

Neuroanatomical basis of acupuncture treatment for some common illnesses

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The acupuncture treatment formulae for some common conditions are reviewed. These conditions include low back pain, sciatica, trigeminal neuralgia, facial nerve palsy, asthma, nausea and vomiting, gastritis and dysmenorrhoea. It is found that in many cases, the acupuncture points traditionally used for the treatment have a neuroanatomical significance from the viewpoint of Western medicine. And from that one can hypothesise a plausible mechanism of action as to how acupuncture achieves its therapeutic effects in terms of contemporary Western medicine. These mechanisms of action include intramuscular stimulation for treating muscular pain and nerve stimulation for treating neuropathies. The sympathetic ganglion may be involved in the acupuncture treatment of asthma. Somato-autonomic reflex may be responsible for the acupuncture effect on gastritis.

Among the various modalities of complementary and alternative medicines, acupuncture is considered by many to be at the forefront in terms of acceptability and proven efficacy.¹⁻⁴ Acupuncture is now used for a variety of medical conditions from musculoskeletal pain, neurological disorders to illness such as nausea and vomiting.⁵ However, a major obstacle that prevents acupuncture from being integrated with Western medicine is that the theory of Traditional Chinese Medicine (TCM), on which acupuncture is based, is fundamentally different from the theory of Western medicine. The theoretical background of TCM is based on the metaphysical concepts of *Qi*, *Yin* and *Yang* imbalance,⁶⁻⁸ whereas mainstream Western medicine is based on contemporary scientific disciplines such as biochemistry, physiology, anatomy and pharmacology. Many critics view acupuncture as an antiquated medical practice that lacks a plausible foundation. Despite the known efficacy of acupuncture in treating many conditions, many practitioners are hesitant to embrace it because acupuncture seems nothing more than folk medicine. The purpose of this study is to show that the clinical applications of acupuncture do have a neuroanatomical basis aside from the concepts of TCM. In this study we review the acupuncture treatment for some common conditions. While the treatment plans are derived from concepts of TCM, it is found that the acupoints used in many treatment plans do have a neuroanatomical significance consistent with the concepts of Western medicine.

ACUPUNCTURE FORMULAE FOR SOME COMMON CONDITIONS

In this work we review the acupuncture formulae for the treatment of some common conditions from five different

acupuncture textbooks and reference books⁷⁻⁹⁻¹² that are written or edited by a panel from academic or state institutes, and examine if the acupoints have any neuroanatomical significance in terms of Western medicine. We have chosen applications whose efficacy is at least to some extent supported by evidence. The common conditions under consideration are: low back pain, sciatica, trigeminal neuralgia, facial nerve palsy, asthma, nausea and vomiting, gastritis and dysmenorrhoea. The formulae are shown in table 1.

One problem with the acupuncture formulas for various medical conditions is that the formulae from different sources can be quite different. Traditionally, Chinese medicine lacks the scientific discipline and vigour of mainstream Western medicine and sometimes the formulae may be based on unfounded practices and are flawed. In order to gain useful insights on the neuroanatomical significance of the acupoints, we must first filter out the outliers and use only the valid ones.

To filter out the outliers, we use only acupoints that are in agreement among the five sources. Essentially, if a treatment formula for a given condition is available in all five sources, we consider acupoints that are cited in at least four sources. And if a treatment formula is available only in four or fewer sources, we consider only acupoints that are cited in every source and ignore the rest. The consensus acupoints are listed in the last column of table 1. The objective of finding the consensus acupoints is to see if the treatment formulae from different sources converge to something meaningful in terms of Western medicine.

NEUROANATOMICAL SIGNIFICANCE OF THE ACUPOINTS

An examination of the consensus acupoints shows that in many cases they do

have a neuroanatomical significance in accordance with Western medicine, even though the formulae are derived from ideas of TCM. The significance of the acupoints is summarised in table 2. It is useful to classify the neuroanatomical significance of the consensus points into four different types:

1. Local effect, intramuscular stimulation;
2. Local effect, nerve stimulation;
3. Systemic effect possibly associated with the sympathetic ganglia;
4. Systemic effect, significance unclear.

In the last type, the neuroanatomical significance of the acupoints is less clear. The acupoints for the treatment of low back pain belong to type 1. The acupoints for the treatment of sciatica, trigeminal neuralgia and facial nerve palsy belong to type 2. The acupoints for asthma belong to type 3. Those for nausea and vomit, gastritis and dysmenorrhoea belong to type 4.

Local effect, intramuscular stimulation

For the treatment of low back pain, the consensus acupoints BL23 and *ah shi* are located at the affected muscles. An *ah shi* point is an extra-meridian acupoint in TCM. It is a functional point located at wherever pain is felt, and is analogous to a trigger point in Western medicine. Its location has no relation to the meridians.

In this application, acupuncture acts on the affected muscles and exerts its effect locally via intramuscular stimulation. This idea has long been part of Gunn's model¹³ for the treatment of myofascial pain of radiculopathic origin. According to his model, in a neuropathy a nerve and its innervated structures, such as striated muscles, become supersensitive. The neuropathy also increases muscle tone and causes muscle shortening resulting in various painful conditions due to the muscle's pull on various structures. Gunn also refers to myofascial pain as the "shortened muscle syndrome". The central concept in his model is that myofascial pain is associated with muscle shortening and the goal of acupuncture treatment is to release the muscle shortening. Gunn also suggested that acupuncture has a longer lasting effect than other physical treatment modalities because it causes tissue injury which unleashes the body's healing resources. His hypothesis of muscle shortening is intuitive but lacks supporting data. But his idea of tissue injury and healing is in accordance with

Table 1 Acupuncture formulae for some common illnesses

Diagnosis	Shanghai 1996	Sun 2001	Li 2001	Ming 1997	Lai 2002	Consensus acupoints
Low back pain	BL23, BL24, BL25, Jiaji, BL52, GV4, <i>ah shi</i>	BL23, BL25, GV3, <i>ah shi</i>	BL23, GV3, BL40, Jiaji, <i>ah shi</i>		BL23, BL40, Jiaji, <i>ah shi</i>	BL23, <i>ah shi</i>
Sciatica	BL25, BL54, GB30, GB34		Jiaji-L3-L5, BL54, GB30, BL37, BL57, BL40, BL60	BL23, BL25, BL54, BL40, GB30, GB34	BL32, BL24, Jiaji-L3-L5, BL32, BL54, GB30	BL54, GB30
Trigeminal neuralgia	BL2, GB14, EXHN4, ST2, ST3, SI18, CV24, ST6, ST7, LI4, LI3, ST44	BL2, EXHN4, EXHN5, ST2, SI18, ST7, CV24, TE17	BL2, GB14, EXHN4, ST2, ST3, SI18, CV24, ST6, ST7, GV24, GV20, LI4, LI3, ST44		BL2, GB14, EXHN4, ST2, ST3, SI18, CV24, ST6, ST7, TE17, LI4, LI3, ST44	BL2, EXHN4, ST2, SI18, CV24, ST7
Facial nerve palsy	GB20, TE17, GB14, LI20, ST4, LI4	GB20, TE17, GB14, ST2, ST4, ST6, ST7, LI4, ST44, LR3		ST4, ST6, GB14, LI20, LI4, TE17	GB20, TE17, ST6, ST4, LI4, LR3	TE17, ST4, LI4
Asthma	EXB1, CV22, PC6	BL13, CV17, CV22, LU5	GV14, BL12, BL13, LU5, LU9	BL13, LU5, EXB1, BL12, ST40, LI4, CV22, PC6	CV17, BL13, LU6, LU10	BL13
Nausea, vomit	PC6, CV12, LR3, ST36		CV12, PC6, ST36, SP4	PC6, ST36	CV12, BL12, ST36, PC6	PC6, ST36
Gastritis	PC6, ST36, CV12	BL20, BL21, CV12, ST36, PC6	CV12, ST34, ST36, PC6	CV12, ST36, PC6, LR3, LR14	ST36, CV12, PC6, SP4	PC6, ST36, CV12
Dysmenorrhea	CV4, SP6	CV4, CV6, SP6, ST36	CV4, CV6, SP6	CV4, ST36, BL20, BL23, KI3	CV6, SP6	SP6

more recent studies which show that the acupuncture needle stimulates the nerve fibres in the muscle and triggers the release of vasoactive substances locally, thereby improving the local blood flow and promoting healing.¹⁴⁻¹⁶ There is another mechanism involving segmental analgesia¹⁶ which may also contribute to the therapeutic effect of intramuscular stimulation. Briefly the acupuncture needle activates some afferent nerve fibres to the dorsal horn of the spinal cord. This inhibits the nociceptive pathway at the same spinal level and gives an analgesic effect at the same dermatome level.

In this application, acupuncture when used with electric stimulation (ie, electroacupuncture) is akin to or perhaps indistinguishable from percutaneous electrical

nerve stimulation, an analgesic therapy of Western medicine origin for treating muscular pain.¹⁷

Local effect, nerve stimulation

As can be seen in table 2, the location of the consensus acupoints BL54 and GB30 for sciatica corresponds to that of the sciatic nerve. The consensus acupoints for trigeminal neuralgia are located in proximity to the branches of the three divisions of the trigeminal nerve (ophthalmic nerve or V1, maxillary nerve or V2, mandibular nerve or V3). Similarly, the consensus acupoints TE17 and ST4 for facial nerve palsy correspond to the location of the facial nerve and affected muscle. (The significance of the other consensus

acupoint LI4 is unclear.) It is tempting to speculate that acupuncture, if it works, exerts its effect by stimulating the affected nerves locally. At present there is no data to support or refute this hypothesis. Increased blood flow in nerves by acupuncture has been observed in animal studies. For example, Inoue *et al*¹⁸ observed that electroacupuncture stimulation of the pudendal nerve increases blood flow in the sciatic nerve in animals. More data is needed to establish this hypothesis. And data supporting the efficacy of acupuncture treatment for trigeminal neuralgia and facial nerve palsy is also lacking. The use of percutaneous stimulation for treating trigeminal neuralgia has been discussed by Brown.²⁰ Johnson and Birchiel²¹ have reported a

Table 2 Location and neuroanatomic significance of the consensus acupoints for treating some common illnesses

Acupoint	Location	Neuroanatomical significance
BL23	1.5 <i>cun</i> lateral to the inferior border of the spinous process of 2 nd lumbar vertebra	Erector spinae and quadratus lumborum muscle
<i>Ah shi</i>	Painful point	Affected muscle
BL54	In gluteal region, 3 <i>cun</i> lateral to the sacral hiatus	Sciatic nerve
GB30	In gluteal region, at the junction of lateral 1/3 and medial 2/3 of the line joining the greater trochanter and sacral hiatus	Sciatic nerve
BL2	Medial end of the eyebrow	Supraorbital nerve, branch of V1
EX-HN4	Midpoint of the eyebrow	Supratrochlear nerve, branch of V1
ST2	Inferior to and in line with the pupil, in the depression of the infraorbital foramen	Infraorbital nerve, branch of V2
SI18	In a depression inferior to the zygomatic bone, in line with lateral canthus of the eye	Zygomatic nerve, branch of V2
CV24	Inferior to the lips, on the midline, at the midpoint of the mentolabial sulcus	Mental nerve, branch of V3
ST7	In the depression formed by the mandibular notch below the zygomatic arch	Inferior alveolar nerve, branch of V3
TE17	Inferior to the root of the ear, in the depression between the mastoid process and the mandible	Main trunk of facial nerve
ST4	Lateral to the commissure of the lips, in line with the pupil	Orbicularis oris muscle
LI 4	In the hand, on the belly of 1 st interosseus dorsalis muscle	Neuroanatomic significance not clear
BL13	1.5 <i>cun</i> lateral to the inferior border of the spinous process of 3 rd thoracic vertebra	Sympathetic ganglion at T3
PC6	2 <i>cun</i> proximal to anterior crease of the wrist, on ulnar side of tendon of flexor carpi radialis	Neuroanatomic significance not clear
ST36	3 <i>cun</i> distal to patella, anterior to tibia	Neuroanatomic significance not clear
CV12	Midline, 4 <i>cun</i> above umbilicus	Neuroanatomic significance not clear
SP6	3 <i>cun</i> above the apex of the medial malleolus, behind the tibia	Neuroanatomic significance not clear

A *cun* is the unit for measuring anatomic distance in Traditional Chinese Medicine. It corresponds to the width of the thumb at the interphalangeal joint.

retrospective case series of subcutaneous electrical stimulation of branches of trigeminal nerve for treating trigeminal neuralgia and concluded that it is effective and that a clinical trial is warranted. The efficacy of acupuncture for facial nerve palsy has been reviewed by He *et al*²² and deemed to be inconclusive due to the inadequate quality of the data.

SYSTEMIC EFFECT POSSIBLY ASSOCIATED WITH THE SYMPATHETIC GANGLIA

The consensus acupoint BL13 for asthma is the *Shu* point for the lungs. According to the theory of TCM, the *Shu* points are a series of acupoints located in the back where the *Qi* of the various organs flows to the back. Through a *Shu* point, one can modulate the *Qi* of the associated organ. It should not be surprising that based on the theory of TCM the consensus acupoint for asthma is the *Shu* point for the lungs. There may also be a neuroanatomical basis in terms of Western medicine for using this acupoint for asthma. The location of BL13 corresponds roughly to that of the sympathetic ganglion at the level of the vertebra T3, which sends postganglionic fibres to the pulmonary plexus and cardiac plexus.

We note that there are *Shu* points for organs other than the lungs, though some of those organs are entities that exist only in TCM but not in modern anatomy that we know of. Interestingly, the locations of the *Shu* points from the entire series correspond to those of the sympathetic ganglia from T3 through S3. While this striking correspondence could be sheer coincidence, it is tempting to speculate that the sympathetic ganglia play a role in the systemic effect of acupuncture via the *Shu* points. There is no scientific data to support or refute this speculation. Furthermore, the sympathetic ganglia are not safely accessible to acupuncture needles directly. Feng *et al*²³ have studied the role of the sympathetic ganglia in the acupuncture treatment of asthma. They postulated that the stimulation of the acupoint (the *Shu* point) inhibits the uptake function of the dorsal root ganglion. As a result the synthesis and release of certain neurotransmitters in the ganglion, in particular substance P, is decreased. This results in a series of reactions affecting the activity of the airway. We would emphasise that the above is only a hypothesis. Furthermore, the efficacy of acupuncture treatment for asthma has not been established. Systemic reviews and meta-analyses on the efficacy have been limited by the quality of data.^{24 25}

Systemic effect, significance unclear

The consensus acupoints for dysmenorrhoea is SP6, but its neuroanatomical significance is unclear. There is some evidence for the efficacy of acupuncture treatment for this condition. Proctor *et al*²⁶ reviewed some clinical data and concluded that it may be effective. A more recent review by Yang *et al*²⁷ failed to find convincing evidence for the efficacy due to low methodological quality and small sample size.

The consensus acupoints for nausea and vomiting are PC6 and ST36. This application perhaps has the most convincing data to support its efficacy. However the neuroanatomical significance of the acupoints is also unclear.

The consensus points for gastritis are PC6, ST36 and CV12. We offer here a hypothesis for the mechanism of action and the neuroanatomical significance of one of the consensus points, ST36. It is the site where a potent somato-autonomic reflex can be elicited. The modulation of visceral functions by somato-autonomic reflex has been studied by Sato and Schmidt.^{28 29} Their studies showed, for example, that the stimulation of the muscles in the hindpaw of anaesthetised rats results in increased gastric vagal efferent nerve activity and increased gastric motility. This is consistent with the study by Wang³⁰ on the regulation of gastric activity by acupuncture at ST36. In particular, Wang found that this process requires the vagus nerve and that a bilateral vagotomy essentially abolishes the effect. Thus a plausible mechanism for the effect of acupuncture stimulation on ST36 on gastric activity is the somato-parasympathetic reflex. The acupuncture needle provides the somatic sensory stimulation. Then the muscle afferent fibres carry the nerve activity to the medullary reflex centre, and eventually the efferent parasympathetic nerves that innervate the stomach elicit the gastric response.

The neuroanatomic significance of the acupoint ST36 could be that it is the site, compared to others, where the most intense somato-autonomic reflex can be elicited. The effectiveness of the acupoint ST36 may be associated with the fact that muscle bellies, especially those in the extremities, are relatively rich in nerve fibres. ST36 lies in a muscle belly distal to the knee (tibialis anterior and extensor digitorum longus muscles).

A consequence of the hypothesis that the somato-autonomic reflex is responsible for the systemic effect of acupuncture is that the acupoints are not unique for this purpose. While they are probably the

sites where a more potent response is elicited, compared to other sites and hence lies their neuroanatomical significance, the distinction between an acupoint and non-acupoint cannot be all or none. Furthermore, the idea of a "point" of effectiveness cannot be true. Rather, it should be a region of influence. These are significant contradictions to the core principles of traditional acupuncture. However they are ideas that can be verified or disproved by studies. Indeed this non-uniqueness of the acupoints has been reported in the literature. For example, Ma³¹ has observed that the stimulation of many "non-acupoints" or "sham" acupoints in various control studies has some of the same effect as "real" acupuncture.

DISCUSSION

It is remarkable that acupuncture, a modality conceived thousands of years ago, is still being used today, and used not only in China, but all over the world. There is much interest in using acupuncture in the Western medical community. Much progress has been made during the last few decades in understanding acupuncture from the standpoint of modern science and medicine. It is now well known that acupuncture causes secretion of endorphin, an endogenous opioid. However this hardly explains how acupuncture achieves its therapeutic effects in specific clinical applications. From a clinician's point of view it is important to have a working knowledge of how acupuncture achieves its therapeutic effect in terms of concepts of Western medicine, and some guidelines on how to select the acupoints. A neuroanatomical approach to acupuncture seems to be a promising one for this purpose. This approach in fact has long been used by Wong,³²⁻³⁴ and expounded in a recent work¹⁶ where the authors used the term "Western medical acupuncture" to represent their approach. They classify the mechanisms of acupuncture into four types: local effects on tissue, segmental analgesia, extrasegmental analgesia and central regulatory effects. We have to acknowledge that while their classification is derived to a large extent from known data, our classification of acupuncture mechanisms in this work is an intuitive one based on the location of the acupoints in relation to their therapeutic effect. Our intention is to generate hypotheses and examine if the hypotheses are supported by observation. Nevertheless, the two classifications are somewhat similar and share the important common aspect that the mechanism

for the local effect of acupuncture is very different from that for distal effects. In either case the local mechanism is better understood whereas the distal mechanism is quite obscure even for an application with convincing efficacy such as the treatment of nausea and vomiting. Much more work needs to be done to further the understanding of acupuncture. And to better incorporate acupuncture into mainstream medicine, the work needs to be done based on contemporary scientific disciplines rather than metaphysical entities that are neither observable nor verifiable.

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