Neuroanatomical characteristics of acupuncture points: relationship between their anatomical locations and traditional clinical indications

Kwokming James Cheng

Abstract
This study examines the relationship between the anatomical location of traditional acupuncture points and their clinical indications as stated in two textbooks of traditional Chinese medicine (TCM). The following relationships are noted: (1) The acupuncture points in the trunk and their stated effects on the internal organs in the trunk have a segmental relationship—that is, acupuncture points within certain spinal segments in the trunk affect the functioning of the organs that receive autonomic innervation from the same spinal segments. This is consistent with the concept of segmental acupuncture and the idea that acupuncture may act via the somatic sympathetic reflex with a spinal pathway to affect the trunk organs. (2) The acupuncture points in the trunk and extremities have a musculoskeletal effect that is local or regional, but not distal. This is consistent with some of the models of acupuncture mechanisms on musculoskeletal effects in the Western medical acupuncture approach. (3) The acupuncture points on the head and neck preferentially affect the nearest organ. This presumably reflects the belief in TCM that acupuncture can somehow regulate the functioning of the proximal organ. No clear relationship can be identified between the myotome level of the acupuncture points in the extremities and their non-musculoskeletal clinical indications.

INTRODUCTION
Western medical acupuncture foregoes the metaphysical concepts in traditional Chinese medicine (TCM) and adheres to the principles of contemporary science and orthodox medicine.1–3 Numerous models have been proposed for the mechanism of action of acupuncture. These include the secretion of endorphin for acupuncture analgesia,4 5 intramuscular stimulation for the treatment of musculoskeletal pain conditions6 7 and somatic autonomic reflex for the regulation of visceral functions.8–11 There is no single mechanism that can explain the diverse clinical effects of acupuncture. Instead, different clinical applications involve different mechanisms. One approach is to consider separately the local and non-local effects.2 12 The local effect involves principally the treatment of musculoskeletal pain conditions. Its mechanism is relatively well understood and it is also by far the most common application of acupuncture. The non-local effect principally involves the regulation of visceral functions and other systemic effects. Its mechanism is less well understood and efficacy is less established.

The autonomic nervous system (ANS) may play an important role in the regulation of visceral functions by acupuncture. It is convenient to divide this non-local action of acupuncture into a spinal segmental level and brain level effect. This classification of acupuncture mechanisms has been reported in the literature.2 The segmental effect refers to the case when the myotome (or dermatome) where the acupuncture needles are placed and the autonomic innervation of the target visceral are within the same spinal segment—in other words, the neural pathway of the somatic autonomic reflex lies within the same spinal segment. The concept of segment acupuncture has been expounded by Bekkering and van Busse13. The brain level effect refers to the case when the neural pathway of the somatic autonomic reflex involves the brain. These ideas of segmental and brain level effects have been explored in animal studies by Sato et al8 9 who demonstrated that stimulation to the trunk elicits a somatic autonomic reflex at the spinal level whereas stimulation to the extremities elicits a somatic autonomic reflex at the brain level. This observation, if also found to be true in the clinical applications of acupuncture, would be of value to the understanding of the mechanism of acupuncture. This study is an attempt to validate some of the abovementioned mechanisms of acupuncture.

The study examines the clinical indications of all the traditional acupuncture points (360 in total) on the 14 meridians (12 regular meridians plus the Conception vessel and Governor vessel), as stated in two standard acupuncture textbooks from TCM.14 15 As in any scientific discipline where the theories have to agree with observations, the stated indications of the acupuncture points are taken as observations made by ancient clini-

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also examined. Here the acupuncture effect was clearly local or regional, in accordance with the models described by various authors.\(^2\) In addition, the relationship between the anatomical location of acupuncture points in the head and neck and their stated clinical indications was studied. Some preference was found to use the acupuncture points on the face to affect the nearest organ.

Before reporting the results of the study, a brief overview of some of the proposed acupuncture mechanisms is presented.

**MUSCULOSKELETAL EFFECT OF ACUPUNCTURE**

Acupuncture has a musculoskeletal effect locally by causing tissue injury which unleashes the body’s healing resources.\(^2\) More specifically, it stimulates the nerve fibres in muscles resulting in the release of vasodilating neuropeptides, thus improving local blood flow and facilitating healing. Acupuncture may be considered as a variant of a cortisone injection to myofascial trigger points, except that acupuncture needles rather than hypodermic needles are used, and without cortisone. This has been referred to as dry needling.\(^16\)

An elaborate model of the effect of acupuncture on musculoskeletal pain has been put forward by Gunn who used the more descriptive term ‘intramuscular stimulation’ instead of acupuncture. Two essential elements of his model of myofascial pain of neuropathic origin are muscle shortening and neuropathy. According to his model, myofascial pain is associated with muscle shortening, and neuropathy is commonly caused by spondylosis and is associated with sensory and autonomic manifestations. The goal of intramuscular stimulation treatment is to release muscle shortening and promote healing.

Regardless of the details of these Western models for the musculoskeletal effect of acupuncture, clinically one arrives at the same guidelines on where to put the acupuncture needles—locally or regionally, but not distally.

**SOMATIC AUTONOMIC REFLEX AND SEGMENTAL ACUPUNCTURE**

It has been proposed that the ANS—and in particular the somatic autonomic reflex—plays a significant role in the regulation of visceral functions by acupuncture.\(^9\)–\(^11\) This reflex may involve the brain or occur at the spinal level. In the former case, various pathways involving different neurotransmitters and structures that mediate the reflex have been proposed. For example, the dorsal motor nucleus of the vagus nerve, which is the principal parasympathetic nucleus of the brain, may mediate the gastrointestinal (GI) effect.\(^17\) The arcuate nucleus in the hypothalamus, the ventrolateral periaqueductal gray in the midbrain and the ventrolateral medulla may mediate the cardiovascular response to acupuncture stimulation.\(^18\)–\(^19\) In the latter case, the reflex pathway may lie completely within the same spinal segment—that is, the innervation of the muscles stimulated by the acupuncture needles, the afferent fibres travelling to the dorsal horn of the spinal cord and the sympathetic fibres travelling to the target visceral are all in the same spinal segment. It is tempting to speculate that acupuncture stimulation to the trunk—if indeed it affects the visceral function—will have a preference for this segmental pathway as it is shorter.

**STUDY METHOD**

The data source for this study is from two textbooks of acupuncture from TCM.\(^14\)\(^15\) We start with the stated clinical indications of all the traditional acupuncture points on the 14 meridians and construct tables that demonstrate a possible relationship between the myotome level or anatomical location of the acupuncture points versus their clinical applications. The data were first manually entered into a spreadsheet, and subsequent manipulation of the data and construction of the tables were performed using Visual Basics for Applications (VBA) programs. The following illustrates how the table is constructed for the relationship between the myotome level of trunk acupuncture points and their non-musculoskeletal indications.

According to Ming and Yang, the acupuncture point BL21 has the following list of indications: stomach ache, abdominal distension, borborygms, vomiting, weak spleen and stomach. Using a lookup table that assigns a clinical indication to a therapeutic class, this is converted to the list shown in table 1 involving different therapeutic classes.

The entries ‘stomach ache’ and ‘vomiting’ became an entry in the column for ‘GI-gastric biliary’ as the two symptoms are considered to be of gastric biliary aetiology. Similarly, the entries ‘abdominal distension’ and ‘borborygms’ became an entry in the column for ‘GI-intestine’. The entry ‘weak spleen and stomach’ has no meaning in Western medicine and is not classifiable, so it is put in the column for ‘Others’. This converted list for BL21 means that the acupuncture point has indications (one or more) for the therapeutic classes ‘GI-gastric biliary’, ‘GI-intestine’ and also under the category ‘Others’. In this study we have chosen to classify the clinical indications into 15 therapeutic classes. The choice of therapeutic classes is arbitrary. It is made to illustrate certain neuroanatomical characteristics of the acupuncture points.

The next step is to assign the acupuncture points into their myotomes. Each acupuncture point in the trunk and extremities is assigned into two myotomes using a lookup table. This lookup table is compiled using data available in the literature.\(^2\)\(^20\)\(^21\) For example, based on the fact that BL21 belongs to the myotomes T10 and T11, the above list is converted to two entries in the table for myotome versus therapeutic classes (table 2).

Table 1  An acupuncture point and its therapeutic classes

<table>
<thead>
<tr>
<th>Cardiac</th>
<th>Resp</th>
<th>GI-gastric</th>
<th>GI-intestine</th>
<th>Urinary</th>
<th>Genital</th>
<th>Genital</th>
<th>Eye</th>
<th>Ear</th>
<th>Mouth</th>
<th>Pharynx</th>
<th>CNS</th>
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</tr>
</tbody>
</table>
This procedure is repeated for all the acupuncture points. If multiple acupuncture points from the same myotome have indications for the same therapeutic class, the entries are summed. The end result is Table 3. Essentially, the final entry in the table represents the number of acupuncture points in a particular myotome that have at least one stated indication in a particular therapeutic class according to that textbook of TCM.

It should be noted that the assignment of acupuncture points to myotomes is only approximate, probably good only to within one myotome level. Furthermore, the response to acupuncture stimulation probably involves adjacent myotomes as well. However, as long as the response is strongest at the site of stimulation, the end result will be the same since we are interested only in the relative peaks of distribution in the table.

In this study the anatomical locations of the acupuncture points are classified according to their myotomes rather than dermatomes. Before reaching the muscle layer, the acupuncture needle obviously pierces through the dermal layer and activates nerve receptors in that layer. One may thus argue for the classification of acupuncture points according to their dermatomes. We classify according to the myotomes in view of the fact that stimulation of the muscle rather than dermal tissues by the needle seems to be more essential for eliciting the acupuncture effect.

## The Result

### Relationship between myotome level of trunk acupuncture points and their non-musculoskeletal clinical indications

Each row in Table 3 shows how the trunk acupuncture points that have indications for a particular target organ are distributed among various myotomes using data from Ming and Yang. The cells with solid bold borders correspond to the spinal levels that supply sympathetic innervation to the target organ system. This is consistent with the concept of segmental acupuncture. In particular, this agrees with the observation by Sato that stimulation to the trunk elicits a somatic autonomic reflex at the spinal level.

A similar result using data from Cheng is shown in Table 3A in the appendix in the online supplement, and each subsequent table in the main

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### Table 2 Myotome levels of an acupuncture point and their therapeutic classes

<table>
<thead>
<tr>
<th></th>
<th>Cardiac</th>
<th>Resp</th>
<th>GI-gastric biliary</th>
<th>GI-intestine</th>
<th>Urinary</th>
<th>Genital male</th>
<th>Genital female</th>
<th>Eye</th>
<th>Ear</th>
<th>Mouth</th>
<th>Pharynx</th>
<th>CNS</th>
<th>Fever</th>
<th>Musculo</th>
<th>Other</th>
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### Table 3 Myotome level of trunk acupuncture points vs their non-musculoskeletal clinical indications

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<th>C7</th>
<th>C8</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>T5</th>
<th>T6</th>
<th>T7</th>
<th>T8</th>
<th>T9</th>
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<th>T11</th>
<th>L1</th>
<th>L2</th>
<th>L3</th>
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<td>4</td>
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</table>

The value of 11 in the cell Respiratory-T1, for example, means that there are 11 acupuncture points in the myotome T1 that are indicated for treating conditions associated with the respiratory system. The cells with solid bold borders correspond to the spinal levels that supply sympathetic innervation to the target organ, and the broken bold borders correspond to parasympathetic innervation. The cells are colour coded with the lowest values in blue, highest in red, progressing according to the colours of the rainbow.

Raw data from Ming and Yang.14

GI, gastrointestinal.
body of this paper has a companion table using data from Cheng\textsuperscript{15} in the appendix in the online supplement.

For comparison, the analyses leading to table 3 were repeated using the dermatome instead of the myotome to classify the anatomical locations of the acupuncture points. This is shown in table 3B in the appendix in the online supplement. The result is similar.

Relationship between myotome level of extremity acupuncture points and their non-musculoskeletal clinical indications

Each row in table 4 shows how the extremity acupuncture points that have indications for a particular target organ are distributed among various myotomes. While acupuncture points in the extremities are used much more commonly than those on the trunk for affecting visceral functions, no obvious relationship is seen between the myotome level of the acupuncture points and their stated non-musculoskeletal clinical indications. Nevertheless, the following observation can be made. For conditions associated with the GI, urinary and genital systems, the lower extremity acupuncture points, rather than those of the upper extremity, are principally used. The association acupuncture points at myotome levels S2–S4 should be associated with the large intestine, bladder and genitals among the trunk organs. Yet, according to table 4, the associated acupuncture points are mostly from S1 and S2.

The lack of relationship between myotome level of extremity acupuncture points and their non-musculoskeletal clinical indications may be expected of the plausible hypotheses for acupuncture mechanisms. A somatic autonomic reflex with a pathway involving the brain should not have any preference towards a particular myotome in the extremity. Acupuncture may have endocrine effects via the pituitary and hypothalamus,\textsuperscript{2,22} and this will not have any myotome specificity either.

Yet one may ask if some relationships do exist between the anatomical locations of the extremity acupuncture points and their non-musculoskeletal effect on body functions, but that myotomes (or, for that matter, dermatomes) is the wrong way to characterise their locations. In other words, is there any point or region specificity regarding the effect of the extremity acupuncture points on the functioning of the organ systems?\textsuperscript{23} According to TCM, there is point specificity. For example, SP6 (located in the leg superior to the medial malleolus) is a potent point for regulating gynaecological problems and ST36 (located in the leg distal to the patella anterior to the tibia) is a potent point for GI problems. However, there is no known mechanism that explains why SP6 is specific for gynaecological problems but not GI, and vice versa for ST36. It is possible that this specificity does not exist at all, contrary to the long-held beliefs in TCM. Knowledge of this point or region specificity, or the lack of it, would be of value towards the understanding of acupuncture mechanisms.

<table>
<thead>
<tr>
<th>Target organ</th>
<th>Myotome of acupuncture point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac</td>
<td>C5  8  11  10  4</td>
</tr>
<tr>
<td>Respiratory</td>
<td>C6  8  7  7  3</td>
</tr>
<tr>
<td>GI-gastric biliary</td>
<td>C7  7  1  1  3</td>
</tr>
<tr>
<td>GI-intestine</td>
<td>C8  1  7  1  3</td>
</tr>
<tr>
<td>Urinary</td>
<td>C9  2  7  2  5</td>
</tr>
<tr>
<td>Genital male</td>
<td>L1  3  7  7  2</td>
</tr>
<tr>
<td>Genital female</td>
<td>L2  1  1  1  3</td>
</tr>
<tr>
<td>Eye</td>
<td>L3  3  1  1  1</td>
</tr>
<tr>
<td>Ear</td>
<td>L4  3  2  1  1</td>
</tr>
<tr>
<td>Mouth</td>
<td>L5  4  6  2  1</td>
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<td>Pharynx</td>
<td>L6  1  1  1  1</td>
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<td>CNS</td>
<td>L7  3  7  7  3</td>
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<td>Fever</td>
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<td>Musculo</td>
<td>L9  5  6  2  1</td>
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<tr>
<td>Others</td>
<td>L10 6  5  3  1</td>
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</tbody>
</table>

Raw data from Ming and Yang.\textsuperscript{14} GI, gastrointestinal.
vicinity of the musculoskeletal dysfunction. This is in agreement with various models of the musculoskeletal effects of acupuncture based on contemporary neuroanatomy and physiology.

**Relationship between anatomical location of head and neck acupuncture points and their clinical indications**

Table 6 shows the acupuncture points in the head and neck. To illustrate the association between the location of acupuncture points and their indications in the head and neck, the location of the acupuncture points is classified according to their vicinity to one of the following structures or organs: scalp, eye, ear, nose, mouth, face, neck (see first row in table 6). The stated clinical indications are classified into one of the following 14 groups according to the target condition or organ: dizziness, headache, CNS epilepsy, CNS psych, face, eye, ear, nose, mouth, pharynx larynx, neck musculo, neck goitre, respiratory, others (see column 1 in table 6).

Examination of Table 6 column by column shows that there is some preference to use acupuncture points to treat the dysfunction of their near organ. For example, the column for ‘eye’, which represents the acupuncture points located near the eye, has its peak at the target organ ‘eye’. The same is true for the column for ‘ear’. The columns for ‘nose’ and ‘mouth’ do have a single peak. Nevertheless, the corresponding target organ is one of the peaks. No such correlation exists in the columns for ‘face’ and ‘neck’. The column for ‘scalp’ is far more populated than others due to the abundance of acupuncture points on the scalp. It is seen that the two most common indications for scalp acupuncture points are dizziness and headache. This presumably reflects the belief that dizziness and headache are dysfunctions of the head and thus the scalp acupuncture points would be effective, in accordance with the idea of using acupuncture points to affect the near organ.

**CONCLUDING REMARKS**

This study of the traditional clinical indications and anatomical locations of the acupuncture points shows two patterns that are consistent with the proposed mechanisms in Western medical acupuncture. One involves the association of myotome levels of the trunk acupuncture points with the spinal level of sympathetic innervation of their target organs. This is consistent with the concept of segmental acupuncture. The other involves the use of acupuncture points locally or regionally but not distally to treat musculoskeletal conditions. This is consistent with various mechanisms of the effect of acupuncture on musculoskeletal conditions. The study also shows a pattern among acupuncture points in the head and neck where the acupuncture points are used preferentially to treat conditions in the proximal organ. It does not reveal any definitive relationship between the myotome levels of extremity acupuncture points and their target organs to be treated.

A general observation that can be made from these analyses is that of the use of near points. In order to treat a condition, acupuncture points near the location of the dysfunction are used. This is essentially the pattern seen in tables 3, 5 and 6. It is interesting to note that, despite all the ideas of ‘Qi’ and energy channels in the diagnosis and acupuncture point selection process in TCM, in the end much of the acupuncture point selection amounts to this simple rule of using the near points.

This study is based on the stated clinical indications of the acupuncture points. It is important to bear in mind that the efficacy of many of these indications is unproven. If there had
been a way to filter out the ineffica-
cious indications, leaving only those
that are efficacious, the study would
have been less confounded by errone-
ous data. The result would have been
more meaningful, and more useful
insights might have been gained into
the mechanism of action of acupunc-
ture. However, as it stands, TCM is
more anecdotal than evidence-based
and embraces principles different from
contemporary science and medicine.

To advance our understanding of
its mechanism of action, acupuncture
needs to be formulated on modern
neuroanatomy and physiology rather
than metaphysical concepts. To incor-
porate acupuncture into mainstream
medicine, it needs to be evidence-
based rather than anecdotal. The
theory and practice of acupuncture that
does not follow scientific principles or
clinical evidence will not evolve as sci-
ence advances nor refine itself as cli-

cal data emerge, but the theory and
practice of neuroanatomical evidence-
based acupuncture will.

▶ Additional data are published in the online
appendix. To view the files please visit the
journal online (http://aim.bmj.com/content/early/
recent)

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