CT Acupuncture White Paper

The Biochemistry of Acupuncture

Introduction

The purpose of this white paper is to show that acupuncture point sites and meridians exist, connect to specific areas of the nervous system and brain, and through scientifically measurable biochemical interactions have curative benefits on human health conditions; including chronic pain management.

Acupuncture Point Sites and Meridians Exist

In 1976, Becker, et. al., funded by the NIH, designed a rolling electrode array to measure skin conductivity patterns around the site of acupuncture points. They discovered coordinated formations of electrical conductivity that are particular to acupuncture point sites (Figure 1).

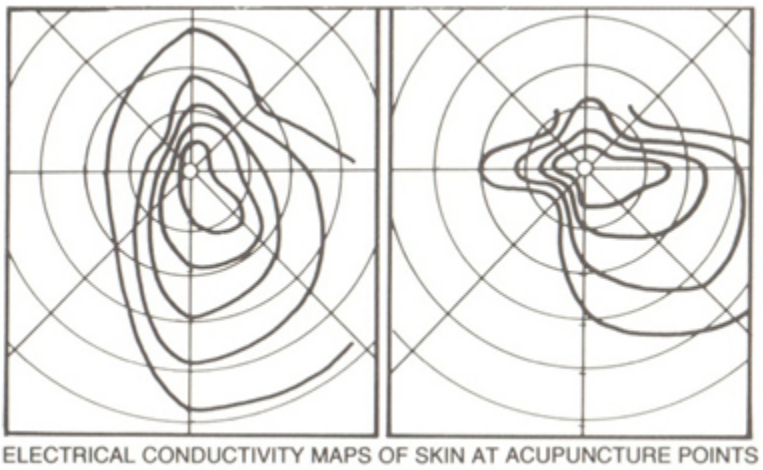


Figure 1
The electrical conductivity maps of the skin at two discrete acupuncture points. Becker, et. al. [1]

As seen above, the lines representing electrical differences compared to the surrounding skin indicate a lower electrical resistance, and therefore greater conductivity. It is this difference which creates an electrical potential that can be measured directly at the point site, and enables verification of its location, and thus, the existence of the acupuncture points.

Furthermore, in 2004, Jones, Bae, et. al., used high frequency ultrasound imaging techniques to empirically demonstrate the existence and location of acupuncture point sites as can be seen in their graph below (Figure 2).

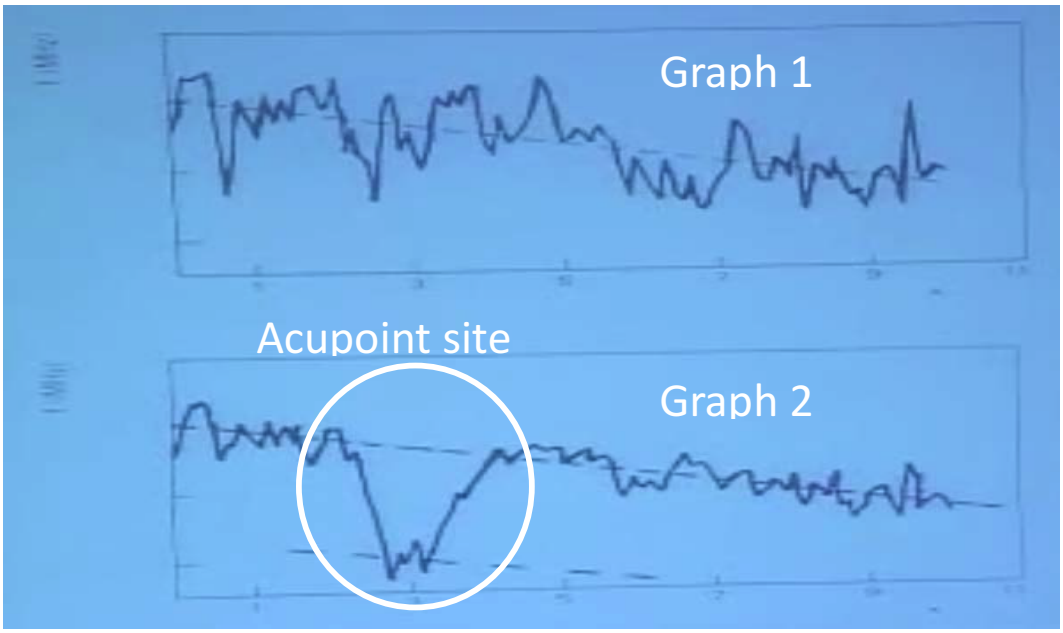


Figure 2
Graph 1 – Ultrasound of normal skin (non-acupoint)
Graph 2 – Ultrasound of acupoint
Jones, Bae, et. al. [2]

Over the course of their research, Jones and Bae discovered discrete structures of increased ultrasound attenuation (scattering or absorption of sound waves) at the location of acupuncture points. Since changes in electrical properties are almost always associated with changes in acoustical properties, the team surmised that acupuncture points represent regions of enhanced electrical conductivity, further supporting Becker's 1976 electrical conductivity mappings. Graph 1 shows attenuation in normal tissue not around an acupuncture point site. Graph 2 shows "highly distinguished" attenuation in an acupuncture point. Readings were done at a depth of 11mm.

In regards to meridians and their existence, Becker stated:

> *"Our reading also indicated that the meridians were conducting current, and its polarity, matching the input side of the two-way system, showed a flow into the central nervous system. Each point was positive compared to its environs, and each point site had a field surrounding it, with its own characteristic shape [1]."*

Becker, Robert, et. al. in 1976 and Jones, Bae, et. al. in 2004, are two of countless studies that have demonstrated the existence and characteristics of acupuncture points and meridians [1,2].

Acupuncture Sites Are Connected To The Brain

Point Site Physiological Response – Electrical Stimulation from Needling

In the most basic sense, a needle entering the skin stimulates the nervous system. This initial stimulation, as well as the body's normal physiological response, dictates the effects of the treatment on the patient. Nociception, or "pain sense" as defined by Dorland's Medical Dictionary, is the process through which this pain sense, or nerve stimulation, takes place.

As defined by the American Pain Society, the nociception process occurs in four steps:

1. **Transduction**: the conversion of the energy from a noxious thermal, mechanical, or chemical stimulus into electrical energy (nerve impulses) by sensory receptors called nociceptors.
2. **Transmission**: the transmission of these neural signals from the site of transduction (periphery) to the spinal cord and brain.
3. **Perception**: the appreciation of signals arriving in higher structures as pain.
4. **Modulation**: descending inhibitory and facilitory input from the brain that influences (modulates) nociceptive transmission at the level of the spinal cord [3].

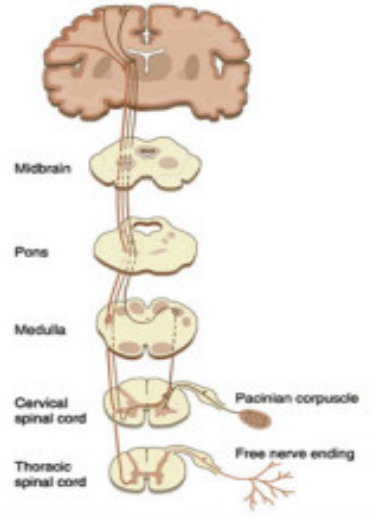
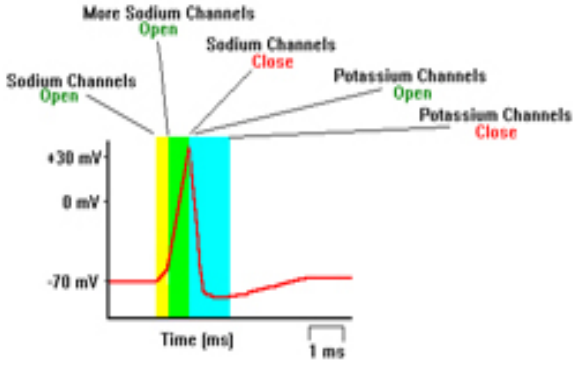


Figure 5. When nociceptors (free nerve endings) detect harmful stimuli, they relay pain messages through neurotransmitters along peripheral nerves to the spinal cord and brain.



The body can produce between 10 and 100 millivolts, this electrical voltage is created by the potassium and sodium ions being in a state of imbalance, namely between the interior and exterior of the cells [4].

This electricity is the median through which nociception takes place.

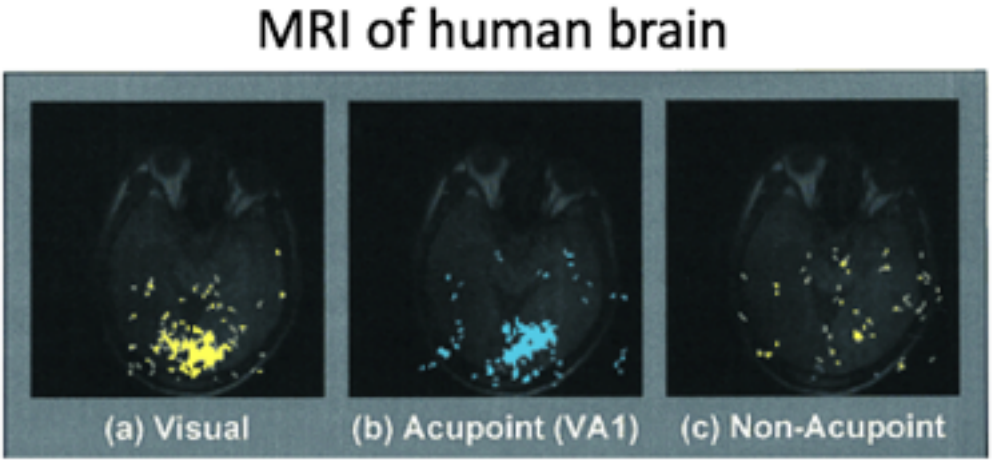
The reinforcing needling method initiates the process of transduction with the needle's mechanical stimulation being converted into the electrical nerve impulse energy.

More specifically, during needle movement within the skin, the local chemical change in the surrounding cell's potassium/sodium differentials is disturbed, and thus creates the electricity needed to initiate nerve stimulation. The stimulation then transfers to the skin

axons, and then to the “network of local ‘interneurons’ within the spinal cord. Some of these were ‘excitatory’ interneurons, which appeared to act as synaptic relay stations, between the nerves sending information from the skin and internal organs, and the neurons carrying information to the brain” [5]. Once the electrical stimulus is generated at the point site, it propagates through the neurological network to the brain, as well as being transferred through the conductive pathways that comprise the body’s acupuncture meridians [6].

Acupuncture Points Are Connected To Specific Areas Of The Brain

Cho, Chung, et. al.’s 2006 study utilizing MRI brain scan technologies empirically demonstrated that acupuncture points do activate specific regions of the brain (Figure 3) [7].



(a) – Patient sees blinking light, no acupoints are treated
(b) – Patient is blindfolded, acupoint connected to vision is treated
(c) – Patient is blindfolded, random skin point that is not connected to vision (a “sham point”) is treated

Cho, Chung, et. al. [7]

The Curative Nature of Acupuncture

Acupuncture is a mechanically induced electrical stimulation of a point site, which impacts the site’s electrical conductivity, biochemistry, and the functioning of the body’s electrically conductive pathways (meridians). This affects all major physiological systems such as the immune, the lymphatic, the tendo-muscular, the neurological, the endocrine, and the cardiovascular system. The appropriate stimulation of these meridians can be utilized to achieve desired physiological changes and curative benefits.

Methods of Needling

The various methods of needling within the discipline of manual acupuncture treatment can produce a range of results on the patient. The three main methods of manual needling (reinforcing, even, and reducing) produce different effects on the patient's physiology, and are therefore used to treat different symptoms.

The *reinforcing method* of needling consists of repetitive twisting or reinsertion of the needle, in short succession, to achieve a heightened response at the acupuncture point site. At present, there are two generally adopted methods of acupuncture analgesia: (1) twisting the needle, and (2) pulling and reinserting the needle. The needle may also be twisted, pulled, and reinserted simultaneously. The frequency of twisting is about 10 – 200 twists per minute; faster is better. The amplitude of the twist is generally 90-360 degrees, i.e. twisting one-fourth of a circle to twisting nearly a full circle. The amount of pulling and reinserting is generally within 10 mm; this gives the patient a medium-strength stimulation [8].

This method of needling produces local chemical physiological responses that can be leveraged to facilitate both direct and remote analgesic effects. The remote analgesic effects are made possible through manipulating the electrically conductive point site pathways, or meridians through mechanotransduction [9].

The manual manipulation of the needles gives the highest degree of control over the amount of stimulation the patient receives, and the method of manipulation may be adjusted by the acupuncturist to optimize the effectiveness of the analgesic effect. Furthermore, the hand manipulation allows for more accurate transfer of changing point-site characteristics, as well as patient awareness of the modulating stimulation [8].

The Biochemistry Behind Acupuncture

The Electrical Attraction Between Needle and Cellular Tissue

The field of mechanotransduction is the initial mechanical coupling which results from attractive forces between needle and tissue, such forces likely being surface tension and electrical attraction. Connective tissue is composed of cells embedded in extracellular matrix made of interwoven collagen and elastic fibers associated with glycoproteins and negatively charged proteoglycans. Electrical attraction may therefore occur between the metal needle and fixed tissue charges. Such attractive forces are likely to be relatively weak, but strong enough to cause initial winding of tissue around the rotating needle. This is made easier by the small diameter of the needle. Once some wrapping has occurred, frictional forces take over. The collagen and elastic fiber network is likely to have some initial laxity, allowing the initial wrapping to occur without having to overcome large tensile forces [*9*].

The biochemistry of the conductivity between the needle and the cell membrane

(The following is an excerpt from Hodgkin and Huxley):

Current can be carried through the membrane either by charging the membrane capacity or by movement of ions through the resistances in parallel with the capacity. The ionic current is divided into components carried by sodium and potassium ions (INa and IK), and a small "leakage current" (Ii) made up by chloride and other ions. Each component of the ionic current is determined by a driving force which may conveniently be measured as an electrical potential difference and a permeability coefficient which has the dimensions of a conductance. Thus the sodium current (IN,) is equal to the sodium conductance (gNa) multiplied by the difference between the membrane potential (E) and the equilibrium potential for the sodium ion (ENa). Similar equations apply to I X and I I and are collected on p. 30 (p. 505 of original paper). Our experiments suggest that gNa and g~: are functions of time and membrane potential, but that ENa, EK, El, C u and 01 may be taken as constant. The influence of membrane potential on permeability can be summarized by stating: first, that depolarization causes a transient increase in sodium conductance and a slower but maintained increase in potassium conductance; secondly, that these changes are graded and that they can be reversed by repolarizing the membrane [4].

The Effect of Needles on Various Cell Populations Surrounding the Needle

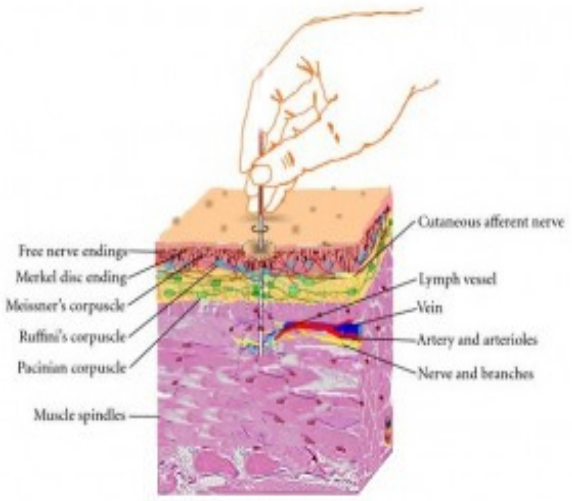
(The following is an excerpt from Langevin and Yandow):

The importance of establishing a mechanical coupling between needle and tissue is that mechanical signals:

(1) are increasingly recognized as important mediators of information at the cellular level (Giancotti and Ruoslahti, 1999),
(2) can be transduced into bioelectrical and/or biochemical signals (Banes et al., 1995; Lai et al., 2000), and
(3) can lead to downstream effects, including cellular actin polymerization, signaling pathway activation, changes in gene expression, protein synthesis, and extracellular matrix modification (Chicurel et al., 1998; Chiquet, 1999).

Changes in extracellular matrix composition, in turn, can modulate the transduction of future mechanical signals to and within cells (Brand, 1997). Recent evidence suggests that both tissue stiffness and stress-induced electrical potentials are affected by connective tissue matrix composition (Bonassar et al., 1996) and that changes in matrix composition in response to mechanical stress may be an important form of communication between

different cell types (Swartz et al., 2001). Acupuncture needle manipulation, thus, may cause lasting modification of the extracellular matrix surrounding the needle, which may in turn influence the various cell populations sharing this connective tissue matrix (e.g., fibroblasts, sensory afferents, immune and vascular cells) [6].



Curative Benefits of Acupuncture

(The following is an excerpt from the NIH 1997 Consensus Statement):

"Many studies in animals and humans have demonstrated that acupuncture can cause multiple biological responses. These responses can occur locally, i.e., at or close to the site of application, or at a distance, mediated mainly by sensory neurons to many structures within the central nervous system. This can lead to activation of pathways affecting various physiological systems in the brain as well as in the periphery. A focus of attention has been the role of endogenous opioids in acupuncture analgesia. Considerable evidence supports the claim that opioid peptides are released during acupuncture and that the analgesic effects of acupuncture are at least partially explained by their actions. That opioid antagonists such as naloxone reverse the analgesic effects of acupuncture further strengthens this hypothesis. Stimulation by acupuncture may also activate the hypothalamus and the pituitary gland, resulting in a broad spectrum of systemic effects. Alteration in the secretion of neurotransmitters and neurohormones and changes in the regulation of blood flow, both centrally and peripherally, have been documented. There is also evidence of alterations in immune functions produced by acupuncture. Which of these and other physiological changes mediate clinical effects is at present unclear" [10].

The National Pharmaceutical Council partnered with the Joint Commission on Accreditation of Healthcare Organizations had the following to say about the benefits of acupuncture in their monograph published in December of 2001:

> "*Acupuncture may cause the secretion of endorphins and interfere with transmission of nociceptive information to relieve pain for treatment of postoperative, radiculopathy, chronic LBP, fibromyalgia*" [11].

Fang, Fang, et. al. have quantified mechanisms by which acupuncture exerts anti-inflammatory and pain reducing medical benefits. A new laboratory experiment proves that true electroacupuncture and not sham acupuncture causes biological reactions responsible for eliminating pain and inflammation. Researchers discovered that acupuncture inhibits ERK1/2-COX-2 pathway activation and ERK1/2-CREB-NK-1 pathway activation. Let's take a look at why these biochemical pathways are so vitally important to pain management.

COX-2 is an enzyme responsible for pain and inflammation. NK-1 is also an integral mediator of pain and inflammation in the central nervous system. Both NK-1 and COX-2 regulate sensitivity to pain. ERK1/2 is a signaling protein that regulates expression of both NK-1 and COX-2. In this study, electroacupuncture has been proven to regulate expression of both the ERK1/2-COX-2 and ERK1/2-CREB-NK-1 pathways thereby causing reductions in both pain and inflammation.

Application of acupuncture needles to acupuncture points effectively regulated the pain pathways of NK-1 and COX-2. Superficial sham acupuncture was also tested. Superficial sham acupuncture did not significantly regulate changes in the NK-1 and COX-2 pathways whereas the true acupuncture repeatedly and consistently regulated the pathways.

This research goes well beyond clinical issues of whether or not acupuncture stops pain. The research team successfully measured exact biological responses to acupuncture and the consequent reductions in pain and inflammation by use of specific acupuncture points. The researchers have identified exact biological pathways responsible for pain and inflammation reduction that are regulated by the application of acupuncture [12].

The above excerpt is from: http://www.healthcmi.com/Acupuncture-Continuing-Education-News/1352-acupuncture-anti-inflammatory-effect-revealed

Goldman, Chen, et. al. published a study in Nature Neuroscience in July of 2010 that highlights acupunctures ability to release adenosine.

A scientist of this study, Maiken Nedergaard, said "I believe we've found the main mechanism by which acupuncture relieves pain. Adenosine is a very potent anti-inflammatory compound and most chronic pain is caused by inflammation…the twisting of the needles seems to cause enough damage to make cells release adenosine. The chemical is then picked up by adenosine receptors on nearby nerves, which react by damping down pain. Further tests revealed that levels of adenosine surged 24-fold in the tissues around the acupuncture needles during and immediately after each session." Nedergaard believes that most of these points are along major nerve tracks, and as such, are parts of the body that have plenty of adenosine receptors [13, 14].

Conclusion

Scientific research conducted over the past fifty years, as outlined in this white paper, have verified conclusively that acupuncture point sites exist, respond to needling, and, as a result, generate curative benefits to all major systems of the human body, including tissue repair and chronic pain reduction.

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