Treatment Mechanisms of Acupuncture

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It is important to understand what exactly is being done and what is occurring in an affected persons body when approaching brain injuries and associated symptoms with Chinese medicine. In this chapter mechanisms of action will be explored along with risks and cautions associated with these treatment approaches. Emphasis will be placed on modern research into physiological mechanisms and responses. The reason for this being twofold: firstly, classical descriptions of mechanisms are easily accessible in many books on Chinese medicine; secondly, it is important for a practitioner to understand these physiological responses when communicating with other healthcare professionals unfamiliar with Chinese medical theory/terminology in explaining what care is being provided to a patient. Often those recovering from a brain injury are being treated by a wide group of professionals that may include their primary care, neurologist, nurses, neuropsychiatrists, speech-language pathologist, occupational therapist, neuro-optometrist, physical therapist, etc.

This is not to dismiss or downplay classical descriptions and actions. In discussing treatment and symptoms later in this text, pattern differentiation, pulses and tongue diagnostics, and treatment principles are essential to treatment and laid out in accordance with these principles. It is still very important for a practitioner to understand how an individuals organ systems, Qi, Blood, Shen, Fluids, etc. are being affected. These are foundational components of Chinese medicine and arguably the reason it can work so well to address a wide range of symptoms simultaneously and work to reregulate the body system as a whole. However, the onus lies on the Chinese medicine practitioner to be able to bridge any communication gaps and effectively convey what they are doing. This involves using terminology biomedical practitioners are familiar with in order to work together in providing the best care and garner the most benefit for the affected individual.

A significant advantage to the use of Chinese medical treatment approaches is their relative safety and low risk of negative ("side") effects.With acupuncture, the primary risks are minimal and infrequent – mild bruising, numbness and tingling may occur at the insertion sight, hematomas are rare but may also occur. An individual may begin to feel dizzy or light headed during or for a short duration immediately following a treatment. If performed improperly there is a risk of pneumothorax or other organ puncture, nerve damage or infection due to non-sterile conditions. So long as the practitioner has done adequate and proper training the likelihood of these occurring are very small. For the patient seeking treatment however, this is an important reason to make sure their provider has completed adequate training in a full Chinese medical curriculum rather than truncated programs aimed at medical professionals which only teach basic approaches to needling such as exclusively dry needling.

Acupuncture Mechanisms

Local Effects – Pain reduction, anti-inflammatory effects, initiation of the healing response

The insertion of an acupuncture needle into the skin, in essence, creates a type of microinjury. While this is not enough to cause damage to the area, it is a breaching of the epidermis, which alerts the body to respond in a number of various ways. Upon needle insertion, an "axon reflex" occurs throughout the meshwork of surrounding nerves. This stimulates local muscle fibers including A-delta (also A-gamma and sometimes A-beta) and II and III muscle fibers. Through this there is a triggering of calcitonin gene-related peptide (CGRP), a powerful vasodilator, which opens local capillaries and releases various neuropeptides - prostaglandins, red and white blood cells, glutamate, excitatory amino acids, substance P, and serotonin - from local mast cells. This release downregulates the pain cascade, works to reduce inflammation in the area, initiates the healing response of tissue, fights infections and increases local circulation. The local tissue cells including arterioles, nerve terminals and mast cells can stimulate vascular nerve fibers which triggers nitric oxide (NO) production. Other tissues that may be involved include smooth muscle cells and endothelium cells as a result of NO production which further increases the blood flow and local circulation.[5]

Acupuncture is thought to have it's analgesic effect through the release of local endorphin and of the neurotransmitter encephalin, which inhibits the nociceptive pathway as a means of " hyperstimulation". A 2010 study demonstrated acupuncture to effectively trigger a local increase in the extracellular concentration of ATP, ADP, AMP and adenosine[6] a key component in energy exchange during metabolic processes. By increasing ATP the body is better able to create not only a well-recognized analgesic effect but also contribute more usable energy and innate healing potential within the body.

Acupuncture likely has it's effect of regulating homeostatic states or the somatic autonomic reflex of both the sympathetic and parasympathetic branches of the autonomic nervous system to reinstate a balanced dynamic between the two. This has been likened to a scientific basis for the concept of the balance between Yin and Yang found within Chinese medical theory. When an acupuncture needle is inserted into the desired acupoint, there are several different peripheral afferent fibers that can be found in the area of insertion. These are the true A-delta, A-beta, and A-gamma fibers in the skin, C-fibers and II and III muscle fibers that create the neural network underneath the surface. Surface oxygen levels have also been demonstrated to be in higher concentrations at locations of traditional acupuncture points.[7]

Different sensations associated with the phenomena known as "Da Qi" or "Attaining the Qi" in which the patient feels an achy or heavy sensation after needling are directly associated with different neural tracts, with different terminal endings producing different outcomes.

Classical De Qi Sensation Associated Nerve Fiber

Soreness	C-fiber
Numbness	A-gamma
Vibration	A-beta
Heaviness	A-delta, III muscle fiber
Achy	IV muscle fiber
Cold	A-delta
Hot	C-fiber, IV muscle fiber
Pinprick	A-delta

Neuromuscular Effects
Muscle motor points, trigger points, and classical Ashi points can all be used to stimulate the neural compartments of the needles muscle(s). Here the primary afferent nociceptive system which have terminal endings throughout the limbic regions of the brain become stimulated. This may help to "reset" the muscle to a state of relaxation. Gunn[8] uses the term intramuscular stimulation rather than acupuncture when referring to the needling process in which he describes two essential elements of myofascial pain - muscle shortening and neuropathy. The goal of this intramuscular treatment is to release muscle shortening and promote healing. In this sense it has been argued that acupuncture may be considered a variation of cortisone injection within myofascial trigger points. In the case of neuralgias and neuropathies acupuncture stimulation may have a local effect on restoring the diseased nerve by improving the local blood flow and accelerating the metabolism.

Spinal Exiting Nerve Muscle Innervation	
C1	None
C2	Longus colli, sternocleidmastoid (SCM), rectus capitis
C3	Trapezius, splenius capitis
C4	Trapezius, levator scapulae
C5	Supraspinatus, infraspinatus, deltoid, biceps
C6	Biceps, supinator, wrist extensors
C7	Triceps, wrist flexors
C8	Ulnar deviations, thumb extensors, thumb adductors
T1-T2	Minor innervations of intrinsic muscles of the hand, elbow, forearm, shoulder, scapulae, upper back, and neck
T3-T12	Innervations of the upper torso, as well as posterior and anterior aspects
L1	None
L2	Psoas, hip adductors
L3	Psoas, quadriceps, thigh atrophy
L4	Tibialis anterior, extensor hallucis
L5	Extensor hallucis, peroneals, gluteus medius, dorsiflexors, hamstrings and calf atrophy
S1	Calf and hamstring, wasting of gluteals, peroneals, plantar flexors
S2	Calf and hamstring, wasting of gluteals, plantar flexors
S3	None
S4	Bladder-rectum

Spinal Segmental Effects – Acupuncture Analgesia and the "Gate Theory"
All primary afferent nociceptive fibers enter the spinal column via the dorsal horn. At the level of the dorsal horn neurotransmitters, including serotonin and norepinephrnie are released which have a general depressive effect on dorsal horn activity. This modulates and reducing the signaling of pain. This also inhibits visceral dysfunctional autonomic reflexes and relaxes the smooth muscle of the associated segment. This relaxation inherently releases unnecessary stress on the organ, increases circulation, and aids in enhancing the organ's function. Small intermediate cells are also stimulated with enkephalin being released to block the transmission of pain in the substantia gelatinosa. Somatic and visceral afferent nerve fibers converge at the dorsal horn, then cross over and travel up the same single spinothalamic tract, passing through the reticular formation into the intralaminar nuceleus of the thalamus. Tertiary neurons project to diverse areas of the intermediate and higher brain including the limbic cortex, insular cortex, and prefrontal cortex.

Peripheral Nociceptors and their transmitted sensations			
Sensory Fiber	**Skin**	**Muscle**	**Sensation**
Large myelinated	None	I	None
Large myelinated	A-beta	II	Light touch, pressure, vibration
Medium myelinated	A-gamma	II	Numbness
Small myelinated	A-delta	III	Deep pressure, heaviness in muscle, pinprick in skin, cold
Small myelinated	C	IV	Small myelinated

Acupuncture is theorized to travel along a second channel which terminates the lamina in the spinal cord. Secondary neurons then terminate in various nuclei of the thalamus including the ventroposteriolateral nucleus, dorsomedial nucleus, intralaminar nuclei and the centromedian nucleus. Major pathways followed include the spinothalamic tract, spinoretinar tract, and the spinomesencephalic tract which all project to the various cortical areas of the higher brain such as the sensory cortices, limbic and insular cortices, and prefrontal cortex. More importantly, while en route to the thalamus, collaterals of these tracts branch out to terminate at various levels of the brainstem and hypothalamus. At the level of the brainstem, further collaterals branch to the periaqueductal grey and the nucleus locus ceruleus to the nucleus raphe magnus and the nucleus reticularis paragigantocellularis. Monoaminergic neurons here work to inhibit ascending pain signals at the lamina. At the level of the hypothalamus there are two ascending tracts acting on the hypothalamic nuclei (the arcuate nucleus) as well as other hypothalamic cells that secrete beta-endorphin. This has been postulated to account for some of the the mechanism of "distal acupuncture" procedures.

Fascial Structure Effects

It has been observed independently by various researchers that the fascia (connective tissue) planes throughout the body form a network that resembles the meridians traditionally described in Chinese medicine. Langevin and Langevin and Yandow[9] examined the locations of acupuncture points and meridians in gross anatomical sections of the arm of cadavers and found significant correspondences between the locations of acupuncture points and intermuscular or intramuscular connective tissue plane junctions. Yuan et al.[10] Constructed a virtual human body model, digitally constructing a three-dimensional network of fascial connective tissue areas that resemble the network of meridians and acupuncture points. They hypothesized this network to be a hitherto undiscovered auto-surveillance system in the body that may lead to further explanations of the basic mechanism of acupuncture action. Meyers has also explored this correlation in the 3rd edition of his well received book Anatomy Trains.[11]

The nerves within these fascial planes carry signals throughout. It has been suggested that a mechanical signal propagating along these channels may be responsible for some of the therapeutic effects of acupuncture. In essence, when the inserted acupuncture needle impacts connective tissue, it causes the "needle grasp" phenomenon in which the fascia responds, "wraps" around the needle in response to the stimulation/contact with it. This results in a perturbation of mechanical force within muscle tissue which propagates to neighboring muscles. This mechanical signal evokes a response in connective tissue downstream resulting in adaptive changes in fascia or anti-inflammatory response. Other signals such as the flow of paracrine-signaling molecules[12] and piezoelectric signal conduction throughout the liquid crystalline structure[13, 14] of the fascial network have also been proposed.

Endogenous Opioid Circuit (EOC) Effects

The hypothalamus is one of the largest manufacturers of beta-endorphins, our endogenous poly-opioids which reduce pain. As noted above, signals from needle insertion make their way to the hypothalamus. These opiod substances immediately travel to the periaqueductal gray to depress all pain signaling from the periphery. Serotonin is also released in the brainstem and stimulates further serotonin releases, along with norepinephrine within the dorsal horn. Both of these strongly inhibit pain signaling in both directions. Opioid release has been studied extensively in treatment of addiction disorders utilizing electro-acupuncture. Specific millicurrent frequencies have shown to elicit greater releases of particular endorphins.[15]

Endorphin	Receptor	Frequency/amperage	Location
Beta-endorphins	Mu	2-4 Hz millicurrent	Midbrain, periaqueductal gray, pituitary
Enkephalins	Delta	2-4 Hz millicurrent	Dorsal horn of the spine
Dynorphins	Kappa	50-100 Hz millicurrent	Brainstem/spine
Orphanin	Mu	2-15 Hz millicurrent	Widespread
NK Cells	Immune	4 Hz millicurrent	Widespread
5HTP	5HTPr	20-50 Hz millicurrent	Hypothalamus
Oxytocin	OXTR	2-15/30 Hz millicurrent	CNS

Dopamine	D1	2, 15-30 Hz	Prefrontal
NOS	Epithelium	2, 15-30 Hz millicurrent	Widespread

Central Nervous System and Disease Treatment Effects
Endocrinological effects occur through stimulation of the hypothalamus which influence the anterior pituitary and ultimately the adrenals, having an impact on the entire hypothalamic-pituitary axis (HPA). In this way endocrine regulation can occur throughout the HPA via acupuncture stimulus arriving at the higher brain centers by passing through the limbic system. This induces the higher brain to initiate the needed commands (possibly from the prefrontal cortex) which passes to the hypothalamus (some through limbic structures) for the final execution of endocrine, autonomic, and other homeostasic tasks. This may include the sensory cortex-multimodal association-amygdala-prefrontal cortex-amygdala-hypothalamus circuitry. ACTH and beta-endorphins are shown to be released, as has 5-hydroxytryptophan (5-HTP).

Immunological influences take place through generalized autonomic changes in the lymphoreticular system of the marrow and spleen. Beta-endorphins are released into the blood stream and there have been demonstrated increases in natural killer cells and changes in gamma- interferon levels.

Primo Vascular Effects
Bong-ham Kim, a Korean surgeon, reported observing a novel extensive microscopic duct system distributed throughout the body that may correspond to the meridians. This structure was initially named after its founder as Bonghan ducts, and has since been referred to as the primo vascular system. It has been extensively studied and recently reviewed by others[16, 17]. Observation of the primo vascular system requires special staining. The primo vascular system forms a new circulatory system in the body apart from the blood and lymphatic systems, carrying a liquid that contains, among other substances, hormones, amino acids, and free nucleotides. While holding vast potential in reconciling traditional descriptions of the meridian system, significantly more research is necessary to substantiate the primo vascular system.

Cortical Region Activation and Deactivation Effects
Results of functional magnetic resonance imaging studies have shown that stimulation at a traditional acupuncture point produces a distinct response in specific areas of the brain. This was distinctly different from stimulation at other points on the same spinal segment, and also different from the stimulation at neighboring points on the same meridian.

Neurophysiological studies have also demonstrated point indication specificity. In a meta-analysis of fMRI studies done in which they mapped areas of the brain influenced by acupuncture it concluded “Two third (64%) of 25 studies showed that acupuncture treatments were associated with more activation, mainly in the somatosensory areas, motor areas, basal ganglia, cerebellum, limbic system and higher cognitive areas (e.g. prefrontal cortex). Three studies also showed more deactivation in the limbic system in response to acupuncture.”[18] The limbic system is associated with most of the body's emotional processing and acupuncture's regulatory effect on this region may explain why it can be helpful in mental-emotional concerns following a brain injury such as hypervigilance and anxiety. An example of these brain region activations being point specific was shown in a study finding the point KI-3, located posterior to the medial malleolus, was shown to enhance connectivity between the superior temporal gyrus and postcentral gyrus, while GB-40, located anterior to the lateral malleolus, enhanced connectivity between the superior temporal gyrus and anterior insula[19]. These studies are limited however, and further research seems essential to create a thorough map of these influences.

A recent study also demonstrated acupuncture's ability to increase glucose metabolism and improve cerebral blood flow in the brain areas related to cognition and memory by increasing the expression of glucose transporter 1 (GLUT1) which is involved in cellular respiration, regulation of glucose levels and vitamin C uptake. The laboratory results indicated that upregulation of GLUT1 by acupuncture alleviates ischemia and anoxia related cognitive impairment.[20]

The Role of Acupuncture in Neuroplasticity and Neurogenesis
Acupuncture has been shown to have a direct influence on neuroplasticity and neurogenesis within the brain. This is the body's ability to create new neural connections and even generate new nerve cells. Until relatively recently it was thought that any neuronal loss due to injury or aging in adults was permanent. It is now known that neural stem cells are still active in certain regions of the adult brain, namely the dentate gyrus of the hippocampus and the subventricular zones. During neurogenesis stem cells are capable of developing into all major types of neural cells: Neurons, astrocytes, and oligodendrocytes. While this ability is now known to exist in adults, it is at a significantly slower rate than in children.

A recent study showed that acupuncture induced cell and neuroblast differentiation in the hippocampus, providing evidence that it may be useful as a neurogenesis-stimulating therapy. There has also been a demonstrated effect on cAMP signaling, a transcription factor important in proliferation, differentiation, and survival of neural precursor cells. The regulation of neurotrophic factor which supports the growth, differentiation and survival of neurons has also been demonstrated. The following acupuncture points have been shown to influence neuronal proliferation:

ST-36	CV-17	GV-16
GV-20	CV-12	GV-8
PC-6	CV-6	LI-11
HT-7	SP-10	TW-5

One of the most studied and clinically used points among these is ST-36, located on the superior tibialis anterior muscle. Simulation of ST-36 is used for a wide range of conditions affecting the digestive, cardiovascular system, immune and nervous systems, as well as having been widely used for brain disorders. In addition to the above listed actions, ST-36 was shown to upregulate the expression of neuropeptide Y, which promotes the proliferation of neuronal precursor cells and appeared to lessen the neuropathologic effects of stress in rats.[21]

One study examined the role of acupuncture on brain tissue after cerebral ischemia (loss of blood supply to an area of the brain). This study showed a greater proliferation and differentiation of neural stem cells in the brain and an ability to increase blood flow and decrease cell death. Two points on the head, GV-20 and GV-26, regulated cells which "increase the release of nerve growth factors (NGFs) to make nerve cells survive and axons grow, synthesize neurotransmitters, (and) metabolize toxic substances." Similarly the use of GV-20 and GV-14 was shown to increase neural repair after ischemic damage. These points also activate bodily self-protection and reduction of nerve cell death in and near the site of injury. Needling points along the midline of the torso, traditionally referred to as the conception vessel, were also shown to increase growth factors - basic fibroblast growth factor, epidermal growth factor and NGF messenger RNA - in the subventricular zones and dentate gyrus.[22]

Scalp Acupuncture

The majority of acupuncture points are located on the trunk and limbs. However, the points along the surface of the head play an important role in addressing sequelae of brain injury with acupuncture. GV-20, located at the top of the head, has been shown to increase cerebral blood flow velocity of the middle cerebral artery and anterior cerebral artery without significant changes in blood pressure and pulse rate.[23] Specific scalp acupuncture systems and protocols are a relatively new, yet promising, method to treating brain injury and its related symptoms[24-26]. Several scalp "systems" exist, including needling over the sensory-motor humunculi along the parietal and frontal lobes to increase both movement and sensory feedback. Often immediate benefit can be found from this method. A system known as "Yamamoto New Scalp Acupuncture" has a system of reflex points located over the temporal region that have influence on the functional integrity of the internal organ systems as well as a set of points along the anterior scalp which are noted to correlate to cranial nerve pathology.[27] Future research may be aimed at scalp acupuncture and its effects on the release of neurotransmitters and neurohormones.

Resources

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