medicine explain role of Acupuncture for pain:

- Ancient Chinese believe that there is an inner energy or vital force that, is called "Qi".
- Pain, or any physical dysfunction, is considered in Traditional Chinese Medicine to be due to stagnant Qi in that area. When using acupuncture, the inserted needles will break up this stagnation allowing Qi to move freely within the channels alleviating low back pain.
- Acute Cases Of Pain: the principle of treatment is to invigorate Qi and blood to remove stagnation and unblock the channels to stop pain. The main focus in acute cases is to use distal points with strong stimulation.
- Chronic Cases Of Pain: the principle of treatment is to expel any pathogens invading the body, invigorate the circulation of Qi and Blood and tonify any underlying deficiencies. Generally in Chronic cases points local to the area of pain and distal points would be used in conjunction with each other.