



## REVIEW ARTICLE

# Acupuncture in Modern Society

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### Abstract

For at least 2,500 years, acupuncture has been an integral part of traditional Chinese medicine. However, recently as more people in western countries are diagnosed with chronic disease poorly treated with modern medical therapies, many are turning to acupuncture and other forms of alternative medical treatments. Based on the theory of harmonious flowing *qi* being the basis of good health, acupuncture focuses on restoring *qi* by manipulation of the complementary and opposing elements of *yin* and *yang*. However, in the modern medical community we struggle to with the concept of *qi*, given a lack of anatomic and histological evidence supporting its existence. However, with the surge in public interest in acupuncture, the scientific community begun heavy investigation of acupuncture's efficacy, as well as the physiologic basis behind it. Thus far, evidence supports the use of acupuncture in post-operative nausea and vomiting, postoperative dental pain, chronic pain conditions such as lower back pain, and possibly also such psychologic conditions as addiction. It is possible that by affecting afferent nerve signaling, acupuncture may influence the release of endogenous opioids to promote pain relief. This effect may be augmented by release of ACTH and cortisol, as well as through down-regulation of signaling through pain fibers. When treating patients who may utilize alternative forms of medicine, it is important that medical practitioners be educated in regards to the basic fundamental beliefs behind acupuncture, as well as the scientific evidence supporting its use and revealing its efficacy. The purpose of this review is to give western trained physicians exposure to history, basic knowledge and its clinical applications of acupuncture to accommodate accelerating interests in acupuncture in modern society.

## 1. Introduction

Although acupuncture is a traditional form of healing used for over 2,500 years in China, its widespread use is a relatively new phenomenon in the United States and other western countries [1]. Acupuncture is a technique that relies upon placement of hair-thin needles along specified acupuncture points,

its name originating from the Latin words *acus* meaning “needle” and *pungere* meaning “prick”. After placement, needles are then manipulated via manual needling, electrical stimulation (electroacupuncture), heat (moxibustion), pressure (acupressure) or laser energy in order to realign the body's “vital energies”. Although acupuncture as it is recognized today is believed to have originated in

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China, forms of the art can be found in other regions, including Japan, Tibet, and Korea. Most recently, acupuncture has become part of the mainstream movement of alternative medicine practiced in the United States, and interest in its use has sparked numerous clinical trials and academic studies into the efficacy and mechanism of acupuncture.

Acupuncture was relatively unknown in the United States prior to the 1950s, and one was hard pressed to find a practitioner of traditional Chinese Medicine who could perform the ancient technique. However, this changed rapidly when President Nixon opened the door to Chinese medical practices with his visit to China in 1972. Since then, interest in complementary forms of therapy has escalated as more and more Americans are diagnosed with chronic illness. With this surge in interest came attention from the scientific community, as well as the political front. In 1992, US Congress officially recognized complimentary medical forms by establishing the Office of Alternative Medicine [2], and in 1997 the National Institutes of Health published a national consensus on acupuncture, citing level 1 evidence of efficacy for using acupuncture both in the treatment of nausea and vomiting (postoperative and chemotherapy-related), and in the treatment of post-surgical pain [3]. In 1998, acupuncture became the most popular complementary and alternative medicine modality with over 7,200 practitioners located in the US, and this number is projected to increase by approximately 88% over the next 15 years [2].

Although currently one million Americans receive acupuncture treatments annually, clinical research continues to question the efficacy of acupuncture. Though evidence is strong for nausea, vomiting, dental pain, and lower back pain, research into the use of acupuncture for other ailments such as anxiety, neck pain, and headaches often reveal neutral or mixed results. Despite its extensive use in the treatment of chronic pain syndromes, studies have not been able to demonstrate that acupuncture is more useful than placebo in patients with chronic pain disorders [4]. However, investigation into the biological mechanisms behind acupuncture reveals possible modulation of normal pain responses in humans, suggesting that acupuncture-induced pain relief may have a biological basis. And although there is no anatomical or histological evidence supporting the existence of specific acupuncture points, studies have been able to display efficacy of acupuncture over sham acupuncture treatments at non-acupuncture sites. Regardless of scientific evidence, more and more Americans are turning to acupuncture as a form of medical treatment when conventional treatments fail, and the US health care professional must be prepared to discuss the use of such alternative treatments with their patients.

## 2. History of Acupuncture

Although accounts of acupuncture's use in China date back over 2,500 years, and closely resemble modern acupuncture practices utilized today, new evidence has surfaced that suggests that forms of acupuncture in treating ailments may have been in use some 5,000 years ago on another continent [5,6]. In examining the mummy of the Tyrolian Iceman, Dorfer et al (1999) noted that several tattoos localized along the back and legs did not appear to be decorative in nature, and interestingly are located within striking proximity of Chinese acupuncture points. The group's study calculated that over nine of the Iceman's tattoos are on or within 6 mm of an acupuncture point, which they claim suggests possible needling and tattooing as a form of medicinal care, or prehistoric acupuncture. If this is to be believed, a medical treatment similar to acupuncture was being utilized approximately 2,500 years before it first appeared in China.

The arrival of acupuncture practices in China was ushered in by a generation of more human-centered beliefs such as Taoism around 300 BC, which replaced older supranatural ideals and promoted a departure from medicinal practices focusing on illness being caused by external demons and evils [5]. Whether the origin of Chinese acupuncture is rooted in the tattooing used by ancient European civilizations is unknown, but first Chinese accounts of healing by sites similar to acupuncture points used today involved application of heat, or blood letting along pre-determined areas of the body [5]. Regardless of its original form and origin, acupuncture as we know it today was formally recognized for the first time in the first Chinese medical text known as *Inner Classic of the Yellow Emperor*, or *Neijing*, where after it became a commonly used modality in Chinese medical practice [5].

## 3. Traditional Theory Behind Acupuncture

Central to historical teachings on acupuncture is the theory of *de qi*, which describes the connection and interplay between the acupuncture needles and the *qi* energy of the body. *Qi* is an untranslatable word that in essence signifies the potential to transform from one state to another state and each state's interconnectedness, but is most commonly described as the body's "vital energy". *Qi* is obtained from three different sources throughout life: from air (air *qi*), from food (grain *qi*), and via inheritance from one's parents (original *qi*) [1]. After *qi* is obtained, it is believed to flow throughout the body from deep organs to the superficial skin by means

of interconnecting meridians, with acupuncture points serving as major confluences of these meridians [1,5].

The flow of *qi* itself is determined by the interplay of complementary and contradicting forces known in traditional Chinese practices as *yin* and *yang*. *Yang* is understood to be related to activity, strength, daylight, and masculinity, while *yin* is associated with flexibility, receptivity, rain, stillness, and femininity [1,5]. In good health, *yin* and *yang* are in balance with one another, and *qi* flows throughout the body harmoniously. Poor health, on the contrary, is blamed on overabundant, absent, or blocked *qi* from an unbalanced interplay between *yin* and *yang* [5]. Pain, for example, is believed to indicate blockage of *qi* flow.

By understanding the theory of *qi*, it appears then that *de qi* is the process by which acupuncture and needling adjusts the individual's *yin* and *yang* based on the acupuncturist's assessment of the patient's own personal "climate" or state of being. Balancing of *yin* and *yang* forces thus allows for awakening and harmonizing of the body's *qi*. *De qi* first appears in Chinese literature in 305–204 BC in the *Neijing* text [5]. As described by *Neijing*,

"When the acupuncturist needles the patient, the first needle insertion can dispel the *yang* evil, the second needle insertion can dispel the *yin* evil, and the third needle insertion can draw the grain *qi*".

The process of drawing the *qi* with needles is experienced by the patient and acupuncturist as *de qi*. For the acupuncturist, the sensation of *de qi* is described as heaviness in the needle, as though the needle is being drawn to a magnet [1,7]. The patient experiences *de qi* as a soreness or numbness at the needle site itself [1,7]. According to traditional teaching, acupuncture is successful only with the experience of *de qi*, which suggests correct localization of the acupuncture point, and of *qi* arrival.

Despite the comfort that most Americans have with concepts of *qi* and acupuncture, aligning the notion of *qi* flowing through meridians dictated by the balance between *yin* and *yang* with contemporary scientific knowledge of human anatomy and histology poses a problem. Furthermore, acupuncture's reliance on human sensory perception (*de qi* sensation), and complete lack of quantitative measurement or confirmatory testing makes it difficult for modern practitioners to accept. Although the use of specific acupuncture points appears more effective than sham acupuncture practices, the NIH consensus summarizes it well when it states "despite considerable efforts to understand the anatomy and physiology of acupuncture points, the definition and

characterization of these points remains controversial" [3,8,9]. Though the foundations of acupuncture remain difficult to reconcile with the scientific community and the investigative process, it continues to play an important role in patient care.

#### 4. Acupuncture in Clinical Practice

The ability of acupuncture to influence pain is one of the most widely used indications cited by acupuncture patients. In 1998, the NIH released a consensus statement regarding the use of acupuncture, and indicated that acupuncture appears effective in certain conditions, namely postoperative and chemotherapy-related nausea and vomiting, as well as postoperative dental pain [3]. Although its use in other conditions, such as lower back pain, osteoarthritis, fibromyalgia, headache, smoking cessation, and depression is common, few studies have been completed examining efficacy, and equivocal results obtained from these studies may in part be secondary to poor design, small sample size, and inadequate controls. For example, the use of sham acupuncture at non-acupoints may serve as a questionable control, given that insertion of a needle in any location may still bring about a biological response not anticipated by the researcher. Still studies exist which display that acupuncture, in the correct patient and under the correct conditions, may serve a role in more general forms of pain.

Several well-designed studies have demonstrated the degree to which the pain threshold in acupuncture patients is altered. In 2002, Lin et al measured the effect of pre-operative acupuncture on individuals receiving abdominal surgery by measuring total opioids required by a PCA. The group measured a 61% decrease in requirements with high-frequency electroacupuncture versus a 21% decrease in the sham acupuncture group [10]. A randomized, sham-controlled study completed by Chen et al (1998) displayed similar results in pain control [8]. Women undergoing hysterectomy or myomectomy were randomized to receive either: (1) sham stimulation at *Zusanli* acupuncture points with no current applied, (2) non-acupoint stimulation of the shoulders, (3) non-acupoint stimulation along the incision dermatome, or (4) true electroacupuncture stimulation at *Zusanli* points. Effectiveness was measured using dosage and demand of a hydromorphone PCA. Results displayed significant reduction in dose and demand in both groups 3 and 4 compared to groups 1 and 2, with the incidence of postoperative nausea and vomiting also being significantly reduced.

In cases of specific forms of pain, perhaps one of the most common indications for acupuncture cited by American adults is lower back pain, either

acute or chronic. In 2005, Manheimer et al conducted a review of 22 randomized, sham-controlled trials that evaluated lower back pain after acupuncture using well-validated scales and functional measures [11]. In the case of chronic lower back pain, the group found that true acupuncture was significantly more effective than both sham acupuncture and no treatment in relieving pain, although it was significantly less beneficial than spinal manipulation [11]. The group found that in the case of acute back pain, trials are much more sparse and inconclusive, and thus deduced that no conclusions can be made regarding the use of acupuncture in this condition. Similar results were found by a systematic review conducted by Furlan et al (2005) of 35 different randomized clinical trials of acupuncture or dry-needling [12]. In the case of chronic lower back pain, again acupuncture was significantly more effective than sham acupuncture and no treatment; however it was not more effective than other interventions. The study showed that spinal manipulation may be slightly more effective in cases of chronic lower back pain, while massage, celecoxib, and rofecoxib are equally as effective as acupuncture [12]. However, in both of the above reviews, many of the included studies were considered to be of poor quality. Thus it is not yet possible to definitively suggest that acupuncture is effective in the treatment of chronic lower back pain, and more well-designed studies are required.

The role of acupuncture in migraine headache is another commonly investigated topic, although trials are sparser and less well-designed than other pain syndromes. A recently completed study by Alecrim-Andrade et al (2008) examined the ability of acupuncture versus sham acupuncture to prevent migraine recurrence in 37 patients with diagnosed migraine who received a total of 16 treatments over 3 months. With an endpoint of a  $\geq 50\%$  reduction in the rate of migraine, Alecrim-Andrade et al (2008) concluded that early in treatment ( $< 2$  months) acupuncture was more effective than sham treatments in reducing headache incidence by  $\geq 50\%$  ( $p < 0.2$ ) [13]. However, due to improvements in the sham acupuncture group this difference disappeared by 2 months, with 63% of true acupuncture and 47% of sham acupuncture patients meeting the endpoint goal of a  $\geq 50\%$  reduction in headache incidence by the third month [13]. In a multicenter randomized, sham-controlled study completed by Diener et al (2006) comparing acupuncture versus sham acupuncture versus standard therapy, results were nearly identical to those found by Alecrim-Andrade, in that there was no significant difference between true acupuncture, sham acupuncture, or standard therapy in reducing the incidence of migraine headache [14]. With the endpoint of  $\geq 50\%$

reduction in migraine rate, the group reported that 47% of acupuncture patients, 39% of sham acupuncture patients, and 40% of standard therapy patients after 26 weeks met the endpoint [14].

Although acupuncture is commonly used in cases of osteoarthritis, evidence is minimal showing a clear benefit of the treatment. In 2001, Ezzo et al conducted a systematic review of seven randomized trials examining the effectiveness of acupuncture in the treatment of osteoarthritis of the knee. The group found that in three high-quality trials, acupuncture compared to sham treatment is more effective in the treatment of osteoarthritis, but inconclusive results were found when acupuncture was compared to physical therapy and no treatment, partially secondary to the fact that over half of the seven trials were of poor quality [15]. Manheimer et al (2007) found similar results in a meta-analysis of 11 randomized-control trials displaying a clinically insignificant, although statistically significant improvement in osteoarthritis pain with acupuncture versus sham [16]. Thus although evidence suggests there may be a slight advantage of acupuncture over sham in the treatment of osteoarthritis, further evaluations with larger patient populations and tighter controls are necessary to reliably deduce the size of any effect.

Perhaps the most controversial application of acupuncture recently seen in the literature includes the use of the technique during surgical anesthetic practice. Reports from China site utilization of acupuncture as the sole anesthetic agent during procedures such as open-heart surgery [17]. In order to further evaluate the use of acupuncture in anesthetic practice, Greif et al examined the ability of acupuncture to induce analgesia and thus reduce anesthetic requirements. By randomizing healthy volunteers to receive auricular acupuncture versus no intervention during maintenance of general anesthetic, the group measured partial pressures of desflurane required to prevent movement to noxious electrical stimulation [18]. It was observed that acupuncture reduced desflurane anesthetic requirements by 11% ( $p < 0.001$ ), suggesting that acupuncture may provide an adjuvant therapy to general anesthetic [18]. However, in 2002 Morioka et al found conflicting results with a cross-over study also examining the ability of acupuncture to reduce a desflurane concentrations during general anesthesia. Using electroacupuncture at acupoints *Zusanli*, *Yanglingquan*, and *Kunlun*, the group did not detect a statistically significant decrease in desflurane requirements with acupuncture [19]. Although the use of acupuncture during general anesthesia provides advantages, such as low side-effect profile, reduced postoperative nausea and vomiting, and minimal cardiovascular or pulmonary

physiologic effects, much more investigation is required to understand its contribution to anesthetic practice if one exists.

Acupuncture has also been investigated for its use in cases of psychological illness. In 1994, Han et al used electroacupuncture and transcutaneous acupoint stimulation to treat opioid addiction [20]. Clinical data has shown that acupoint stimulation used in heroin addicts reduced the amount of buprenorphine needed by the addicts to complete the detoxification procedure by more than 90% [21]. Similar results with opioids addiction were also observed by Zhang et al (2006), who found that acupuncture can effectively reduce the relapse of psychic dependence on opiates after detoxification [22].

## 5. Scientific Mechanisms Behind Acupuncture

With the growing public interest in acupuncture, the scientific community has responded with several well-designed investigations of the physiologic basis behind acupuncture. Early western theories of how acupuncture functioned relied heavily upon its ability to induce neurologic signals along afferent nerves that in turn modulated spinal cord signal transmission of pain. In 1987, Bruce Pomeranz formulated a hypothesis of acupuncture signaling based on his finding that Naloxone administration is able to block analgesic effectiveness of acupuncture [23]. Pomeranz suggested that needling stimulates A-delta and C afferent fibers, which transmit to the spinal cord and result in release of endogenous opioids. In turn, he proposed that signaling is further propagated to the midbrain, specifically the Raphe Nucleus and the Peri-Aqueductal Gray area, resulting in modulating signals that promote pain suppression in the spinal cord. Since the proposal of his theory, several studies have further supported the Pomeranz hypothesis of acupuncture-induced pain relief. For example, acupuncture requires an intact nervous system in order to be effective, as evidenced by the fact that application of local anesthetic abolishes its effect [2].

Pomeranz's hypothesis in regards to the role of endogenous opioids in acupuncture analgesia is also heavily supported. Several studies in addition to Pomeranz's have displayed the effectiveness of Naloxone in reversing or preventing pain relief by acupuncture [23]. However, endogenous opioids have also been directly identified as possible mediators by their extraction from the CSF of acupuncture-treated individuals. Clement-Jones et al (1973) displayed that in 10 patients with chronic pain who received electroacupuncture, CSF levels of beta-endorphin increased significantly ( $p < 0.02$ )

compared to controls [24]. Furthermore, it appears that varying the frequency of electroacupuncture stimulation results in variations in the type of endogenous endorphine released. Guo et al (1996) displayed that low-frequency electroacupuncture (2 Hz) produced increased expression of enkephalin precursor proteins, whereas high-frequency stimulation (100 Hz) increased expression of dynorphin precursors [25]. The release of endogenous opioids in response to acupuncture is one of the leading theories regarding the mechanism of action of acupuncture, and has been deemed the "neurohormonal theory" by the scientific community.

A second theory behind the mechanism of action of acupuncture that is gaining popularity in the scientific community relies on the notion of long-term depression. In cases of long-term depression, prolonged and low-frequency stimulation induce long-lasting downregulation of synaptic transmission throughout the CNS [26]. According to a hypothesis proposed by Sandkuhler (1996), extrasynaptic transmission of neurotransmitter released after nociceptive stimulation may lead to long-lasting downregulation of A-delta and possibly also C-fiber signaling. Although not completed as of yet in humans, several animal studies have displayed such long-term potentiation after cyclic or tonic stimulation of the afferent nerve fibers [27,28]. It has been proposed that acupuncture provides a similar form of low-frequency stimulation, and in doing so produces depression of afferent neurotransmission along A-delta fibers of the dorsal horn [26]. In doing so, acupuncture would produce a long-term antinociceptive effect well beyond termination of therapy, which has been demonstrated in clinical practice [29].

Many opponents of acupuncture cite the placebo effect as the mechanism behind acupuncture success, and point out that studies of placebo also suggest that it may result from release of endogenous opioids since expectancy placebo appears to be reversed by Naloxone administration, similar to acupuncture-induced increases in pain threshold [30]. However, the delayed onset of action by 1–2 hours observed after acupuncture is not characteristic of placebo effect, which is usually instantaneous [29]. Acupuncture often produces relief for up to 2 weeks after cessation of treatment, which is highly uncharacteristic of placebo as well [29,31]. Furthermore, several studies have examined the effectiveness of acupuncture versus placebo, and have found that acupuncture produces a significantly higher effect than can be explained by placebo alone [32–34]. Mayer et al was the first group to examine acupuncture versus placebo directly. In their 1977 study, 35 volunteers were subject to dental pain induced by electrical stimulation of

a tooth, and then randomized to receive either acupuncture or an injection of saline which they were told would act as a powerful analgesic. Acupuncture produced a 27.1% increase in pain threshold, a value which was significantly larger in effect than placebo (range of -18 to 40%), and administration of Naloxone reduced efficacy of acupuncture to the level of placebo [33]. As the authors suggest, it is unlikely that the observed effect can be completely explained by placebo analgesia alone.

Still evidence has been uncovered that acupuncture may be linked to or has a component of placebo expectation. Pariente et al (2005), suggested that in addition to a direct analgesic affect, a portion of acupuncture's success is secondary to the effect of anticipation and a belief of a benefit. By using both true and sham acupuncture with Steitberger needles which give the impression of skin penetration, the group displayed that both procedures activated the right dorsolateral prefrontal cortex, the anterior cingulate cortex, and the midbrain which they suggest are involved in expectation of pain relief [35]. However, true acupuncture resulted in a significantly higher increase in activity of the ipsilateral insula compared to placebo sham acupuncture, suggesting that true acupuncture has a more specific physiologic effect [30].

Despite arguments in the literature in regards to the exact mechanism of action of acupuncture in producing analgesia, few can deny that definitive physiologic alterations occur when acupuncture is performed. In all likelihood, acupuncture may use or combine any of the three above theories: placebo effect, neurohormonal effect, or long-term depression. In an attempt to try to elucidate the more complex aspects of acupuncture's effect, many researchers have turned to expression patterns in the CNS in order to examine regions of the brain that are directly affected by acupuncture practice. In his same study examining differential expression of endogenous opioids, Guo et al also investigated the expression of *c-fos* (a marker of neuronal activity) at both high- and low-frequency stimulation, and found that 100Hz stimulation led to increased activity in the parabrachial nucleus which contains both autonomic and nociceptive fibers and projects to the periaqueductal gray area, while 2Hz stimulation increased expression in the arcuate nucleus of the hypothalamus, suggesting two possible separate pathways which are involved in the descending antinociceptive pathway [25].

In attempting to locate other sources of acupuncture-mediated analgesia in addition to the parabrachial and arcuate nucleus, several studies have implicated the pituitary gland in addition to the hypothalamus as being involved. By examining *c-fos* expression in mice stimulated either by immersion

of footpads in hot water (noxious stimuli) or by electroacupuncture, Pan et al (1994) displayed an increase in activity of the anterior lobe of the pituitary gland with acupuncture [36]. They also observed increased *c-fos* expression in the arcuate nucleus in response to acupuncture alone, similar to Guo et al [36]. The group suggested that activation of the anterior pituitary was evidence of a possible increase in release of both ACTH and beta-endorphins by the pituitary gland, which are seen during times of acute stress, and may contribute to acupuncture's analgesic effect mediated by descending antinociceptive pathways [36]. To further examine this possibility, Pan et al (1996) displayed that cells which increased levels of *c-fos* in relation to electroacupuncture also contained increased levels of ACTH, and that this increase in expression was consistent with an increase in levels of plasma ACTH [37].

With new technological advancement in the realm of neuroradiology, investigators have also examined regions of the brain active during acupuncture with the use of PET imaging and fMRI. Hsieh et al (2001) used PET imaging to study the central activation created by acupuncture stimulation at the *Li 4* acupuncture point (well-known for analgesic effect), as well as by non-classical needling at a non-acupoint [9]. Scans were taken at: (1) rest conditions where the needle was advanced 3mm but not manipulated, (2) minimal conditions where the needle was manipulated slightly at 3mm, and (3) *de qi* conditions where the needle was advanced near 1cm and manipulated. During acupuncture at the acupoint under *de qi* conditions, significant activity in both the hypothalamus extending down into the periaqueductal gray and the insula was noted compared to minimal conditions at the acupoint. Stimulation at the non-acupoint regardless of the condition neither activated the hypothalamus, nor the insulae [9]. This study not only supported the role of the hypothalamus, as a member of the descending antinociceptive pathway, in acupuncture-induced analgesia, but also of the insula/limbic regions of the brain. Recently, studies have suggested that the insula plays an important role as a visceral sensory and motor area and as a pain intensity coding region, and thus in the case of acupuncture it may play an important role in sensory integration [9,38].

Involvement of the periaqueductal gray in the acupuncture pathway has been highly investigated given the area's involvement in noxious stimuli and pain modulation through the release of enkephalins on the Raphe nucleus. In turn, the Raphe nucleus is believed to be responsible for releasing 5-HT on excitatory synapses with inhibitory interneurons in the dorsal horn, thereby inhibiting the ascending

pain pathway to modulate pain [39]. Using fMRI on seven health volunteers, Liu et al (2004) demonstrated that acupuncture at the *Hoku* point resulted in intermittent activation of the periaqueductal gray, with the frequency and intensity of activation varying with the length of acupuncture stimulation [40]. Stimulation of a non-acupoint resulted in reduced or no activation of the periaqueductal gray [40].

Higher cortical areas have also been implicated in the analgesic pathway used by acupuncture. Biella et al (2001) used PET imaging in 13 volunteers during three conditions: (1) rest, (2) placebo acupuncture, (3) or true acupuncture at *Zusanli* and *Qi-ze* acupoints with the desired *de qi* effect. During true acupuncture with *de qi* effect only, an increase in activity was noted along the left anterior cingulate gyrus, bilateral insulae, bilateral cerebellum, and the right superior frontal gyrus [38]. Activation of the anterior cingulate cortex was also observed by Pariante et al (2005) when examining the effect of expectation, and thus may play a role in the belief of pain relief [35]. Thus acupuncture may alter pain sensation by integration of pain stimuli in these higher cortical areas.

An fMRI study completed by Zhang et al (2003), displayed similar areas of cortical activation following electroacupuncture [41]. The group examined the effect of acupuncture on brain activity by inducing experimental cold pain during real or sham electroacupuncture. Only those patients randomized to receive electroacupuncture reported a reduction in pain ( $p < 0.01$ ), and displayed increased activity in the bilateral somatosensory areas and medial prefrontal cortices [41]. In the case of peripheral pain, it is thus possible that these high cortical regions of the brain play roles in regulating the overall response to painful stimulation by combining the sensory, affective, and cognitive components of pain, a theory called the neuromatrix hypothesis [42]. If this is the case, then it may be that acupuncture may modify the perception of pain by modulating the sensory and emotional aspects of pain being processed in the “neuromatrix” [38,41].

With the involvement of the midbrain, cerebellum, and higher cortical areas in the process of acupuncture-induced analgesia, the question of whether particular specific acupoints are capable of producing differing results as traditional teachings suggest, and thus activate different spatial areas of the CNS. To investigate this possibility, Zhang et al (2004) examined the differential activation of regions of the CNS during manipulation of the *Zusanli/Sanyinjiao* acupoint or the *Yanglingquan/Chengshan* acupoint using fMRI. What they found was that both acupoints led to activation of the primary and secondary somatosensory areas, the

insula, cerebellum, thalamus, and putamen, but each had specific patterns of activation in addition to this [43]. The *Zusanli/Sanyinjiao* acupoint also resulted in activation of the orbital frontal cortex along with deactivation of the amygdala while the *Yanglingquan/Chengshan* acupoint resulted in activation of the dorsal thalamus specifically with deactivation of the primary motor area and premotor cortex [43].

## 6. Summary

Although acupuncture represents a relatively new modality of complementary and alternative medicine widely used throughout the United States and other western countries, its application in traditional Chinese medicine is long-standing and evidence suggests that the use of needling and tattooing may even predate acupuncture’s evolution in ancient China. Given the recent rise in interest in acupuncture’s use in pain syndromes, many scientific examinations into its efficacy and mechanism of action have been completed. Although biological studies suggest a physiologic alteration in pain pathways occurs with acupuncture techniques, clinical studies have failed to demonstrate a clear and reliable benefit of acupuncture in the treatment of various conditions. Still, patients continue to turn to acupuncture for treatment of many chronic conditions that current medical practice has been unable to effectively treat, and as a result it is imperative that medical practitioners trained in western medicine have a solid understanding of acupuncture, its use, and what the evidence suggests about its efficacy.

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