Clinical Reasoning for Western Acupuncture

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Introduction

Clinical decision making by physiotherapists using acupuncture to treat musculoskeletal disorders should be underpinned by valid and substantiated clinical reasoning. The 'thinking behind practice' has been identified as a vital component in manual therapy practice (Jones & Rivett 2004). Clinicians will identify the predominant tissue and pain mechanisms apparent in the patients' disorder and make a decision as to how and where to intervene therapeutically. The same consideration of underlying mechanisms contributing to an individual's clinical presentation should be made when acupuncture is the treatment of choice. The 'Layering Method' a clinical reasoning model, was developed specifically for clinicians to take a research-evidenced, mechanisms-based approach when treating musculoskeletal disorders with acupuncture (Bradnam 2003, 2007). The model allows the clinician to progressively target the pathophysiology of the patients' condition using the known effects of acupuncture on the central nervous system. This allows a targeted approach to provide the best outcome for the individual patient, and an evidence-based platform for treatment progression. The layering method is fundamentally considered to inform a 'western' application of acupuncture practice and encourages evidence-based practice. However, the model also allows integration of Traditional Chinese Acupuncture (TCA) point selection into the clinical reasoning process for clinicians that wish to take a combined approach.

To begin the process an orthodox physiotherapy diagnosis is made by the physiotherapist. As part of the diagnostic reasoning, likely contributors to the patients' disability and impairment in terms of associated anatomical structures, tissue sources, stage of tissue healing and pain mechanisms are identified (Jones & Rivett, 2004). An acupuncture treatment plan is then generated to target these structures, or sources of the physical impairment and/or pain. Knowledge of acupuncture mechanisms along with the pain and tissue mechanisms underlying the condition allows progression of treatment. This is important when the initial approach does not achieve the desired effect or if pain mechanisms change as the condition becomes more chronic. The theoretical knowledge required by the therapist to apply the layering method is; effects of acupuncture on the human nervous system, clinical presentation of different pain mechanisms along with tissue healing processes, knowledge of acupuncture points, anatomy, segmental and peripheral nerve innervation of muscles and skin, and the neuroanatomy of the autonomic nervous system (ANS).

Acupuncture mechanisms

In review, three general categories of acupuncture mechanisms have been described (Lundeberg 1998). In peripheral tissues when nocioceptive afferents are stimulated by the acupuncture needle, vasodilatory neuropeptides are released into the surrounding muscle and skin (Sato et al; 2000). This effect, known as the axon reflex, is the basis of the 'local or peripheral effects' of acupuncture. In human skin two of the many peptides involved in this response are calcitonin gene-related peptide (CGRP) and substance P (Weidner et al (2000). Sensory neuropeptides modulate immune responses and therefore play an important role in tissue healing (Brain 1997). Centrally, the sensations evoked by acupuncture stimulate primary afferent nerve fibres that terminate within the spinal cord that influence three different sets of neurons. These effects are known as 'spinal' or 'segmental' effects. To initiate neural mechanisms within the spinal cord, acupuncture must be given to tissues with innervation by the appropriate spinal cord level. Therefore, needles must be inserted into or close by the painful body part. The first spinal effect involves the sensory system. Dorsal horn neurons activated by painful inputs may be inhibited by acupuncture via a A-delta fibre mediated gate control mechanism. The second spinal effect is via the sympathetic nervous system. Neurons in the lateral spinal cord (thoraco-lumbar region) contain the cell bodies of the autonomic nervous system efferent fibres, and are influenced by segmental acupuncture. Effects on the sympathetic nervous system are altered depending on strength of needle stimulation. High-intensity needling increases sympathetic outflow to tissues supplied by the segment in the short term, followed by a longer-term decrease in outflow. Low-intensity or non-painful input reduces sympathetic outflow from the segment (Sato et al. 1997). The last effect of segmental acupuncture involves the motor system. Acupuncture can influence alpha-motoneurons in the ventral horn of the spinal cord. This has the potential to reduce reflex activity in muscles supplied by motoneurons in that spinal segment producing muscle relaxation.

Acupuncture can also strongly influence neuronal structures within the human brain (Stener-Victorin et al 2002). This is known as a 'supraspinal' effect. Analgesic pathways such as diffuse noxious inhibitory controls (DNIC) and beta-endorphin mediated descending pain inhibitory pathways from the hypothalamus are stimulated by appropriate needling parameters. Autonomic outflow is also under central control via the vaso-motor centre in the medulla and hence is also influenced by the acupuncture stimulus. Neurohormonal responses affecting the immune, endocrine and reproductive systems of the body are affected by acupuncture (White 1999; Carlsson 2002, Stener-Victorin et al 2002). Recent advances in brain imaging technologies such as fMRI and PET scanning has allowed researchers to better investigate supraspinal effects and have increased the understanding of how acupuncture influences the brain. Several analgesic points in the extremities stimulate activity in cortical and subcortical brain regions. The activation seems to be relatively non-specific and is closely related to areas activated by painful stimuli through the pain matrix (Lewith et al. 2005). In general, studies show an increase in hypothalamic and a decrease in limbic system activity. The limbic system involves a number of brain nuclei where affective and emotional responses to pain are integrated with sensory experience. This is suggested to mediate some of the non-specific effects of acupuncture (Campbell, 2006). Furthermore, many of the brain regions stimulated by acupuncture are closely related to areas mediating placebo analgesia and expectation (Lewith et al. 2005). It is unclear how much change in brain activity is due to the acupuncture stimulus itself and how much is due to 'non-specific' effects of treatment expectation and placebo. Recent neuroimaging research has shown acupuncture to modulate default networks in the brain, indicating it has a powerful effect on brain function. Furthermore, studies using transcranial magnetic stimulation (TMS) have found acupuncture to modulate motor cortical excitability. The change in motor cortical excitability (i.e. excitation or inhibition) is specific to the muscles around the needling site (Lo et al. 2005; Maioli et al. 2006). Interestingly, Maioli et al. (2006) found changes that lasted for 15 minutes following the removal of the needle stimulus, indicating acupuncture can induce relatively long lasting alternations to motor cortical excitability.

Clinical reasoning model: the layering method

The clinical reasoning approach is that the clinician asks themselves a series of questions as to which acupuncture effects are desired to best treat the presenting condition. Clinicians should consider the pain and tissue mechanisms, and the structures involved in the dysfunction or impairment for that individual patient. Appropriate points and stimulation parameters are then chosen to provide an optimum intervention. The clinical reasoning questions can be seen in Table 1.

Local Effects - Healing

If healing of injured tissues or treatment of scar tissue is the aim of therapy, then eliciting local effects to improve blood flow to tissues is useful. Local effects are maximized by using local acupuncture points, or simply by putting the needle directly into the damaged tissue. Lundeberg (1998) recommended needling close to the injured tissue with low-intensity stimulation to encourage peripheral, rather than central, neuropeptide release. However, recently greater blood flow in muscle and skin was observed when the needles were stimulated to de qi (Sandberg et al 2003).

Segmental Effects - Analgesia

Any point chosen for local effect will concurrently induce segmental effects. In acute pain, segmental blocking of painful afferent input can result in strong analgesia. This is desirable, except perhaps in the early stages of an injury when the increase in blood flow is potentially detrimental. In this case it is suggested that acupuncture points in tissues that share an innervation via that spinal segment are chosen (muscles, skin periosteum), as long as the injured tissue is avoided (Bradnam 2003, 2007). In acute nociceptive pain fewer needles should be used since the dorsal horn is already sensitized by painful afferent input from the injury and placing too many needles in the segment may increase pain. As the condition progresses from acute to chronic, more needles can be added into the segment (Lundeberg 1998). Choosing "distant" points in the segment is one method to do this. Distant points are those in other muscles or tissues sharing an innervation with the injured tissue, but are further away from the injury site (Bradnam 2003, 2007). Another method of progression is to use a point that targets a peripheral nerve supplying the injured or painful structure. For example, placing a needle into TE5 into the posterior forearm (posterior interosseous nerve) will affect tissues associated with lateral epicondylitis. A third option is to use "spinal points", i.e. points on the Bladder channel, or Huatuo Jiaji points in muscles close to the spinal level that share innervation with the injured tissue. Here the segment is influenced via the dorsal rami to provide a strong sensory stimulus to the spinal cord at that level.

Segmental Effects - Sympathetic Nervous System

Acupuncture may be used when there are signs and symptoms in the patients' clinical presentation suggestive of an overactive sympathetic nervous system, such as oedema, sweating and severe pain (Longbottom 2006). The sympathetic nervous system can also be manipulated when an increase in blood flow to a particular tissue is desired in a slow healing or chronic injury (Bradnam 2003,2007). Slow-healing musculoskeletal conditions might be related to inhibition of the SNS leading to trophic changes in target tissues (Bekkering & van Bussel 1998). The sympathetic neurons are housed in the spinal segments of the thoracic and upper lumbar neurons, with the efferent supply to the head and neck originating from the lateral horn of the spinal cord in segments T1–T4. The efferent outflows to the upper and lower limbs are T5–T9 and T10–L2, respectively (Bekkering & van Bussel 1998). Needling muscle tissue at the appropriate spinal level will alter the outflow to that region. Indeed, it was shown by Hsu et al. (2006) in healthy volunteers, that 2-Hz electroacupuncture (EA) applied to BL15 increases heart and pulse rates and decreases skin conductance over acupuncture points on the upper limb. These are all signs of increased sympathetic outflow. In addition, needling a point in the periphery with afferent input into the chosen segment with strong stimulation increases sympathetic outflow and blood flow to target muscles (Noguchi et al (1999). For example, LI4 is located in the adductor pollicis muscle and is innervated by the T1 segment. Needling LI4 may activate the sympathetic lateral horn at T1 and alter sympathetic outflow to the head and neck. If the desired outcome is inhibition of sympathetic outflow (for example in chronic regional pain syndrome), gentle stimulation to the spinal points is given. Strong stimulation may generate the opposite effect and aggravate the condition. Alternatively, ear acupuncture will increase parasympathetic activity (Lundeberg & Elkholm; 2001) reducing sympathetic outflow and points that influence the cranial (e.g. BL10) and sacral nerves (e.g. BL28) may stimulate the parasympathetic nervous system and reduce overactive sympathetic responses Longbottom (2006). Scalp acupuncture can also stimulate the parasympathetic nervous system and suppress sympathetic activity in healthy humans (Wang et al. 2002).

Supraspinal Effects – Analgesia

When the needles are left into any acupuncture points for 30-40 minutes then supraspinal effects will be generated as these are time and intensity-related, and not dependant on needle placement (Andersson & Lundeberg 1995; Lundeberg 1998; Lundeberg & Stener-Victorin 2002). Neuroimaging research supports the concept of an intensity related neural response in brain tissues. Needles must be stimulated to deqi to alter brain activity, and greater the intensity of stimulation (and hence deqi), the greater the increase in activity of affected cortical regions (Backer et al. 2002, Wu et al. 2002; Fang et al. 2004). That strong stimulation is required to influence activity in the brain is also supported by a study in rodents. Uchida et al. (2000) found that only strong electro acupuncture, to stimulate high-threshold muscle fibres increased cerebral blood flow in the rat brain.

Activating descending pain inhibitory systems by segmental acupuncture evokes analgesia that is stronger than that elicited by extrasegmental needle placement but is only short lasting (Lundeberg et al. 1988a). Hence a combination of both segmental and extrasegmental needling is commonly used in clinical practice (Barlas et al 2006). However, when trying to activate descending inhibitory pathways to treat acute nociceptive pain or centrally evoked pain, it may be prudent to do this via extrasegmental inputs to avoid overloading the sensitized spinal cord segment. The experimental evidence from fMRI and PET experiments to date has found the following points increase activity within the hypothalamus; Large Intestine (LI) 4, Lung (LU) 5, Gall Bladder (GB) 34, Spleen (SP) 6, Stomach (ST) 36, GB40 and Liver (LV) 3 (Wu et al. 1999, 2002; Hui et al. 2000; Biella et al. 2001; Hsieh et al. 2001; Zhang et al. 2003; Fang et al. 2004; Yan et al. 2005). Furthermore, deactivating brain regions associated with the limbic system was found with points; ST36, LI4, LV3, SP6 and GB34 (Wu et al. 1999, 2002; Hui et al. 2000, 2005; Hsieh et al. 2001; Kong et al. 2002; Zhang et al. 2003; Napadow et al. 2005). Clinicians should bear in mind that the interpretation of the acupuncture sensation by the patient may be important in determining the outcome of treatment. Hui et al. (2005) found that the limbic system was deactivated when deqi was elicited at the point, but this switched to activation when the needle response was considered painful. An alternative method of choosing points to activate supraspinal effects is to use strong analgesic points as suggested by TCA (known as 'big' points).

Finally, it has been suggested that the opioid pain inhibitory systems are less effective for peripheral neurogenic pain due to increased synthesis of the neuropeptide cholecystokinin, an endogenous opioid antagonist (Wiesenfeld-Hallin & Zu 1996). A suggested approach is to use electro acupuncture applied with a high-frequency/low-intensity paradigm to activate the noradrenergic (non-opioid) pathways in the spinal cord (White 1999).

Supraspinal Effects – Autonomic Outflow

Autonomic outflow is under central control by the hypothalamus regulating the sympathetic and parasympathetic nervous systems (Kandell et al. 2000). Stimulation of this system with acupuncture is again non-specific in terms of point location. As for the sensory system, central autonomic effects are more dependent on intensity and length of stimulation. In order to effectively activate central autonomic responses, "strong" points, similar to those used to evoke central responses are recommended. Acupuncture may increase or decrease sympathetic activity depending on the state of the target organ or tissue (Sato et al. 1997). For optimum treatment of body organs, Stener-Victorin (2000) recommended the use of high-intensity, low-frequency electro-acupuncture for strong stimulus to the CNS.

Supraspinal Effects – Motor Cortex

A novel use of acupuncture is to specifically excite and inhibit motor regions of the brain associated with overactive or inhibited muscles. This suggests acupuncture can be used in the treatment of musculoskeletal and neurological motor control disorders. Acupuncture can modify excitability of the primary motor cortex. Maioli et al. (2006) found that by needling LI4, the motor cortical area for the abductor digiti minimi hand muscle was inhibited, but there was no significant alteration in excitability of forearm flexor muscle representations, indicating effects on the motor system are localized to a region. In contrast, Lo et al. (2005) showed acupuncture to LI10, significantly increased motor cortical excitability to the motor representation of the first dorsal interosseous. More research is needed to clarify motor cortical responses and optimal needling parameters. However, this exciting work has demonstrated a modulating effect of acupuncture on motor cortical excitability and highlights a potential new treatment strategy for motor disorders.

Supraspinal Effects – Immune System

Following acupuncture beta-endorphin and adrenocorticotropic hormone (ACTH) are released in equimolar amounts from the pituitary gland into the blood stream (Lundeberg, 1999). In turn, ACTH may influence the adrenal gland, increasing the production of anti-inflammatory corticosteroids (Sato et al. 1997). Beta-endorphin levels may fluctuate with changes in the number and activity of T-lymphocytes and natural killer (NK) cells. These effects may optimize healing in slow to respond conditions such as people with immune deficiency or high-intensity athletic demands. Lundeberg (1999) proposed that the organs producing T-lymphocytes, NK cells (i.e. the thymus, spleen and lung) can be stimulated by acupuncture, by needling segments that house the sympathetic innervation to the target organ (Table 2). Because of the close association of the sympathetic and immune systems sympathetic points and ear acupuncture points may also be considered because of their potential to influence vagal parasympathetic activity (Lundeberg, 1999).

Conclusion

The present clinical reasoning model proposes a theoretical framework for the application of Western acupuncture. The model uses current neurophysiology to underpin and inform clinical decision-making, and suggests a basis for treatment progression. It is recommended that clinicians measure outcomes and use reflective practice when implementing the model until it been validated by primary research in a clinical setting. One limitation of the model is that it takes a mechanistic view of acupuncture as an intervention. Clinicians should always consider the affective-cognitive component of their patients' conditions and other psychosocial factors that impact on their recovery and ensure they educate as to the 'place' of acupuncture in their overall management.

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Table 1. Layering technique for acupuncture treatment of musculoskeletal conditions: A quick checklist

(1) Peripheral effects (Yes/No)
If No: Needle away from injured tissue
If Yes: What are the points? Or needle directly into tissue you want to influence. Use few needles and stimulate gently to maximize local effects. If treating superficial injuries, high-frequency, low-intensity electroacupuncture will aid blood flow to skin by reducing sympathetic tone

(2) Segmental/spinal effects (Yes/No)
If No: Needle tissues with a different segmental nerve (extrasegmental) supply to that of the damaged tissue
If Yes: Do you want to needle into the damaged tissue?
If Yes: Choose local points situated anatomically near or in the damaged tissue
If No: Choose points in other tissues that are supplied by the same myotome, scleratome or dermatome as the damaged tissue. If choosing a myotome, choose a muscle that is hypertonic and/or in which the points are tender to palpation
Acute nociceptive pain: Use fewer needles in the segment (high-frequency, low-intensity electro-acupuncture to maximize spinal cord inhibition, then progress to manual acupuncture or low-frequency, high-intensity electro-acupuncture)
Chronic nociceptive pain: Use more needles in the segment
Plus: Choose a distant point in the disturbed segment, in either a dermatome, myotome or scleratome. If treating for pain, a point in a bordering segment could be chosen as a distant point since nociceptive stimuli will affect bordering segments
Or: Choose a distant point that stimulates the peripheral nerve supplying the damaged tissue
Add a layer: Choose a spinal point that influences the segment sharing the nerve supply with the spinal level (e.g. the Huatuo Jiaji point, Bladder point or facet joint in the cervical spine). Needle for 10–20 min

3. Supraspinal effects (Yes/No)
If No: Needle for 10–15 min with moderate stimulation. Choose segmental points to damaged tissues and do not use "big" points
If Yes: Choose extrasegmental points, and the "big" points of the hands and feet (commonly used traditional Chinese acupuncture points?). Needle for 20–40 min with strong stimulation. This activates descending inhibitory systems from the hypothalamus and possibly diffuse noxious inhibitory controls

4. Sympathetic outflow (when condition not improving with somatic treatment) (Yes/No)
If No: Think of the somatic nerve supply and treat according to the above principles
If Yes: Choose the segmental level of the tissue you want to influence and needle the Huatuo Jiaj or Bladder points at that spinal level. The head and neck supply is T2-T4, the upper limb is T5–T9 and the lower limbs are T10–L2

Plus: Choose a distant point in tissues innervated with the same sympathetic segmental nerve supply as the tissue that you wish to influence. Needle strongly for at least 10 min to increase sympathetic outflow, or gently to decrease outflow.

5. Central sympathetic effects?
If Yes: Autonomic nervous system control by the hypothalamus; stimulated in same manner as analgesic supraspinal effects. Choose large points on the hands and feet, and stimulate strongly for 20–40 min

6. Immune effects
If Yes: Use points at the segmental level of the spleen, lung and thymus and use general strong points that influence the hypothalamus and regulate autonomic outflow (the hands and feet)

Repeat treatments: Strong stimulation for 30 min
Auricular points: Affect vagal efferent activity

Table 2. Nerve supply to body organs

Viscera	Sympathetic	Parasympathetic
Heart	T1 – T5	Vagus
Lung & bronchi	T2 – T4	Vagus
Stomach	T6 – T10	Vagus
Small Intestine	T9 – T10	Vagus
Large Intestine (upper)	T11 – L1	Vagus
Large Intestine (lower)	L1 – L2	S2 – S4
Liver & Gall bladder	T7 – T9	Vagus
Testis/ ovary	T10 – T12	nil
Bladder	T11 – L2	S2 – S4
Uterus	T12 – L1	S2 – S4