

# The Connective Tissue Hypothesis for Acupuncture Mechanisms

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## Abstract

This article examines whether there is evidence to support the idea that acupuncture channels have an anatomical reality as fascia or connective tissue planes. An examination of what is meant by 'acupuncture channel' and to what the terms 'fascia' and 'connective tissue plane' refer is followed by an analysis of evidence published over the last ten years; the article concludes with a summary of what can be said to be proven, and the implications of such proof for acupuncture research and practice. The paper finds that there is little good quality conclusive evidence available; what little there is, however, is compelling and suggests that there is much more to find out - information that could potentially explain more about acupuncture's physiological mechanisms. Two case studies are included to illustrate how knowledge of connective tissue planes can be integrated into acupuncture practice.

## Introduction

This paper is a review of evidence regarding the correlation of acupuncture channels with anatomical structures known as connective tissue planes<sup>1,2</sup> or myofascial trains.<sup>3</sup> Assertions have been made that correlate fascia or loose connective tissue with acupuncture channels,<sup>4,5</sup> and suggestions put forward regarding their contribution to the physiological basis of acupuncture effects.<sup>6,7,8,9</sup> The endeavour to investigate the relationship between fascia and acupuncture takes place in a wider context of acupuncture mechanism research, which also includes examining neurological and endocrine models.<sup>10</sup> Although there is evidence that acupuncture causes changes within the central nervous system and endocrine system,<sup>11</sup> how this occurs is not understood; it is generally thought to be neurally mediated.<sup>10</sup>

Acupuncture channels do not always follow the pathways of major nerves or blood vessels, which has led some to conclude that the channel system does not physically exist.<sup>12</sup> There is currently a paucity of good quality evidence confirming the relationship of connective tissue to acupuncture; what there is, however, is compelling and suggestive. Establishing a biological mechanism for acupuncture is likely to increase acceptance by the medical orthodoxy; if such evidence encompasses traditional channels and points then Chinese medical theory is also more likely to become more widely accepted.

### What is an acupuncture channel?

The channels used in Chinese medicine are conceived as conduits along which physiological substances - qi and blood - flow. This concept is usually regarded as energetic rather than structural.<sup>13,14</sup> That is, whilst blood is thought to actually physically move through the blood vessels, the primary function of the qi and

blood flowing through the channels is thought to be that of providing nourishment. The Chinese view of the body differs culturally from that of the Western medical tradition; whilst in the West the focus tends to be on reductive physical anatomy, the Chinese tend to view the body in terms of its growth, function and movement as an integrated whole.<sup>15</sup> The 'truth' of the channels was not determined by dissection but by lived experience and reference to ancient knowledge.

Acupuncture channels are properly viewed not as individual anatomical entities, but as a physiological system unifying the other systems of the body into a cohesive whole; they are, amongst other things a communication system.<sup>16</sup> The channels are described in the Han dynasty classic *Nei Jing Su Wen (Yellow Emperor's Inner Classic Plain Questions)*<sup>17,18</sup> - thought to date from around 200BCE - as being within the 'body lining'.<sup>9</sup> In the *Nei Jing Ling Shu (Yellow Emperor's Inner Classic Spiritual Pivot)* they are described as lying 'between the muscle layers which can hardly be seen'.<sup>17</sup> In the *Nan Jing (Classic of Difficulties)* the yang qi is said to flow in the space between the organs, bones and flesh<sup>19</sup> - which is where the connective tissue is located. The channel pathways used today were formalised during the Song dynasty (around 1026CE), at the inception of Chinese state medical education;<sup>20</sup> prior to this they were not usually formally described but were rather found by palpation.<sup>9</sup>

### What is fascia or loose connective tissue?

Fascia is the name given to the connective tissue that forms planes in the body surrounding muscle groups, organs and blood vessels. It is composed of collagen, elastic and lattice fibres, ground substance (a transparent fluid constituent) and also contains cells (e.g. fibroblasts, myofibroblasts).<sup>21</sup> Until recently the purpose of fascia had been thought to be something

that 'filled the gaps between individual structures' - thus forming a displacement layer<sup>22</sup> - and as a force transmission structure.<sup>23</sup> This is no longer understood to be the case, as it seems fascia has elastic<sup>24</sup> and contractile qualities,<sup>25,26</sup> as well as possibly functioning as a body-wide signalling network.<sup>27</sup>

Since the study of fascia is relatively new, there is some discrepancy between the definitions given by the sources studied here.<sup>28</sup> According to recent literature, fascia is an uninterrupted three-dimensional web of connective tissue that maintains structural integrity, provides support and protection, contributes to haemodynamic and biochemical processes, defends against infection and assists with tissue repair.<sup>29</sup> More recently in the field of fascia research the names of different kinds of fascia have been proposed in order to facilitate clearer communication on the subject; most of the research presented here refers to what has been termed areolar connective tissue.<sup>30</sup> This is characterised by a non-dense irregular arrangement of collagen fibres in the fascia which allows movement between adjacent dense connective tissue layers; for example, the epimysium is a dense connective tissue layer surrounding muscle units - the areolar layer connects the muscle units together in such a way that they can still slide past each other. This movement should be free and easy, but in the case of damage or long-term misuse (poor seated posture and lack of activity for example), changes in the fascia cause the tissue to become restricted.

### Historical and cultural considerations

The research reviewed here can be seen in the wider historical context of the 'scientisation' of Chinese medicine<sup>31</sup> since the Qing Dynasty (1644-1911CE). There is evidence that the Chinese court was exposed to Western anatomy and medical ideas as early as the late 17th century,<sup>32</sup> although it was not necessarily incorporated into medicine at the time. In the 19th century, as the 'truth' of Western anatomy became harder to ignore, discourses were published that initially criticised Western anatomy, but then moved toward ideas of convergence and 'double truths'<sup>33</sup> in which both the Chinese and Western systems were seen to be correct. One product of this discourse was Tang Zonghai's concept in his *Zhong Xi Hui Dao Yi Jing Jing Yi (Essential Meanings of the Medical Classics in Light of the Convergence of China and the West, 1892CE)* that Chinese anatomy is the anatomy of qi transformation as opposed to crude matter,<sup>33</sup> and that channels are the 'pathways for the qi transformation of the organs'; such channels could not be discovered by dissection because they are only present in living bodies.

The process of scientisation took on political

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dimensions in 20th century China when, despite the apparent rejection of 'bourgeois Western influences' during the 1970's, the 'scientific' reinterpretation of Chinese medicine formulated during the 1950's remained essentially intact.<sup>31</sup> Unschuld, who describes Chinese medical theory as the theory of 'systematic correspondence', states that 'one should regard all those attempts as questionable and misleading that try to eliminate this distinctive feature [i.e. systematic correspondence] of traditional Chinese thought by artificially isolating a coherent and - in the Western sense - consistent set of ideas and patterns from ancient Chinese sources'.<sup>31</sup> Therefore all of the research reviewed here, including this paper, might also be seen as an attempt to legitimise Chinese medical theory by translating it into Western biomedical language under the modern project of 'integration'. To describe something that is functional and relational in structural terms is likely to cause it to ultimately lose its meaning and significance. Some sources assert that looking for anatomical acupuncture channels constitutes a fundamental misunderstanding of the nature of the channels and what they represent.<sup>35</sup> This should be borne in mind when reading any research in this area of study; even if an anatomical correlate is identified in the fascia, it does not necessarily encompass all that a channel actually is. That said, there is clearly something to be gained by establishing the biological mechanisms of acupuncture.

### Review of the literature

The papers reviewed here were found by searching the PubMed, AMED and Cinahl databases and following references cited in relevant papers. The resulting body of research varies in its pertinence and specificity to the topic, but all good quality relevant studies have been included for completeness.

### Review articles

A systematic review (Ahn et al) looking at the electrical properties of acupuncture points and channels<sup>36</sup> is well conducted but limited to English language studies. The authors acknowledge that it does not constitute a comprehensive review, however, and point out the small sample sizes, poor quality and limitations in

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the research covered. Dividing the studies into those looking at the properties of points and those looking at channels, they find that the studies into channels are of better quality and show more evidence of electrical impedance differences between the channels and their immediate physical surroundings than with points. They conclude that the available data is inadequate to draw clear conclusions, but that the evidence supports the notion of channels being electrically distinct and thus they recommend further research. Their interpretation of the data suggests that 'deeper, subcutaneous tissue layers may be an important component' of acupuncture mechanisms.<sup>36</sup> The review is thus suggestive of the presence of an anatomically measurable substrate corresponding to the channels, although connective tissue involvement is merely hinted at rather than definitively confirmed.

Napadow et al<sup>11</sup> summarise a selection of presentations from the 2007 Society for Acupuncture Research conference. Each presenter is given a section and many outlooks are included. Of relevance to the current paper is Ahn's assessment of points and channels, which discusses evidence of connective tissue correlation with acupuncture channels by looking at tracer migration along channels that seem to indicate some form of fluid flow along connective tissue planes. Langevin, who has contributed substantially to this field of research, also has a section in this paper in which she suggests that connective tissue may be the mechanism linking acupuncture stimulation and neurological effects; she also encourages further research into the field.

Both review articles included here are reasonable in their own right, essentially summarising Langevin's body of work and making cautious, logical conclusions. They are thus not particularly useful in establishing the credibility of the hypothesis that connective tissue is correlated with the physical location of the acupuncture channels, although they show this hypothesis in the context of a wider field of research.

#### **Anatomical studies**

The anatomically-focused papers are perhaps of the greatest relevance to this review, since they focus directly on fascial anatomy. Stecco et al. look at the fascial continuity of the upper limb through the dissection of 15 unembalmed cadavers.<sup>2</sup> The authors provide enough background information and are

sufficiently methodical in describing their processes to make their experiments repeatable. They roughly follow the anatomy of the Lung channel, testing for functional continuity by measuring force transmission at different points along the course of the connective tissue planes. They find that connective tissue forms a continuous line of force transmission across muscles, from the wrist to the pectoralis major, with minor variations between all subjects. They discuss the implications of this for biomechanics and the treatment of myofascial pain syndromes. They define the area they are studying in terms of the acupuncture channels of the flexor aspect of the forearm, anatomy chains<sup>3</sup> and the 'antemotion sequence' (the work of L. Stecco<sup>37</sup>), noting that all of these models overlap - although they avoid drawing conclusions as to their relative accuracy.

Another study looks mainly at the upper limb but also presents some data on the thigh.<sup>1</sup> The background information provided covers the history of acupuncture and outlines some historical issues relating to studies that aim to explain the mechanisms of acupuncture and the channel system. Other research into connective tissue by the authors is cited, which supports their hypothesis that acupuncture channels follow the course of fascial planes between muscle, bone or tendinous structures. They assert that points needled in acupuncture therapy are more likely to be at junctions between fascial planes, where there is theoretically more connective tissue and therefore a stronger physiological effect. This study involves locating points and channels in the traditional manner - using palpation and location on a live human arm - and then transposing this to post-mortem tissue sections. They look at the upper arm merely to simplify the study and use ultrasound and MRI (magnetic resonance imaging) to examine the anatomy. They find that 80 per cent of points and 50 per cent of channel intersections coincide with intramuscular or intermuscular connective tissue cleavage planes, calculating that the probability of this occurring by chance is  $P < 0.001$ .

Some Chinese research has recently been presented<sup>38</sup> that builds on the paper of Langevin and Yandow above,<sup>1</sup> although it has not yet been published in English language journals as far as the author of this paper is aware. An English translation was supplied by the researchers at the recent Fascia Research Congress.<sup>39</sup> This paper appears to be rigorously conducted and involves cadaver dissections, with CT and MRI imaging of 12 living human volunteers; it finds a strong correlation between intermuscular connective tissues and the distribution of acupuncture channels, concluding that acupoints are the places along such connective tissue that produce strong

biological reactions. There is, however, the possibility that this study is biased in terms of where in the body the researchers conducted their investigations; they may have found other connective tissue pathways that do not correspond with classically described channels if they had looked elsewhere. They also do not present any data to support their conclusion regarding points producing stronger biological reactions than their immediate physical surroundings.

### Clinical research

Langevin et al.<sup>40</sup> show how needling a traditionally located acupuncture point (on the Gall Bladder channel along the iliotibial band of the thigh) causes connective tissue displacement further up the channel - as confirmed by ultrasound elastography techniques; such changes were significantly different at a control point on the biceps femoris muscle belly. The authors build on their previously developed hypothesis - that the mechanism of acupuncture effects is via connective tissue. It is a well designed and fully described study, controlling reasonably for confounding factors by using computerised equipment and doing so in vivo on live humans. Only 12 subjects are tested, but the results are consistent and additionally show that ultrasound techniques are potentially useful for researching connective tissue. Konofagou and Langevin<sup>41</sup> refer to the latter study in their paper, in which they conduct similar research on a different part of the leg, including further work on the use of ultrasound. They bring together a body of evidence dealing with the distant effects of acupuncture along tissue planes and the reactions of connective tissue to needling, and draw conclusions about the implications of this for acupuncture research as well as speculating on whether this explains the mechanism of acupuncture.

Ahn et al.<sup>42</sup> measure electrical impedance and tissue displacement along connective tissue planes corresponding to two acupuncture channels in 24 human subjects. They find a significant difference between one channel (Pericardium) and a control (a parallel line 0.8cm medial to the channel), but such a difference is not evident in another channel (the Spleen). The authors posit the lack of a significant difference as being due to the control needle also penetrating the connective tissue.

The other group of papers in this section<sup>43, 44, 45, 46</sup> focus on the effects of needling connective tissue rather than on the question of the existence of planes that correspond to acupuncture channels. They are all rigorously performed, with clear descriptions of methods and equipment; findings and appropriate statistical analysis are also clearly presented. They examine the physical coupling of connective tissue

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to a needle ('needle grasp') in animals and humans, its relation to the felt sense of spreading (deqi) in a patient, cytoskeletal remodelling in connective tissue (where cells change shape and exert tension on their surroundings) and fibroblast migration (where more fibroblasts are found in a specific area of connective tissue after needling). References are made in all of these studies to the effects of needling on the wider tissue matrix and the possibility of connective tissue playing a role in biological communication through distant effects produced along these planes. As such they are judged to support the primary evidence in the current review.

### Theory articles

The first article dealing with connective tissue theory considered here<sup>47</sup> summarises the research completed to-date on signalling through connective tissue and includes a preliminary hypothesis of how acupuncture works. As with some of the clinical studies, the evidence of a myofascial correlation with acupuncture channels is not the main point of this paper, although such a relationship is outlined. Because this paper primarily uses the papers considered above as sources, it does not as such add to the evidence base but rather constructs theoretical bases for future research.

Another paper<sup>27</sup> focuses on biomedical physiology in order to explain acupuncture mechanisms, and draws on recent research into the cellular physiology of skin, nerves and connective tissue. The author refers to the conclusions made in other research - that connective tissue forms a continuous network around and through all of the other tissues and organs, that it has contractile qualities and that it is important in mechanotransduction. Most important is the suggestion that connective tissue acts as a medium for communication between cells and distant parts of the body, and that this happens most directly along the planes which correspond to acupuncture channels.

Langevin<sup>47</sup> posits connective tissue as a possible unifying key to understanding cross-system integration in medicine, presenting the body as a unified relational whole - a concept that is in keeping with new ideas in systems biology. The argument is built logically and reaches reasonable conclusions from the evidence given. Although this paper does not add to the sum of knowledge on connective tissue-channel correlations, its hypothesis is possibly a useful one to explore. She

takes the extant knowledge and proposes a theory that explains it coherently and more comprehensively than the paper considered above.

The final paper considered here<sup>12</sup> consists of a complex combination of theories regarding the correlation of acupuncture channels with connective tissue planes together with theories of embryology and growth control factors at a cellular level. It proposes that as well as corresponding with connective tissue planes, acupuncture channels relate to growth control boundaries in embryogenesis (termed separatrices) and that at such places acupuncture can alter gene expression and produce mechanical and neurohumoural effects.

### Synthesis

The studies detailed above form a body of useful evidence covering an array of related areas and establish appropriate systems of measurement, suitable research protocols and reliable methods. In terms of research into acupuncture mechanisms, studying the relationship of acupuncture and connective tissue may be a more sensible way to proceed than trying to establish a mechanism for acupuncture without knowing what to measure or how to best control for it; such studies may look in the wrong place to assess the physiological effects produced by acupuncture and then conclude that it does not have a therapeutic value. For example, many studies have shown acupuncture causes changes in hormone and neurotransmitter activity,<sup>36</sup> although what these changes represent is frequently not understood. The approach suggested above may contribute to establishing the link between the physiological and therapeutic effects.

As to the question of whether connective tissue planes are the same as acupuncture channels, it would be necessary to consider that these planes are three dimensional sheets of tissue which surround physiological structures in the body - more like tents than two-dimensional lines. The hypotheses made in the literature are that where planes come together they have more connections, and that this is where the channel and point correspondences appear to be.<sup>1</sup> As such they are not so much like the 12 main acupuncture channels, but more akin to the jingluo network. The anatomical fascial planes constitute a continuous network throughout the body around muscles, bones and organs; the 12 main channels may constitute the key functional places where these fascial planes intersect.

Channels were not conceived by the ancient Chinese as structural, but rather as functional manifestations of the associated organ systems.<sup>16</sup> The question of what they are 'in reality' contains the theoretical bias that Western biomedical anatomy is the truth and that the ancient Chinese system is somehow mistaken;<sup>33</sup> caution should therefore be employed when directly equating the two.<sup>31</sup> The evidence collected here implies some structural overlap,<sup>1,2</sup> as well as a broader physiological similarity that

is in keeping with classical ideas about the channels.<sup>27,45</sup> The evidence is provocative and shows the promise of discovering more about human physiology and health, as well as the possibility of understanding the mechanisms of acupuncture in biomedical terms. Although it cannot necessarily be said that channels and connective tissue are the same thing, establishing their relationship could be both useful and interesting.

### Case study one

Patient one presented with a three year history of plantar fasciitis. He complained of excruciating sharp, burning pains on the soles of his feet that would come and go but were usually worse in the morning. The right foot was worse than the left and the right hamstrings, lower back, soleus and medial head of gastrocnemius were all very tight. The pain extended to the medial heel in the area of Zhaohai KID-6. He had dry skin, but slept well and was otherwise healthy. His tongue was pale and dry with a red tip and his pulse was wiry (xian) and deep (chen) in both proximal positions.

The plantar fascia is said to connect to the muscles of the calf, including the deep posterior compartment muscles flexor digitorum longus, flexor hallucis longus and plantaris.<sup>22</sup> Such fascial theory directed the focus of treatment towards points along the Bladder channel local to these muscles, in order to release the constriction causing the pain (diagnosed as qi and blood stagnation with underlying blood deficiency). In addition to these points others were used local to the pain to invigorate qi and blood in the channels, support the blood and harmonise qi. The points needled were as follows:

- Weizhong BL-40 to release popliteus, activate the channel and clear heat.
- Chengshan BL-57 to release gastrocnemius and soleus and activate the channel.
- Heyang BL-55 to release plantaris and tibialis posterior and activate the channel.
- Yinmen BL-37 to release the hamstrings and activate the channel.
- Zhaohai KID-6 as a local point for pain and to support blood production by nourishing the Kidneys.
- Zhongdu LIV-6 (the xi-cleft point) to move blood.
- Sanyinjiao SP-6 to harmonise qi in the three yin channels and support blood.

This treatment was intended to produce an immediate effect, with a view in subsequent treatments to working to balance his posture and underlying Chinese medical patterns. Needle technique was even or reducing; in the case of Chengshan BL-57 and Yinmen BL-37 the needle technique 'blue turtle finds the cave' was used to disperse qi and blood stagnation - and because it contacts more of the local fascial planes. The patient returned one week

later, reporting a significant reduction in the sole pain, but still complained of tight calves and tightness in his right hip. Based on this, the next two treatments included the following points:

- Juliao GB-29
- Yanglingquan GB-34

These points were included in order to release the tightness around the hips that was biomechanically contributing to his dysfunction to produce backache. After three treatments all his musculoskeletal problems were much improved and he was able to remain pain-free by regular stretching alone.

### Case study two

Patient two had been coming for acupuncture to treat menstrual problems, but on this occasion presented with a recurrence of acute lower back pain. It had started suddenly after bending over to pick something up. Her lower back was tight and the pain was located primarily at the left sacroiliac joint (SIJ), radiating out into the lower back. The pulse was wiry (xian) overall, less forceful (wu li) on the left than on the right and confined (lao) in both proximal positions, indicating qi or blood constraint in the lower jiao. Her tongue was pale and swollen with tooth marks and a purple area at the rear.

Notwithstanding her underlying condition of Liver blood deficiency and Liver qi stagnation, my diagnosis was of qi and blood stagnation in the Bladder channel of the lower back. Musculoskeletal examination revealed that piriformis and gluteus medius were involved, as were the lumbar paraspinal muscles; the root of the problem, however, seemed to be a fixation of the left SIJ, which was confirmed by seated and standing nutation and counternutation tests (testing the small anterior-posterior gliding movements of the sacrum between the ilia). The treatment administered was as follows:

- Shangliao BL-31 to release the deep fascia on the ventral surface of the sacrum.
- Panguangshu BL-28 and Xiaochangshu BL-27 on the left hand side using a strong unidirectional rotation to release the fascia around the SIJ.
- Shenshu BL-23 to release the lumbar muscles and nourish the Kidneys.
- Sanyinjiao SP-6 as a distal yin channel point to balance the point prescription, harmonise the Liver and support the Kidneys (to regulate the underlying menstrual problem).
- Zusanli ST-36 to nourish qi and blood.

The day following treatment she felt stiff in the SIJ area and then the pain disappeared completely. It has not returned in the six months since treatment.

It would of course be entirely possible to come to similar

decisions regarding point selection by purely relying on traditional Chinese medicine channel theory (which in itself perhaps confirms the close relationship of channel and fascial dynamics). To have similar success using different approaches might also be possible. Having a deep awareness of the anatomy and interrelationship of fascial structures and acupuncture channels, however, can help to clarify the clinical decision-making process, inform needle technique and help focus the intent to produce better results from treatment.

### Conclusions

There is evidence to support the anatomical reality of acupuncture channels and their association with connective tissue planes, although more studies with greater subject numbers studying other areas of the body would make the case stronger. It seems from the evidence available that connective tissue may play a role in the physiological mechanisms of acupuncture. The studies show that needling acupoints affects connective tissue and has distant effects along the connective tissue planes. There is some evidence, although less convincing, that needling may interact with neurohumoural systems,<sup>27</sup> with the connective tissue functioning as a communication system similar to the traditional Chinese idea of channels.<sup>16</sup>

### Implications for practice

If the anatomical location of acupuncture channels is better understood it could refine acupuncturists' methods of palpation and the subsequent accuracy of their point location. The ability to feel a point or changes along a channel is important in acupuncture practice, and was apparently particularly so in the way it was originally practised.<sup>9</sup> If practitioners can relate what they feel along a channel to a physical correlate - the fasciae and muscles - it could improve point location and treatment efficacy. Further understanding of the anatomy of channels might also refine a practitioner's needle technique and diagnosis, depending on the treatment aims in question. Wider acceptance of acupuncture therapy in general biomedical care is also more likely if the anatomical structure of channels can be identified, since it renders traditional theory more plausible.

The findings of these studies could influence research design to be more accurate in terms of measuring the effects of needling, and thus in selecting appropriate control methods for clinical trials. If it is accepted that acupuncture channels follow connective tissue planes, then it follows that the 'real acupuncture' arm of a trial should be located on these interstices and the 'sham' control points distant from them.<sup>47</sup> If the sham points are placed on the fascial plane, they are more likely to have a therapeutic effect and thus constitute a poor control. In addition to this, if in a trial both the real and sham points are located off the connective tissue plane without palpatory or other

anatomical confirmation, the statistical significance of the effect of acupuncture is likely to be minimal (as neither point is at the fascial plane where a strong effect would be expected).

Researchers should consider how the information presented here affects their understanding of what they are studying, as well as their conception of the mechanism of the effects of acupuncture. Research needs to be conducted to establish whether myofascial continuity correlates to channels in areas of the body not already examined - notably the torso, where somato-visceral connections have been hypothesised.<sup>6</sup> More research looking into mechanotransduction along connective tissue planes may influence acupuncture practice in the future, and research into fascia itself – how it acts as a communication network

and interfaces with the nervous system - also has the potential to be clinically useful. ■

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