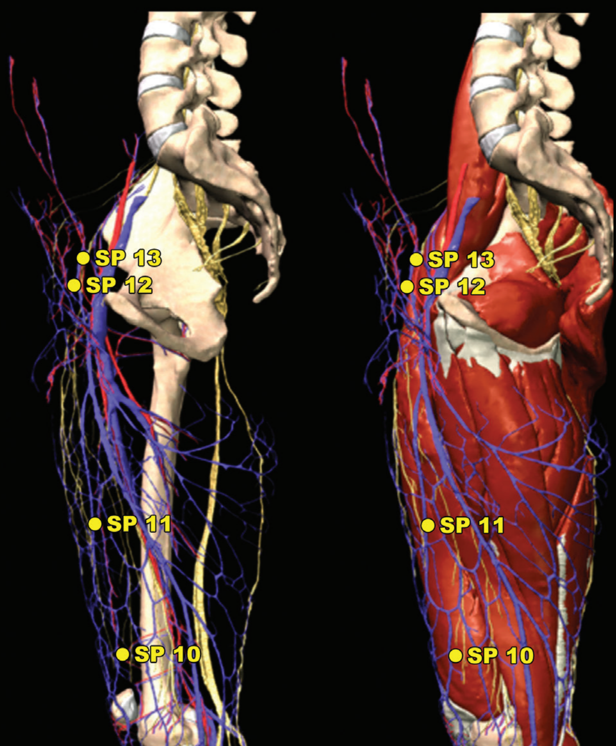
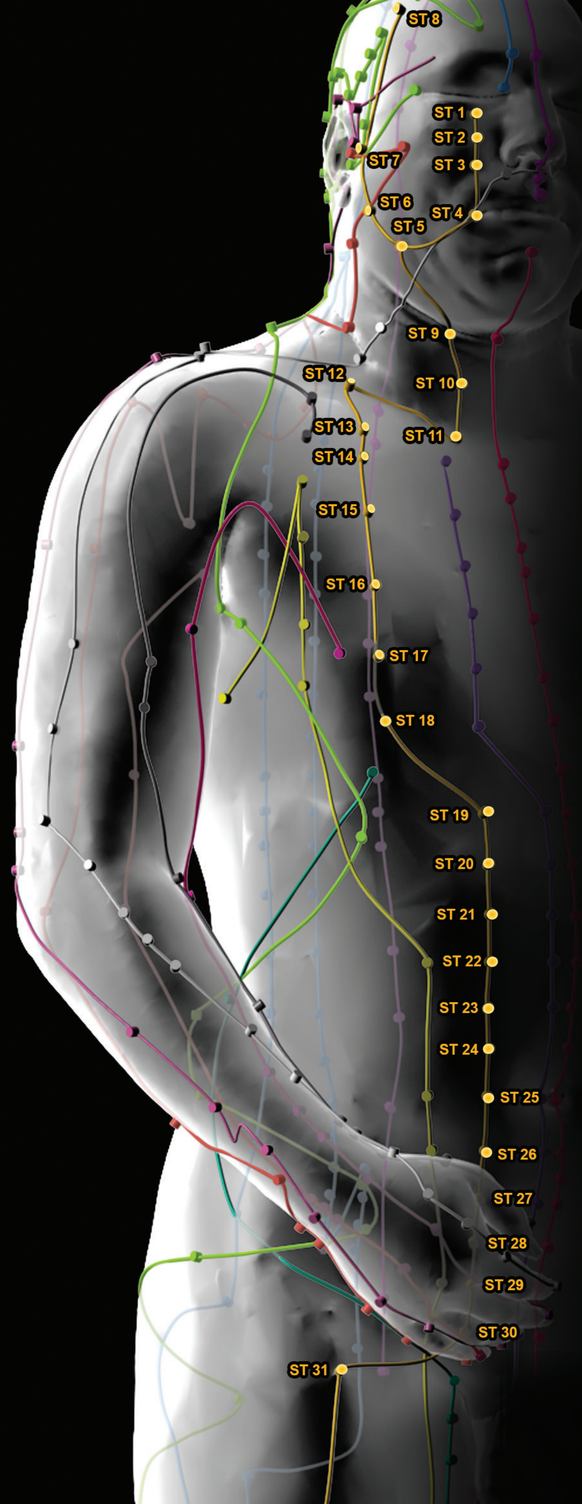
Interactive Medical Acupuncture Anatomy

Narda G. Robinson, DO, DVM, MS, FAAMA





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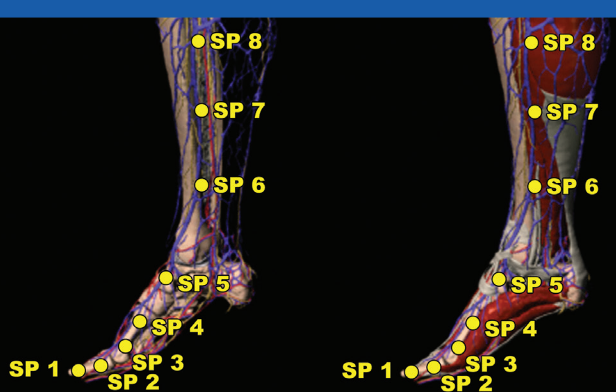

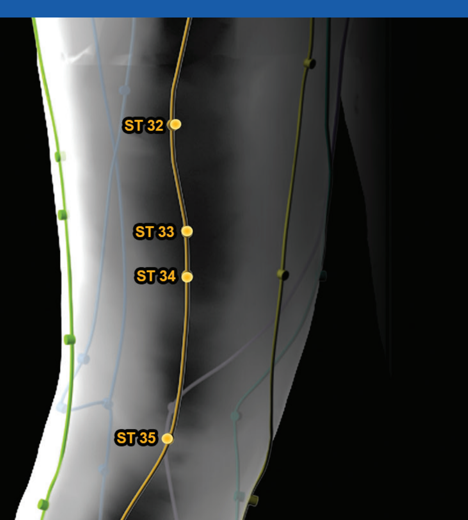

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Preface

Awakening to acupuncture as neuromodulation permanently transformed my teaching and practice. In contrast to the early days of my acupuncture education, when I hungrily consumed and dutifully assimilated the belief systems required to adopt an energy-based viewpoint, I am no longer willing, nor ready, nor able to accept that acupuncture works through mystical, spiritual processes.

That is, I, like so many others, was taught that needling stirred an unseen electrical force (“Qi”) along invisible lines called “meridians”. When I learned, through mentors such as Deke Kendall, OMD, PhD, that the notion of acupuncture as “energy medicine” possessed neither a scientific nor historically accurate basis, I was shocked. How could this entire domain of acupuncture energetics result from a mistranslation of the Chinese word “Qi” in the early 20th century into “energy”, “for lack of a better word”?

After reviewing the evidence for and against an energy-based mindset in acupuncture, I found no other rational explanation for its effects other than through, primarily, the nervous system. Intellectual honesty forced me to let go of belief systems entirely and instead teach only truth based on science and evidence. Intellectual curiosity led me to find far more beauty and wonder in the anatomy of acupuncture than even the most elaborate fairy tales ever could.

What I discovered inspires me endlessly. The modern science of acupuncture replaces the myths and metaphors of yesteryear with detectable mechanisms and measurable outcomes. The neurovascular channels beneath the skin allow us to both literally and figuratively “connect the dots”, i.e., acupuncture points. The anatomical structures assembled at each site tell of their function and thus their effects.

Acupuncture then becomes more accessible, predictable, and sensible. Knowing which nerve pathways to target and why constitutes the cornerstone of noninvasive neuromodulation with acupuncture. Starting at the acupuncture point, one can follow a nerve’s centripetal course to the spinal cord, autonomic centers, and the brain. The nervous system’s responses to scientific medical acupuncture and related techniques thereby become clear, as fact replaces fiction.

Dedication

To my parents, Evelyn and Leonard, who brought me from formless to form, whose love and support gave me the strength and courage to find my own path.

To my brother, Larry, who inspired me to become not only a physician, but an osteopathic physician.

To the ancient Chinese, whose system of point and channels provides me endless amazement.

To Joseph M. Helms, MD, FAAMA, who flung the door to a life filled with discovery and meaning open wide.

To Deke Kendall, OMD, PhD, who caused me to question and rethink what I'd learned, allowing me to find deep fulfillment in a system of knowledge based on indisputable facts and realism.

To Joseph Wong, MD, whose clear message concerning the simple truths of neuroanatomical acupuncture stay with me to this day.

To Dave Mishlove, my life partner, who further cultivated in me a taste for authenticity, a penchant for integrity, and the strength to stand for truth amid staunch opposition.

Acknowledgments

This book and CD resulted from the extraordinary talents and commitment of several individuals, including:

The Visible Productions team, with special thanks to Stew Crawford who provided the computer programming for the CD and Amanda S. Almon, the medical illustrator and computer animator, who patiently worked with me to place the points and lines on the Visible Human anatomy images.

The folks at Teton NewMedia and Fiftysix Forty Design, including Sue Haun, creative director, whose expertise provided a book that is functionally and aesthetically pleasing, as well as Mike Albiniak, production manager, who worked with the project from start to finish to produce the internal layout. Special thanks as well to John Spahr, principal owner of Teton NewMedia, and Carroll Cann, the editor in chief, who saw value in the project and brought it to fruition.

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The Science of Acupuncture Neuromodulation

Chapter 1:: From Metaphors to Modern Medicine

Chapter Highlights

To know acupuncture, know anatomy.
To know neuromodulation, know neuroanatomy.
Neuromodulation explains acupuncture.

Neither mysterious nor nebulous, the wisdom of acupuncture unfolds clearly and readily through the study of anatomy – specifically, neuroanatomy. Acupuncture anatomy eliminates the need to substitute science with myths and metaphors. Scientific investigations have identified and verified many of the mechanisms by which acupuncture and related techniques benefit the central, peripheral, and autonomic nervous systems. Needling results in neuromodulation. Neuromodulation interlocks the events that take place from neuron to brain and back again – no belief systems required.

What Is "Neuromodulation"?

Neuromodulation is a process of engagement with neural structures that helps to normalize nerve function. It reduces excessive firing of nociceptive pathways and improves the ability of endogenous analgesic mechanisms to counteract spinal cord windup and dampen the perception of pain. Effective neuromodulation begins with proper point selection. Neuroanatomically specific acupuncture protocols pinpoint a patient's presenting problem according to where and how it is altering function along the neuraxis and its peripheral as well as autonomic extensions.

By considering the myriad manners in which neural discord mediates and perpetuates aberrant signals, a scientifically based medical acupuncturist outlines neural avenues (i.e., acupuncture points and channels) as well as stimulation methods (e.g., needling alone or the introduction of electrical or laser stimulation) by means of which to restore harmony and homeostasis.[113,114,115,116,117,118,119] That is, neuromodulation impacts sensory, motor, and autonomic activity based on the nerves targeted. The modality and settings selected (e.g., intensity, frequency, and mode of stimulation) further color the patient's physiologic response. The input flows throughout the matrix of the nervous system, from peripheral to spinal nerves, and spinal cord to brain. Brain sites affected include, but are not limited to, the reticular activating system, central autonomic network, the limbic system, brainstem, and the diffuse noradrenergic projection system.[135,142,143]

Neuromodulation began long ago with acupuncture and electrotherapy;[120,121] modern medicine has created more direct interventions through implanted units. Whether they prove more effective, cost-saving, and safer than manual acupuncture (MA), electroacupuncture (EA), or laser acupuncture (LA) requires research comparing techniques head to head.

As with acupuncture, the aforementioned implanted stimulators have benefited patients with pain,[122] epilepsy, neurogenic bladder secondary to spinal cord injury, fecal incontinence, constipation, erectile dysfunction, interstitial cystitis, and lower urinary tract dysfunction (incontinence, overactive bladder, urinary retention).[123] Additional conditions include chronic, refractory angina pectoris,[136] migraine,[137,138] spinal cord injury,[139] and complex pain problems.[140]

Curiously, those who utilize implanted stimulators often insert them along similar nerve pathways as acupuncturists address. For example, implant-driven nerve stimulation for refractory overactive bladder focuses on the posterior tibial nerve.[124,144,145] Acupuncture treatments for urinary voiding dysfunction also focus on the tibial nerve with points such as KI 3, KI 4, KI 5, and SP 6.[125]

Vagal nerve stimulation (VNS) for seizure control offers another example.[126,127,128,129] Electrodes implanted in the cervical portion of the vagus nerve interrupt or abolish experimentally induced motor seizures.[130] Acupuncturists may also choose points on the face or head that speak to the vagus nerve through crosstalk with the trigeminal nerve. Auricular acupuncture opens another door to neuromodulating vagal function. Veterinarian acupuncturists treating epilepsy in dogs may select ear points such as Shen Men, a point shown to have value for seizures in rats as well.[131,132,133] Auricular Shen Men falls into the zone supplied by the auricular branch of the vagus nerve (cranial nerve X, or CN X).[134] Thus, whether through implanted electrodes or inserted acupuncture needles, VNS modifies brain activity and can reduce seizure activity in some cases.[146]

"What If I Prefer to Think of Acupuncture as Moving Energy Instead of Stimulating Nerves? Does It Matter?"

Yes, it matters. Shifting the dialogue from metaphors and metaphysics to meaningful mechanistic concepts requires a thoroughly different premise. That is, a science-based medical acupuncturist needs a modern medical education along with instruction in myofascial palpation and non-invasive neuromodulation skills. Traditional Chinese Medical (TCM) schools and energy-based physician acupuncture courses continue to teach that acupuncture moves energy they call "Qi". The latter approach demands little verification but much belief. Even today, after having sufficient opportunity to "get it right", Traditional Chinese Medicine (TCM), metaphor-based practitioners are still struggling to validate their TCM diagnostic approach. In other words, even experienced TCM acupuncturists cannot come to agreement in their metaphoric analyses of patients in studies after studies.[147,148,149]

Lacking tenable processes, a metaphor-based acupuncturist has limited rational rationales to rely on when deciding on which points to choose. Treating a headache of the "Liver Yang Rising" or "Qi Disturbance" variety affords mostly abstract analysis of the cause and effect. Although the liver often receives much of the blame in causing TCM headaches, the physical liver usually has little to do with producing head pain in most people. Other assessments involving disturbances in Qi, Yang, Yin, and Phlegm also miss the mark by resorting to stand-ins, i.e., metaphors, in place of the actual anatomic, physiologic, and pathologic problems. As such, TCM point selection usually resorts to metaphorical solutions rather than novel protocols based on the patient's actual pathology.[150] Point selection relies more heavily on rote memorization of empirical protocols that give the practitioner minimal insight into why those protocols work from a biological perspective. To illustrate the difference between a metaphoric and scientific view of point effects, review the comparison in Table 1-1.

In contrast, a science-based medical acupuncturist treating head pain would, in practice, ordinarily strive to define the true cause, location, and myofascial relationships to the headache. Even if s/he defaults to a standard protocol for research or training purposes, the mechanisms by which acupuncture affects patients remain clear. To illustrate this, a group of Taiwanese researchers assembled a group of migraine sufferers in order to compare the value of acupuncture and a drug (topiramate) for prophylaxis of headache in chronic migraineurs.[151] Points selected for all sixty-six participants were the same: BL 2, GB 20, Taiyang, and Yintang. The rationale? "All of the selected acupoints were in the distribution of trigeminal and cervical dermatomes related to the trigeminal sensory pathway." Simple. Again, according to the authors, "It is assumed that a variable combination of peripheral effects, spinal and supraspinal mechanisms, and cortical, psychological or "placebo" mechanisms contribute to the clinical effects of acupuncture. Current theories suggest that migraine is a neurovascular disorder involving cortical spreading depression, neurogenic inflammation, and vasodilation. Sensitization and facilitation of pain transmission in central trigeminal sensory pathways may have a particularly important role in the development of CM (chronic migraine). A recent study suggests that acupuncture may have anti-inflammatory action via release of neuropeptides from nerve endings, including calcitonin gene-related peptide (CGRP), an important mediator of neurogenic inflammation and a potent dilator during migraine attack. We selected acupoints in the distribution of the trigeminal and cervical dermatomes because we postulated that an interaction between trigeminal and cervical nociceptive inputs to the trigeminocervical complex via acupuncture may inhibit trigeminal-vascular activation and thus may inhibit migraine attack….It is…important to understand what roles the peripheral as well as the central mechanisms have in CM patients after acupuncture treatment in future studies."

"Isn't Medical Acupuncture "Reinventing" Acupuncture Into Something It Never Was?"

Absolutely not. Admittedly, those already wedded to the metaphorical conceptualization brought to us by TCM may resist the need to learn the biological basis of disease, the anatomical basis of acupuncture, and the physiology of neuromodulation because they believe that a scientific approach to acupuncture is somehow new or foreign to China.[152] This is false. In fact, acupuncturists in China have been striving to practice scientifically for decades, with Zhu Lian making many important strides back in the 1950s.

That is, while the French were reworking acupuncture into an abstract system of "French Energetics" (see the section on George Soulié de Morant, below), Communist China created "The New Acupuncture" with the help of Zhu Lian, a physician trained in Western medicine who held several influential medical posts in China.[68] In keeping with the goal of the Communist Party leader Mao Tse Tung to integrate Chinese medicine with modern science, Zhu Lian, "strongly advocated the application of anatomy and western medicine in acupuncture". Zhu Lian pioneered the neuroanatomic basis of acupuncture well before Mao Tse Tung created Traditional Chinese Medicine (TCM) in the mid-twentieth century. In so doing, she unraveled many former mysteries through her extensive anatomical knowledge.[153] She saw acupuncture's influences as working to "stimulate and modulate the regulatory and control functions of nerve cells."[154]

Scientific research has only bolstered Zhu Lian's visions from the 1950s, as she hoped would happen. Even back then, however, she noted:

"The locations of the fourteen meridians roughly correspond to the anatomical distribution of excitors. Responses of the human body to acupuncture stimulation can basically be explained by neuroscience. Knowledge of higher nerves, however, was not available to ancient therapists, and hence discrepancies inevitably arose, because traditional acupuncturists, without a full understanding of neurology, simply formed associations between acupoints and internal organs."[155] That is, as aforementioned, non-scientific acupuncturists are frequently unaware of how their needling treatments actually work even today. Moreover, although Zhu Lian wanted acupuncture to survive and felt that exposing its factual, rational basis would allow it to do so, politics prevailed and TCM became increasingly engulfed by its murky metaphors.

When it moved west, TCM fell victim to even more myths; the American and European appetite for metaphysics unfortunately prevailed. The term "TCM" only adds to the confusion. That is, although the "T" stands for "Traditional", connoting a long-standing medical system, the Chinese Communist Party invented TCM only fifty years ago, during the years 1953-1956.[70,71] TCM is "a medical construct distinct to Communist China" and symbolizes "the standardized, government- created, institution-bound medicine that has existed in the PRC since 1956."[72] The first Outline of TCM became available in Communist China in 1958, published by the Beijing People's Health Publishers. It was designed to help fulfill the government's goal of having "doctors of Western medicine study Chinese medicine."[73]

In her book, *Chinese Medicine in Early Communist China 1945-1963,* Kim Taylor described the events surrounding the creation of TCM. "The formulation of a basic theory of Chinese medicine was an extraordinary feat, the ultimate in the manipulation of knowledge and its subsequent validation at the hand of politics."[74] She continued: "In general, the main aim of these "Basic Theories of TCM" was to simplify Chinese medicine and to reduce two thousand years of controversy and debate into one easy-access nutshell. This compromises every level of the physician's encounter with the patient, from examination to diagnosis through to prescription. Therefore this newly established theory of TCM simplifies the process of the identification of illness and the appropriate dispensation of drugs to a few basic steps. Such is the structured and measured packaging of a ready-to-use TCM designed for institutional consumption in twentieth- and twenty-first century Communist China."[75]

On the other hand, both in- and outside of China, science-based acupuncturists continued to pursue acupuncture demystification. As one practitioner in the mid-1960s stated:

"If we wish to be taken seriously, and not to be confused with bone-setters or faith-healers, we must abandon the whole more or less Chinese mass of philosophy, cosmogony and mythology in which we have been entangled these forty years past. Let us clear the decks, and look at our problems without preconceived ideas. The study of the anatomy and physiology of the skin, and of the central and sympathetic nervous systems, the investigation of the physico-chemical and enzymic reactions in the body, all these should provide us with the means of solving the problem of what acupuncture really is and does."[1]

Scientific acupuncturists agree that acupuncture depends on nerve function. In 1972, the Peking Acupuncture Anesthesia Coordinating Group reported, "About half of the known acupuncture points are located right over various nerves and the rest are within half a centimeter of one or another nerve. From this, the conclusion was drawn that acupuncture acts in fact on the nervous system, and it is through a nerve that the stimulus produced by needling or applying a mild electric current is transmitted to a certain part of organ of the body where it effects a cure or brings about a state of analgesia."[21] The number of reports showing that acupuncture works via the nervous system began its rapid expansion in the mid-1970's and has continued ever since.[5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20]

Indeed, if acupuncture worked by moving energy, not nerves, then severing nerves should not abolish the body's reaction to needling. However, complete transection abolishes its effects and partial injuries minimize them.[2] This is not to say that acupuncture treatment should be avoided in cases of peripheral nerve, brain, or spinal cord injury, because needling therapy plays an important role (when given the opportunity) in helping patients recover from or contend with these conditions. Rather, it is intended to emphasize the central significance of the nervous system in medical acupuncture and related techniques.

In fact, by now, the neural basis of acupuncture has become so clear that certain authors are replacing the conventional alphanumeric naming system of acupuncture points and channels with nerve names – not remote and possibly imaginary organs as is now the case with commonly accepted nomenclature.[3] This idea,of revising and updating the acupuncture lexicon has a precedent; i.e., over thirty years ago, Dr. Patrick Wall, the co-developer of the gate control theory, felt that a new classification system based on acupuncture points and nerves was overdue.[4]

"You Say "To-May-To" and I Say "To-Mah-To": Don't Scientists and Energy-Based Acupuncturists Arrive at the Same Points?"

No, not always. Acupuncturists from either perspective may or may not select similar points. As indicated earlier, a TCM trained practitioner may view headache as Liver Yang dysfunction and select LR 3, LI 4, and GV 20. While the TCM rationale may involve statements about balancing Yin and Yang, expelling evil influences from the liver, or eliminating wind,[156] a neuroanatomic acupuncturists sees the process much differently. Both LR 3 and LI 4 relate to double arterial arch systems in the foot and hand, respectively. These vascular circuits receive heavy investment of sympathetic fibers. Thus, needle stimulation in their vicinity modulates autonomic function throughout the body. GV 20 impacts vagal function through crosstalk along trigeminovagal and cervicovagal routes. It also lies along the sagittal cranial suture overlying the sagittal venous sinus, thereby further impacting autonomic function and cerebral venous drainage. GV 20 overlies the galea aponeurotica as well; needle stimulation at this site aids in reducing occipitofrontalis muscle restriction that produces a "tension headache" type of pain. For migraine headaches per se, a scientifically based medical acupuncturist might add points to address trigeminal nerve dysfunction, as illustrated above. The weight of evidence supporting a neuroanatomic approach emphasizes the importance of selecting points according to actual patient pathophysiology. To wit, chronic migraine sufferers who received acupuncture at points supplied by the trigeminal nerve experienced a significantly larger reduction in moderate/severe headache days than did those in the topiramate group with far fewer side effects.[157]

Even if a metaphoric practitioner chose the same points as the science-based practitioners did in the migraine study just described, an accurate understanding of the ways in which acupuncture improves acupuncture's legitimacy. Quoting Kendall: "Why does anyone care whether Chinese anatomy and physiology are explained as energy flowing through meridians, or by the circulation of blood, nutrients, other vital substances, and vital air (qi) through the vascular system? The answer to that lies in the moral obligation of every practitioner to provide each patient with the latest medical understanding available. The need to continually search for the truth is the most fundamental principle of science and medicine. If the functioning of the human body cannot be understood under normal physiological conditions, then there is little hope of knowing how to treat it when disease conditions exist. Research so far show that the true concepts of Chinese medicine operate under known physiological principles, involving the complex organization of the neural, vascular, endocrine, visceral, and somatic systems, sustained by the circulation of nutrients, vital substances, and oxygen from vital air."[22]

Why Researchers Need to Recognize the Scientific Basis of Acupuncture

Ongoing research in Asia and on other continents focuses on measurable, physiologic changes due to acupuncture, not the vague nuance and mysticism so commonly found in Western acupuncture literature. According to Kendall, the abstract, unscientific idea that acupuncture has an immaterial basis "has kept Chinese medicine on the fringes of conventional care since the 1930s and 1940s".[23] Countless research dollars and hours disappear in the misguided mission of searching for invisible, energy-conducting pathways, yielding little to benefit patients and further the understanding of acupun cture.[24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44] Moffet appears to concur, criticizing methodologic approaches that cling to "unsubstantiated traditional acupuncture theories".[158] He continues: "When comparing acupuncture interventions [e.g., verum and sham approaches], investigators should offer a biologic rationale to support a hypothesis that the exposures are truly different. A clinical trial with indistinguishable exposures is a poor use of resources…If the acupuncture exposures are indistinguishable, then the investigators have failed to control for the placebo effect." Many examples of inadequate sham selection exist in the medical literature. Most commonly, researchers fail to consider the neuromodulatory overlap that happens when verum (real acupuncture) and sham (placebo acupuncture) excite similar nerve pathways.

Why Today's Clinicians Need to Espouse a Rational Premise for Acupuncture

The demystification of acupuncture in no way diminishes its brilliance. Rather, identifying the structure-function relationships between acupuncture point anatomy and clinical indications brings acupuncture closer to its ancient roots than do musings about energetic evolutions. Clinging to outdated jargon may, in fact, prevent patients from seeking appropriate medical attenti on.[45,46,47,48,49,50,51,52,53] For example, informing a patient complaining of chest pain and shortness of breath that they have "Qi and Yin Deficiency"[54] may have been adequate during the Han dynasty, but not today. Rather, prompt medical attention is in order. Similarly, "Liver Fire blazing with Phlegm-Heat" could indicate Graves' disease or even papillary thyroid cancer, and require treatments other than, or in addition to, acupuncture.[55] Patients with "Kidney Yang Deficiency"[56] may actually be experiencing adrenal insufficiency or crisis. One should neither delay nor preempt further diagnostic workup and appropriate medical intervention by seeking to balance an abstract Yin and Yang.[57,58,59,60]

Why, then, do schools and postgraduate courses promote acupuncture metaphysics? Perhaps too few instructors and students have learned about the actual origin of the energy-meridian misconception. Not thousands of years old, not even hundreds, the Qi-as-energy myth was born less than a century ago, a brainchild of a French citizen residing in China by the name of George Soulié de Morant.

George Soulié de Morant's Hope of Acupuncture Metaphysics

No convincing evidence exists that acupuncture works by pushing energy through invisible transmission lines.[61] As the inventor of the energy-meridian concept, George Soulié de Morant, stated, "Having observed the existence of "something" that passes through a meridian when a point is stimulated, the ancients gave this fluidity, this flux, the name qi, which we translate, for lack of a better word, "energy".[62] Because Soulié de Morant lacked medical training and in that he wanted to present Chinese medicine in ways he thought his French audience would understand, he introduced his own bias about how acupuncture worked, i.e., through unseen energies moving through intangible pathways.[63]

Living within the European cultural and philosophical context when he wrote his landmark text, *l'Acuponcture Chinoise (Chinese Acupuncture)*, Soulié de Morant relied on his readers believing his claim of a metaphysical basis for acupuncture. After all, the concept of "élan vital", or immaterial life force, had spread and grown popular throughout Europe. Élan vital was to have produced and shaped all life; notions about this vivifying impulse permeated the philosophy of that era.[64] Yet, not all were convinced; the British biologist Julian Huxley once commented that élan vital offers no better an explanation of life than élan locomotif accounts for the motion of a train.[65]

Nor was Soulié de Morant's book translator, Paul Zmiewski, convinced of the author's claims. Zmiewski noted in his introduction, "While ideas found in modern English texts are often expressed in English words derived from *l'Acuponcture Chinoise,* these words do not always mean what was meant in the classic works upon which *l'Acuponcture Chinoise* is based."[66] About Soulié de Morant's selecting the term "energy" for "Qi", Zmiewski wrote, "At the beginning of the twentieth century concepts like "human energy" were referenced in dictionaries and were considered valid matters for scientific inquiry. Many nineteenth century ideas of nature were still broadly regarded as truths. Today, however, the scientific era that had just begun when Soulié de Morant chose to use the term "energy," has left that word with new and different associations in both popular and scientific writing." As such, even Soulié de Morant's own idea behind the Qi translation has undergone an evolution, independent of its original meaning in ancient China.

Reinventing acupuncture into an "energy medicine" required that Soulié de Morant downplay the importance of anatomy and physiology in Chinese medicine.[76,77] He did not include *The Yellow Emperor's Classic of Internal Medicine* among his translations. Had he done so, as Kendall indicated, he would have found that the early Chinese physicians living between 600 and 300 BCE had compiled "surprisingly accurate and detailed information on the human body, with some of the ideas clearly equivalent to those of modern Western physiology."[78] Unfortunately, this disregard of acupuncture anatomy and physiology promulgated by Soulié de Morant led to an ensuing disinterest by future acupuncturists in the material foundation of acupuncture.

Some even assert, although incorrectly, that ancient Chinese investigators never performed anatomical investigations.[79] Kendall offers two possible reasons for this misconception.[80] First, historians may have assumed that since Confucian teachings proscribed postmortem dissections, they were not performed. Alternatively, some believe that since ancestor worship pervaded the culture especially strongly many centuries ago, those dissecting the body after death would have likely incurred a great degree of ancestral displeasure. Nevertheless, postmortem autopsy likely occurred long before Confucius existed (551-479 BCE), and still took place during his lifetime. Furthermore, the prohibition on autopsies that occurred in some dynasties happened several hundreds of years after the studies mentioned in the Nei Jing were already documented. Information encountered in the Nei Jing attests to the fact that anatomical dissections took place, producing insights into the size, weight, and capacity of all internal organs.[81]

Even the acupuncture channels (jingluo), which many now

Table 1-1

Metaphorical "Actions" of LI4 stimulation, according to Chinese Medicine[85]	Effects of LI4 stimulation, according to Scientific Studies*
Autonomic Influences	
"Regulates the defensive qi and adjusts sweating"	Both high and low frequency electroacupuncture (EA) stimulation of LI 4 (with SI 3) produced short-term cooling.[86]
	Manual and EA stimulation of LI 4 produced long-lasting warming (indicating a sympatholytic effect) after the transient, segmental increase in sympathetic activity that caused a localized, short-term cooling.[87]
	Acupuncture at LI 4 caused an increase in palm temperature, probably due to cutaneous vessel dilation.[88]
	EA at LI 4 selectively activated the sympathetic, but not parasympathetic, nervous system. In so doing, the rhythmic micturition contraction cycle lengthened and urine excretion increased, as did renal sympathetic nerve activity and blood pressure. These results indicated that EA at LI 4 may benefit patients with hyperactive bladder problems.[110]
	EA at LI 4 and LI 11 increased both pain thresholds and muscle sympathetic nerve activity.[111]
Analgesia	
"Expels wind and releases the exterior"; "Regulates the face, eyes, nose, mouth and ears"; "Activates the channel and alleviates pain"	EA diminished dental pain perception; high intensity EA was most effective.[89]
	Naloxone failed to reverse elevated pain thresholds induced by EA, indicating that non-opioid transmitters are involved in dental analgesia.[90]
	Nitrous oxide blocked the effects of electrical stimulation at LI 4.[91]
	Needle manipulation at LI 4 significantly increased pain pressure thresholds.[92]
	Unilateral EA at LI 4 (and LI 11) transiently inhibited the motoneuron pool in the extensor digitorum communis muscle of the contralateral arm, suggesting that EA operates by central effects, instead of or in addition to peripheral influences.[93]
	Transcutaneous electrical nerve stimulation (TENS) at LI 4 reduced the sensation of pain but not vibration.[94]
Effects on the Central Nervous System	
"Restores the yang" (i.e., "for the treatment of collapse of yang characterised by loss of consciousness, aversion to cold, cold counterflow of the limbs, purple lips etc.")	Manual and EA stimulation of LI 4 produce differential brain activation. Manual needle manipulation caused prominent functional magnetic resonance imaging (fMRI) signal decreases in the posterior cingulate and superior temporal gyrus as well as the putamen/insula. EA caused signal increases in the precentral gyrus, the postcentral gyrus/inferior parietal lobule, and the putamen/insula.[100]
	Somatosensory evoked potentials obtained after EA at LI 4 (which activates radial nerve fibers) differ markedly from those obtained after EA at the median nerve.[101]
	Needle manipulation at LI 4 modulated activity in limbic and subcortical gray structures of the brain, as shown by fMRI.[102]
	Brain magnetic fields measured by SQUID (Superconductive Quantum Interference Device) after acupuncture at LI 4 revealed changes in the biomagnetic fields relating to the projection areas of the face and jaw.[103]
	LI 4 stimulation caused a significant increase in the latency and decrease in the amplitude of peaks reflecting primary cortical afferent activities.[104]
	Needle manipulation of LI 4 activated the hypothalamus, supporting the notion that this classical analgesic point works at least in part to reduce pain through hypothalamic activation.[105,106]
	Manual acupuncture to LI 4 activated both somatosensory cortical areas and the periaqueductal gray.[107]
	High-frequency EA at LI 4 induced specific electroencephalographic (EEG) modulation of Theta activity in the midline frontal region. This may reflect reduced activity in the anterior cingulate cortex, resulting in antinociception.[108]
	Needle manipulation at LI 4 activated structures in the descending antinociceptive pathway (i.e., the hypothalamus and nucleus accumbens) and

	deactivated multiple areas in the limbic system associated with pain (rostral part of the anterior cingulate cortex, amygdala formation, and hippocampal complex), indicating ways in which endogenous pain modulation circuits in the brain may function.[109] EA at LI 4 and LI 11 caused a positive spread of activation across the spinal cord segments C5 to T1, with peak activity taking place at C7. Activation occurred at both the dorsal and ventral parts of the cord, indicating that LI 4 and LI 11 can indeed modulate specific spinal cord regions. This study suggests that individuals with sensorimotor deficits arising from these spinal segments may benefit from acupuncture at these points.[112] Magnetic stimulation of LI 4 affected specific brain areas, such as the anterior cingulate cortex, that differed from those influenced by a "mock" point, also on the hand.[159]
Obstetrical Influences	
"Induces labour"	Acupuncture at LI 4 suppressed uterine contractions induced by oxytocin in pregnant rats.[95] Acupuncture at LI 4 inhibited the expression of the cyclooxygenase-2 (COX-2) enzyme and reduced uterine motility significantly.[96] Acupuncture at LI 4 (and SP 6) helped ripen the cervix at term and shortened the time interval between estimated date of confinement (EDC) and delivery.[97] Ice massage on LI 4 reduced labor pain during contractions.[98] Acupressure at LI 4 and BL 67 reduced labor pain during the active phase of the first stage of labor, but did not significantly affect uterine contractions.[99]

call "meridians", originally pertained to actual blood vessels and their accompanying nerves. This makes sense given that acupuncture started as bloodletting. In his essay, "Blood-letting in early Chinese medicine and its relation to the origin of acupuncture", Epler wrote, "The vessels are organic structures, not functional pathways as they were later to become, blood is a fluid, and pneuma is, certainly in part, a material substance, not the "energy" it was later to become."[82] In his *Dao of Chinese Medicine,* Kendall noted, "Replacing the blood vascular system with nonexistent meridians is the single greatest translation error to befall Chinese medicine."[83]

In the context of his nonmedical background and the times in which he lived, Soulié de Morant's mistranslation of "Qi" as "energy" seems forgivable. What is less "okay" is the perpetuation of this mistranslation by educators today, instead of acknowledging the truth, i.e., that in the acupuncture matrix originally referred to the vascular network with its circulating gases, cells, and nutrients. Forcing acupuncture to stay stuck inside a mystique and superstition it long outgrew binds its natural development like foot-binding did to maturing anatomy, unable to reach its full expression.[67] In both the metaphor-based acupuncture model and the torturous practice of foot-binding, the ideal represented a culturally repressed esthetic as opposed to reality, a system of sustained immaturity weakened by those who curtail proper expansion and innate capacity.

How do acupuncture researchers, educators, and clinicians undo the damage done by this prodigious misstep in acupuncture's history? Like most recovery programs would insist, those addicted to the energy-meridian paradigm need to begin by telling the truth. The time is now to set the record straight and acknowledge the rational, anatomic, and scientific basis of acupuncture.

Summary

The specificity and multiplicity of verifiable and reliable outcomes obtained by scientifically studying a point such as LI 4, as outlined in Table 1-1, illustrate the advantages of allowing acupuncture to mature into a modern medical treatment based on neuromodulatory actions. The steps toward manifesting this transformation first require a comprehensive grasp of neuroanatomy as it relates to acupuncture points, thus the purpose of the book.

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Chapter 2:: Function Follows Form

Key Points

The science of neuromodulation endows acupuncture with a factual, rational basis and a neuroanatomic framework. Together, the science of neurophysiology and the instructional attributes of anatomy inspire cogent and sophisticated protocols for scientific, medical acupuncture and related techniques (SMARTs).

The outcome of a neuromodulation treatment depends on the regions, types, and number of nerves activated, as well as the method of stimulation selected.

Acupuncture stimulation most immediately affects one or more of the three types of peripheral nerves:

- **Motor**
- **Sensory**
- **Autonomic**

Stimulation methods involved in medical acupuncture include but are not limited to:

- **Dry needling, otherwise known as manual acupuncture (MA)**
- **Electroacupuncture (EA)**
- **Laser acupuncture (LA)**
- **Acupressure**

Comprehensive treatment entails three steps:

- **Determine the problem; understand its nature, location, and origin**
- **Identify neural avenues that produced and perpetuate the problem; consider how neuromodulation can affect these or other nerves to undo the damage and promote recovery**
- **Influence nerves from the peripheral, central, and autonomic nervous systems**

Understand the Function of Acupuncture Points through their Anatomy (Form)

For ages, philosophers and physicians have recognized the inseparable partnership of anatomy and physiology.[282,283] Investigating ways in which form meets functions in acupuncture illuminates the wealth of wisdom layered into each needling site. Systematic analysis of the local anatomy uncovers the effects of stimulating a point with delightful directness. Metaphorical medicine then dissipates and dissolves like fog in the morning after a night of rain; science, like the sun, burns away clouds of uncertainty with beams shining light on the ways in which acupuncture actually works.

Not merely an intellectual exercise, the anatomy of acupuncture impels clinicians to ask more precise questions about their patients and informs their thinking fingers during myofascial assessment of them.

In the examination process, one asks, "Is this where it hurts?" as the examiner's hands seek to find tension and tenderness. Three-dimensional anatomy reveals underlying reasons for numbness and weakness by disclosing regions where muscles course over and around nerves. Structure and function show why tension and pain result and where they require intervention. In other words, myofascial impediments may impair nerve communication. Nerve entrapment due to myofascial restriction, fascial bands, or scar tissue may block a signal from reaching its destination or alter its message. Thorough, informed palpation frequently allows the medical acupuncturist to detect sites of nerve compression through findings of tissue tension and tenderness.

Nerves that have suffered from excessive or prolonged pressure, overstretching, or starvation from of insufficient oxygenation and nutrients through poor circulation can become neuropathic. Neuropathic nerves transmit erroneous information. Like trying to carry on a conversation along a poor cell phone connection, injured nerves relay distorted or interrupted messages. Depending on the nerve's job in life and specialization, the patient may experience alterations in sensory, motor, and/or autonomic message delivery. As a result, instead of accurately reporting information about position sense, pain, touch, and so on, neuropathic nerves may cause the patient to feel pain instead of touch or pressure (allodynia) or find a mildly uncomfortable stimulus to cause unbearable pain (hyperalgesia).

Dysfunctional muscle tissue and related neural networks produce myofascial trigger points. Myofascial trigger points, a nearly ubiquitous phenomenon, can cause peripheral nerves to become neuropathic and inflamed due to their chronic nature and tendency to worsen and multiply if left untreated. Attending to trigger point dysfunction with neuromodulation through needling and related techniques is a major process by which acupuncturists benefit their patients.

Where do trigger points occur? One finds most myofascial trigger points in the middle of the muscle belly where the majority of muscle spindles and motor endplates lie as well as in the myotendinous junctions, occupied by Golgi tendon organs. Due to their profound roles in producing and perpetuating pain and dysfunction, these sites of highly specialized nerve endings in muscles and tendons become critical targets for acupuncturists. For example, an acupuncturist may select Gallbladder 20 and 21 (GB 20, GB 21) for myofascial pain the shoulder-neck region. GB 20 is located at the myotendinous attachment of the upper portion of the trapezius, and GB 21 lives in the middle of its muscle belly.

On a broader scale, truncal anatomy (as shown in the layered as well as cross-sectional anatomy in the upcoming chapters) bespeaks how form and function affect both soma and viscera. How do the nerves occupying BL 23 on the body wall affect the kidney? The answer becomes clear when considering the spinal segmental nerve supply that both sites share. Interneurons in the spinal cord yoke neural traffic from the small of the back with signals stemming from the depths of the abdomen and pelvis. Palpation of the paraspinal muscles along the entire back reveal results of aberrant neural traffic from facilitated spinal segments in the form of tissue tenderness, tension, and restriction. These findings of myofascial dysfunction along certain spinal segments serve to raise our awareness of potential somatic and/or visceral disturbances in the body realms subserved by this spinal cord "real estate". This then informs both our diagnosis and treatment of the patient.

Layered and cross-sectional anatomy images also uncover structures beyond our fingers' reach. The bony calvarium keeps us from touching the brain and its vessels. Through the translucent skull in the Visible Human images in this book, connections between channels and vessels such as the Governor Vessel (GV) and the superior sagittal venous sinus remind us of the original, vascular basis of acupuncture as a whole and the eight singular vessels in particular. The Governor Vessel's counterpart, Conception Vessel (CV), represents the vena cava, whose relationship to the overlying central CV on the surface of the anterior (ventral) trunk now makes sense. Clinically, one may detect expansions of the often forgotten collateral venous drainage pathways when the vena cava obstructs, making the connection between deep, interior processes and the body surface, visually striking. In this way, channels' interconnections from deep to superficial and from one to another bring to life the meaning behind the metaphor in ancient writings on acupuncture. Today, scientific pursuits elaborate on these early insights and draw detailed descriptions of how acupuncture and related techniques influence form and function. Let us begin at the point-stimulus juncture.

The Needle-Tissue Interface

In acupuncture, the "rubber meets the road" at the needle-tissue interface. Like tires on pavement, the acupuncture needle must engage with its surroundings in order to gain traction and cause change. When rotated, the acupuncture needle attracts and pulls on collagen and possibly muscle fibers, causing them to grab its shaft. This bond between metal and fibers forces the tissue to respond and initiates a conversation with neighboring nerves, fascia, and fibroblasts.

The message spreads to nearby cells, culminating in a wave of tissue deformation and neural discourse that travels beyond the immediate vicinity. If the needle has reached muscle, the impact of treatment intensifies.[284] Nerves ferry information about the event in both an orthodromic (toward the spinal cord) and antidromic (toward the nerve's terminals) direction along a channel.

The Peripheral Nervous System's Subspecialists: Nerve Endings

In addition to proprioceptors such as muscle spindles that respond to changes in length and Golgi tendon organs that assess tension, a number of other receptors in tissue act as an interface between the external environment and the nervous system. This allows the acupuncturist to employ treatments that adjust or alter sensory input with the aim of supporting the healing process. Knowing the types of nerve endings typically found at acupuncture sites gives the medical acupuncturist a better understanding of the likely outcome of stimulating those points. For instance, if the acupuncture point overlies a blood vessel, a needle tugging on fascia nearby may stimulate its nervi vasorum (vascular nerves). These adrenergic fibers control vessel wall tone. As such, the effects of needling this site could involve neuromodulation of circulation and blood pressure regulation. An example of this type of point is Lung 9 (LU 9).

Acupuncture Points as 3-D Structures

Acupuncture points are three-dimensional events, not static dots on the skin surface. This fact converts the rather simple activity of inserting a needle into a multilayered excursion into a patient's bodily habitus. The dialogue between form and function deepens as the needle traverses skin, then fat, then fascia, muscle, and maybe periosteum. At each level, tissue resistance to the needle tip's travel tells of the tension and tone it encounters. Too much or too little of either tension or tone can signify dysfunction and/or disease.

When the treatment involves trigger point deactivation, attention to tissue texture and tension changes becomes paramount. Isolating a patient's source of pain precedes its elimination. When patients exclaim, "That's it! That's where the problem is!", it confirms palpatory findings. Re-examination through palpation and patient feedback after dry needling verifies or denies that the trigger point has responded. Trigger point deactivation serves as a profound example of the dynamism between form and function that takes place through the needle conduit.

Nerve Chat

Nerves serve as the body's social medium. Not shy, they publicize their messages broadly, speaking to everyone who will listen, whether organs, glands, vessels, muscles, fascia, and other nerves. The messages they send may be momentary, such the faint brush of a breeze going by, or lifelong, as in the case of childhood onset Crohn's disease. Similarly, their emotional and somatic sequelae may place a temporary or permanent imprint, depending on how many signals they send each time they complain, and how long their upset lasts. The "complaint department", i.e., the central nervous system (CNS), responds to neural reports of pain and distress with attempts to alleviate them. If unsuccessful, neural plasticity makes the CNS a codependent partner by prolonging the problem, leading to hyperalgesia, allodynia, inflammation, sympathetic hyperactivity, muscle tension, and long-term stress.[285]

By the time a patient presents for treatment, pain and dysfunction have usually existed long enough to cause a collection of problems. This behooves the medical acupuncturist to develop a neuromodulatory intervention that addresses several levels. It is therefore not enough to ask how the chief complaint started and where it hurts, but also why is it continuing and how does it express itself in the structure (myofascia, posture, joint mobility), viscera (organ, metabolic, and glandular activity), and emotions (anxiety, depression, withdrawal, confusion)? Has the problem not only influenced function, but is it also now altering form?

Acupuncture neuromodulation should, to the degree possible, address each aspect of a patient's discord; i.e., its central, peripheral, and autonomic components. This likely will require several treatments.

Acupuncture Neuromodulation

Neuromodulation is a naturally occurring phenomenon, allowing the body to respond and adapt to endogenous and exogenous stimuli. It provides for the protection, homeostasis, and repair of the organism.[2,3,4,5,6] Sometimes, though, autoregulatory processes either falter or fail. Acupuncture is simply a somatosensory input that assists the body in making the neuromodulatory changes necessary to regain health and homeostasis.[7]

Acupuncture neuromodulation signals initiated near needling sites propagate along nerves toward the CNS.[1] Connections at the spinal cord can course in several directions. The cord may 1) send efferent signals back out to the periphery (leading to antidromic activation of free nerve endings at the site of needling), 2) loop into related visceral neural networks and alter internal organ function in a spinal segmental manner, 3) foster endogenous opioid release in the dorsal horn of the spinal cord to reduce spinal facilitation, or "wind-up", and block pain, and/or 4) proceed to higher centers in the brain, altering neural and hormonal functions. When these impulses arrive at the brain, they influence activity there as well, usually in a beneficial manner.

The Tai Ji symbol illustrates the balanced, intertwining, and evolving relationship between Yin (black) and Yang (white), with elements of the complementary partner held by each component (represented by the small circles).

Exactly how the body responds and which parts of the body react depend on the nerves stimulated.[8] However, the body's pre-needling state may also influence outcomes.[9,10] For example, the point ST 36 treats both diarrhea and constipation, depending on pre-treatment gastrointestinal motility status.[11,12] In this way, the same point can either "quiets things down" in cases of hyper-function, or "fire them up" in hypofunction.

Yin and Yang in the Modern Era

TCM terms such as "Yang Excess" and "Yin Deficiency" can now be viewed as sympathetic hyperfunction or parasympathetic hypofunction.[13,14] Disease states that illustrate Yang Excess include hyperthyroidism and acute fever. "Deficient Yin" describes parasympathetic hypofunction, most dramatically depicted by toxic exposure to anticholinergics, or parasympathetic antagonists. In this case, the victim turns "red as a beet, blind as a bat, dry as a bone, mad as a hatter, and hot as hell".[15]

Conversely, "Excess Yin" connotes just the opposite, i.e., parasympathetic hyperfunction and/or sympathetic hypofunction. One might even see a concatenation of autonomic disruption, as in cluster headaches. These patients exhibit both sympathetic hypofunction, manifesting as miosis and ptosis, along with parasympathetic hyperfunction, with rhinorrhea and lacrimation.

Table 2-1 Sympathetic and Parasympathetic Functions[18,19]

Organ	Effects of Sympathetic System (Yang)	Effects of Parasympathetic System (Yin)
Adipocyte metabolism	Causes lipolysis	---
Adipocyte, brown	Causes heat production	---
Adrenal medulla	Causes adrenaline/epinephrine (80%) and noradrenaline/norepinephrine (20%) secretion	---
Arteries in cranium	Vasoconstricts	May vasodilate
Arteries in erectile tissue (helical arteries and sinusoids in penis and clitoris)	Vasoconstricts	Vasodilates
Arteries in heart[20] (coronary arteries)	Transient vasoconstriction, followed by vasodilation	Some vasodilation
Arteries in skeletal muscle	Vasoconstricts (via adrenergic fibers) under resting tone and vasodilates large arteries (via cholinergic fibers) during exercise	---
Arteries in skin and mucosa of face	Vasoconstricts	Vasodilates
Arteries in skin of trunk and limbs	Vasoconstricts	----
Arteries in viscera	Vasoconstricts	----
Esophagus	Motility decreases Sphincters contract	Motility increases Sphincters relax
Eye	Pupillary dilator muscle dilates pupil Contracts tarsal muscle (lifts lid) Ciliary muscle relaxes for far vision	Pupillary sphincter muscle contracts pupil Contracts ciliary muscle
Gallbladder and biliary ducts	Relaxes	Contracts

Table 2-1 Sympathetic and Parasympathetic Functions, Continued

Heart	Increases heart rate Increases atrial and ventricular contractility	Decreases heart rate Decreases atrial contractility
Intestines	Motility decreases Sphincters relax Secretion decreases	Motility increases Sphincters contract Secretion increases
Kidneys	Arterioles constrict	Arterioles dilate
Lacrimal gland	---	Secretes
Liver metabolism	Causes glycogenolysis, gluconeogenesis	---
Lungs	Relaxes tracheobronchial muscles	Contracts tracheobronchial muscles Increases mucous secretions from bronchial glands
Lymphoid tissue	Reduces activity (e.g., of natural killer cells)	---
Nasopharyngeal glands	---	Secretes
Pancreas[21]	Increases circulating glucose Inhibits insulin secretion from the islet beta cells Constricts pancreatic blood vessels	Increases insulin secretion Dilates pancreatic blood vessels
Piloerector muscles	Contracts	----
Pilomotor muscles of the skin	Causes contraction	---
Pineal gland	Increases synthesis of melatonin	---
Prostate, seminal vesicle	Contracts	---
Salivary glands	Weak serous secretion (submandibular salivary gland) Sparse, thick secretion	Profuse serous secretion
Splenic capsule	Contracts	---
Stomach	Motility decreases Sphincters contract Secretion is inhibited	Motility increases Sphincters relax Secretion increases
Sweat glands of the skin	Induces profuse secretion	---
Thyroid gland	Becomes stimulated	
Ureter	Decreases ureteric tone and motility	Increases ureteric tone and motility
Urinary bladder	Relaxes detrusor muscle (small amount) Increases internal sphincter tone and trigone	Contracts detrusor muscle Relaxes internal sphincter tone and trigone
Uterus	Contracts pregnant uterus Relaxes or contracts the non-pregnant uterus	---
Vas deferens	Contracts	---
Veins	Vasoconstricts	---

Instead of relying on abstract concepts of Yin and Yang, studying the autonomic nerve supply to organs and glands yields insights into ways in which illness manifests neurophysiologically. This then opens the door to acupuncture neuromodulation by outlining neuroanatomic expressways that revise neural traffic. Table 2-1 compares the complementary actions of the two limbs of the autonomic nervous system (ANS), designated by tissue or organ. Most viscera receive dual innervation from both sympathetic and parasympathetic limbs of the ANS.[17]

How Acupuncture Points Affect Internal Organs

While needling neuromodulates nerve activity in local structures through direct effects on tissue, its broader, homeostatic value results from reflexes in the spinal cord and brain.

The Spinal Cord Connects the Soma with Viscera

One of the most salient depictions of how the ancient Chinese linked anatomy (structure) with physiology (function) comes from the Back Shu and Front Mu points. These twelve pairs of points (one Back Shu and one Front Mu for each organ) act upon certain sections of the spinal cord. Their associated spinal cord levels house interneuronal connections connecting pathways that produce reflexes between acupuncture points on the body surface (soma) and internal organs (viscera).

The paraspinal Back Shu points run along the inner Bladder channel from the thorax to the sacrum. The Front Mu points occur on the lateral or anterior aspects of the trunk and generally receive nerve supply from spinal cord segments that overlap with those of the Back Shu points.[122] Back Shu points receive innervation from the dorsal (posterior) ramus of a spinal nerve, while the Front Mu points occur along dermatomes of the same, or neighboring, spinal nerve, supplied by either the lateral or ventral (anterior) ramus.

Because each organ and its associated pair of Back Shu and Front Mu points often share innervation from similar or overlapping spinal cord levels. In the spinal cord, neurons in the deep layers of the dorsal horn receive convergent input from somatic structures and viscera.[124]

Unhappy nerves arise from unhappy organs and body wall structures such as tense or painful muscles and fascia. Nociceptive neurons, when activated, bombard the spinal cord with tales of woe.[123] They become more excitable and fire more readily in response to stimuli. This phenomenon of central nervous system excitation is known as "wind-up" or "facilitation".[125,126] Sensitized neurons will, in some cases, trigger impulses spontaneously, long after the initiating insult has ceased causing tissue damage or irritation. Cells receiving muscle input in the intermediolateral gray column of the spinal cord, where preganglionic autonomic cell bodies reside, become hyperactive as well, propelling a loop within the sympathetic system that participates in the process of referred hyperalgesia.[127]

Central sensitization amplifies output to both visceral and somatic structures. Sympathetic efferent neurons in the thoracic and lumbar spinal cord segments join in this dysfunctional dance. Muscles supplied by sensitized segments become tense due to increased output through somatic motor neurons, causing sustained muscle contraction. This engenders myofascial dysfunction and trigger points.[128] Heightened sympathetic tone drives vasoconstriction and edema; it also amplifies tissue tenderness and texture changes.[129,130,131,132,133]

Organs receiving neural input from "wound up" spinal segments experience decreased perfusion due to sympatho-excitation.[134,135] Conceivably, compromised blood flow in an organ could, over time, lead to insufficiency or, ultimately, failure in that structure. In the kidney, for example, activated renal sympathetic nerves reduce renal blood flow, increase renin secretion, and increase renal tubular sodium reabsorption.[136] Should counteracting autoregulatory controls falter or prove insufficient, hypertension may result.[137]

In practice, an acupuncturist palpates the entire group of Back

Table 2-2
Sympathetic Input to the Back Shu and Front Mu Points[157,158]

Organ	Sympathetic Preganglionic Levels[159,160,161,162]	Site of Synapse of Pre- and Post-Ganglionic Sympathetic Neurons[163]	Course of Nociceptive Afferent Pathways into the Central Nervous System*[164]	Associated Back Shu Point and Vertebral Level**	Associated Front Mu Point and Dermatome Level
Lungs (including the trachea and bronchi)	T2-T7, to upper thoracic sympathetic ganglia	T2-T6 sympathetic ganglia	Afferents travel with the sympathetics to the dorsal root ganglion neurons from T2-T7 and the vagus nerve to the nucleus tractus solitarius (NTS) in the medulla	**BL 13;** T3	**LU 1;** C4,T2
Pericardium	T1-T5, to upper thoracic and cervical sympathetic ganglia	All cervical sympathetic ganglia and T1-T5 sympathetic ganglia	Afferents travel with the afferents in the middle and inferior cervical sympathetic cardiac nerves and the thoracic sympathetic cardiac nerves and enter the cord from T1-T5	**BL 14;** T4	**CV 17;** T4
Heart	T1-T5, to upper thoracic and cervical sympathetic ganglia	All cervical sympathetic ganglia and T1-T5 sympathetic ganglia	Afferents travel with the afferents in the middle and inferior cervical sympathetic cardiac nerves and the thoracic sympathetic cardiac nerves and enter the cord from T1-T5	**BL 15;** T5	**CV 14;** T7
Liver	T5-T10, to superior thoracic (greater) splanchnic nerves and celiac plexus	Celiac ganglion	Afferents travel with the sympathetics and enter the cord from T5-T10	**BL 18;** T9	**LR 14;** T8, T9

Table 2-2 Sympathetic Input to the Back Shu and Front Mu Points, Continued

Gallbladder	T5-T10, to superior thoracic (greater) splanchnic nerves and celiac plexus	Celiac ganglion	Afferents travel with the sympathetics and enter the cord from T5-T10	**BL 19;** T10	**GB 24;** T9
Spleen (Pancreas)	T5-T11, to superior thoracic (greater) splanchnic nerves and celiac plexus	Celiac ganglion	Afferents travel with the sympathetics and enter the cord from T5-T11	**BL 20;** T11	**LR 13;** T10, T11
Stomach and Duodenum	T5-T11, to superior (greater) and middle (lesser) thoracic splanchnic nerves and celiac plexus	Celiac ganglion	Afferents travel with the sympathetics and enter the cord from T5-T11	**BL 21;** T12	**ST 25;** T10
Triple Heater (adrenal)	T7-L2, to superior (greater), middle (lesser), and inferior (least) thoracic splanchnic nerves and the first +/- second lumbar splanchnic nerves	Chromaffin cells of adrenal medulla	None reported	**BL 22;** L1	**CV 5;** T11, T12
Kidney	T10-L2, to middle (lesser) and inferior (least) thoracic splanchnic nerves and the first +/- second lumbar splanchnic nerves → celiac and renal plexuses	Celiac and aorticorenal ganglia	Afferents travel with the sympathetics and enter the cord from T10 to L2	**BL 23;** L2	**GB 25;** T12
Large Intestine	• **Cecum and appendix:** T10-T12 (cecum, appendix) to the superior (greater) and middle (lesser) thoracic splanchnic nerves → celiac and superior mesenteric plexuses • **Colon to the splenic flexure:** T10-L1 to the middle (lesser) and inferior (least) thoracic and first lumbar splanchnic nerves • **Splenic flexure to the rectum:** L1-2 through to the S2-S4 sacral chain ganglia, to the lumbar and sacral splanchnic nerves → inferior mesenteric and inferior hypogastric pelvic plexuses, to the	Superior and inferior mesenteric ganglia and ganglia in superior and inferior hypogastric plexuses	• **Cecum and appendix:** Afferents travel with the sympathetics and enter the cord from T10 to T12 • **Colon to the splenic flexure:** Afferents travel with the sympathetics, course through the superior and inferior mesenteric plexuses and splanchnic nerves, and into the cord from T10 to L1 • **Splenic flexure to the rectum:** Travel with the parasympathetic nerves and the pudendal nerves, into the cord at S2-S4	**BL 25;** L4 (receives sympathetic supply from T10-L2)	**ST 25;** T10
Small Intestine	T8-12 right, T8-T11 left, to the superior (greater) and middle (lesser) thoracic splanchnic nerves to the celiac plexus	Celiac and superior mesenteric ganglia	Travel with the sympathetics through the celiac and inferior mesenteric plexuses, into the cord from T8-T11	**BL 27;** (receives sympathetic supply from T10-L2)	**CV 4;** T12
Bladder	T11-L2 to the middle (lesser) and inferior (least) thoracic splanchnic nerves	Inferior mesenteric ganglion and sacral paravertebral ganglia	Travel with the parasympathetic nerves and some sympathetic afferents, to enter the cord at S2-S4 and L1-L2	**BL 28;** S2 (receives sympathetic supply from T10-L2)	**CV 3;** L1

*The afferent pathways listed in this table only pertain to the nociceptive avenues. Afferent fibers carrying other sensory information exist but have not been included here.

**Note: Sympathetic input to each spinal level is generally multi-segmental. That is, the tissues located in the vicinity of the Back Shu points along the inner line of the Bladder channel likely receive sympathetic supply from a spinal segment above and below that noted in the table.

Shu and Front Mu points in order to indirectly assess the function of the related organs. The point-organ relationships in the Shu-Mu system are arranged in a topographical fashion, with more cranial organs such as the lung and heart relating to more upper thoracic Shu-Mu point pairs, and more caudal organs such as the urinary bladder and large intestine showing up in the caudal point pairs. (See Table 2-2.)

Shu-Mu palpation should assess tension and tenderness in the muscles beneath the point, rather than merely the skin or subcutaneous tissue. Pain referred from an irritated viscus begins in deep somatic structures.[138] However, trophic changes in the skin follow visceral disturbances, as evidenced by thickened subcutaneous tissue and atrophic skeletal muscle.[139] When both members of the Shu-Mu pair demonstrate tenderness to palpation, assessment of that organ system would be prudent, since this may suggest visceral, rather than predominantly somatic dysfunction.[140,141,142,143,144]

Upon finding tender Shu-Mu points, an acupuncturist typically treats them, with the goal of reducing spinal cord windup and associated organ dysfunction. Mild, non-painful stimulation such as that provided by acupuncture may reduce pain and sympathetic hyperactivity in regions supplied by similar metameric/neuromeric/segmental fields.[145]

Table 2-2 also shows which spinal segments feed supply structures associated with the Back Shu and Front Mu points, the sites of synapse of pre- and post-ganglionic sympathetic neurons, and the course of nociceptive afferent pathways back to the CNS.

Table 2-3 provides the associated anatomy of organs outside of the Back Shu-Front Mu system. Relevant acupuncture points that could influence these organs can be determined on the basis of the neural structures linking the body surface (i.e., the soma) to these viscera.

Areas of referred tenderness precipitated by ongoing visceral nociceptive input land in metamerically connected cutaneous, subcutaneous, and muscular tissues. Metameric regions arise from similar segments of the developing embryo; referred pain and tenderness ordinarily occur ipsilateral to the disturbed structure.[146]

In the early stages of visceral disease, referred pain often has a deep, vague, and poorly localized quality. Pain at this phase (minutes to hours after the initial insult) feels like a dull discomfort, nearly always along the midline of the thorax or abdomen.[147] Autonomic concomitants such as sweating, nausea, vomiting, pallor, and a sense of impending death, may accompany true visceral pain in its early stages.[148]

If nociceptive signals continue from an irritated viscus, pain migrates to the body wall in the thorax or abdomen, usually located within similar or nearby spinal segments.[149] The referred pain begins to resemble somatic pain in that it becomes sharper, better defined, and well localized. Receptive fields expand in size in proportion to the number of painful episodes.[150] Over time, central sensitization as well as concurrent problems in other organs may cause pain to refer to adjacent myotomes, at which point neighboring Shu and Mu points could become tender.[151,152]

This is why, although the Back Shu and Front Mu pairs conventionally associate with only one organ, in reality, widespread multisegmental communication occurs. This limits the specificity of organs and acupuncture point relationships. Each paravertebral sympathetic ganglion may supply as many as six ipsilateral dermatomal levels.[153] Less predictable myotomal and scleromal innervation patterns further complicate interpretations of internal organ distress derived by myofascial palpation.[154]

While the nerve supply of the Back Shu-Front Mu points is elaborate and extensive, the general cranial to caudal layout of the Back Shu-Front Mu points exhibits a similar trend across species, even if specific vertebral levels differ. An alternative and probably more realistic arrangement would consist of over overlapping zones assigned to various organs instead of discrete points, as suggested for the horse.[155] Initially, this variance from the human norm arose to address difference in vertebral formulae between humans and other animals. As humans have twelve thoracic and five lumbar vertebrae and horses have eighteen thoracic and commonly six lumbar vertebrae, difficulties arise if one attempts to transpose the Back Shu points directly from the human to the horse.[156] Instead, Panzer proposes multi-level "association segments" rather than discrete association points.

Extrasegmental Acupuncture Points and Autonomic Function

Acupuncture points outside of the Back Shu-Front Mu system also modulate autonomic function, but do so through a variety of connections. Table 2-4 lists the associations between sympathetic structures and acupuncture points on the neck and trunk. Table 2-5 links points on the head and trunk with parasympathetic projections. Bear in mind that these are only partial lists, designed to denote the more common pathways utilized in a diverse and busy acupuncture practice.

The Brainstem's "Grand Central Stations" for Autonomic Reflexes in Neuromodulation: The Nucleus Tractus Solitarius and Rostral Ventral Lateral Medulla

Scientific research over the past decade has answered the question about how a point on the leg, ST 36, can treat both diarrhea and constipation. Instead of influencing autonomic activity in a unilateral direction, appropriately selected and stimulated acupuncture points modulate, or coax, bodily processes toward a homeostatic function.

Neuroscience has thus removed the need to rely on abstract "Yin-Yang balance" conceptualization by substituting metaphors with precise neurophysiologic descriptions that outline the trajectory from point to brain and spinal cord, and then on to the organ.

For example, two points on the limbs, ST 36 and PC 6, affect

Table 2-3
Anatomic Relationships of Organs Outside of the Shu Mu System[165]

Organ	Sympathetic Preganglionic Levels[166,167,168,169]	Site of Synapse of Pre- and Post-Ganglionic Sympathetic Neurons[170]	Course of Nociceptive Afferent Pathways into the Central Nervous System*[171]
Meninges and arteries of the brain	T1-T3 to and through the cervical sympathetic ganglia	T2-T6 sympathetic ganglia	Cranial nerves V, IX, and X enter the spinal trigeminal nucleus; afferents traveling through C1-C3 spinal nerves enter at the C1-C3 spinal cord segments
Eyes	T1-T4, to and through the cervical sympathetic ganglia	All cervical sympathetic ganglia and T1-T5 sympathetic ganglia	Ophthalmic branch of CN V enters the spinal trigeminal nucleus
Lacrimal gland	T1, T2, to and through the cervical sympathetic ganglia	All cervical sympathetic ganglia and T1-T5 sympathetic ganglia	Lacrimal nerve to the ophthalmic branch of CN V, to the spinal trigeminal nucleus
Parotid	T1, T2, to and through the cervical sympathetic ganglia	Celiac ganglion	Parotid nerve to the auriculotemporal nerve of CN V_3, to the spinal trigeminal nucleus
Submandibular, and sublingual glands	T1, T2, to and through the cervical sympathetic ganglia	Celiac ganglion	Submandibular branch of the lingual nerve to CN V_3, to the spinal trigeminal nucleus
Thyroid gland	T1, T2, to and through the cervical sympathetic ganglia	Celiac ganglion	Travel with sympathetic nerves to T1-2 spinal cord segments
Blood vessels of the skin and somatic structures of the head and neck	T1-T4, to and through the cervical sympathetic ganglia	Celiac ganglion	Some travel with sympathetic nerves to the T1-T4 spinal cord segments; others accompany CN V, CN IX, and CN X to the spinal trigeminal nucleus
Larynx	T1, T2, to and through the cervical sympathetic ganglia	Chromaffin cells of adrenal medulla	Superior laryngeal nerve to the spinal trigeminal nucleus
Esophagus	• **Cervical:** T2-T4, to and through the upper thoracic sympathetic paravertebral ganglia • **Thoracic:** T3-T6, to and through the upper thoracic sympathetic paravertebral ganglia • **Abdominal:** T5-T8, to the thoracic sympathetic paravertebral ganglia and superior thoracic splanchnic nerve	Celiac and aorticorenal ganglia	• **Cervical:** Some travel with the vagus to the NTS, others travel with the sympathetics to spinal cord segments T2-T4 • **Thoracic:** Some travel with the vagus to the NTS, others travel with the sympathetics to spinal cord segments T3-T6 • **Abdominal:** Some travel with the vagus to the NTS, others travel with the sympathetics to spinal cord segments T5-T8
Thoracic Aorta	T1-T5, to the thoracic sympathetic paravertebral ganglia	Superior and inferior mesenteric ganglia and ganglia in superior and inferior hypogastric plexuses	Travel with the sympathetic afferent pathways to the spinal cord levels T1-T6
Abdominal Aorta	T5-L2, through splanchnic nerves and direct branches	Celiac and superior mesenteric ganglia	Travel with the sympathetic afferent pathways to the spinal cord levels T5-L2
Ureters	• **Upper 2/3:** T10-L2, to the middle and inferior splanchnic and upper two lumbar splanchnic nerves • **Lower 1/3:** T11-L2, to the S2-S4 sacral ganglia	Inferior mesenteric ganglion and sacral paravertebral ganglia	• **Upper 2/3:** Travel with sympathetics to the spinal cord levels T10-L2 • **Lower 1/3:** Travel with sympathetic and parasympathetic nerves to enter the cord between T10 and T12
Uterus	T6-L2, to the splanchnic nerves to aortic and ovarian plexuses and superior and inferior hypogastric plexuses		Travel with the sympathetic afferent pathways to the spinal cord levels T11-L2
Testes, ductus deferens, epididymis, seminal vesicles, and prostate	T10-L1 through thoracic and upper lumbar splanchnic nerves, the celiac, aortic (intermesenteric), and superior hypogastric plexus, and hypogastric nerves to the inferior hypogastric (i.e., pelvic) plexus	Prevertebral ganglia and inferior mesenteric ganglion	Afferents through the testes (or ovaries) travel to T10. Parasympathetic afferents from these structures enter the S2-S4 portion of the spinal cord

*The afferent pathways listed in this table only pertain to the nociceptive avenues. Afferent fibers carrying other sensory information exist but have not been included here.

Table 2-4
Linkage of Autonomic Structures and Acupuncture Points -- Sympathetics[175,176]

Associated Spinal cord segments (C8-L3)	Structures Near Acupuncture Points and their Function	Acupuncture Points
C8-T5	**Superior cervical ganglion:** Supplies the head, neck, and heart; postganglionic axons "hitchhike" on the carotid arteries and branches to reach their destinations, which include the blood vessels supplying the lacrimal, salivary, and nasopharyngeal glands, the eye and dilator pupillae muscle, and remaining tissues.	SI 17
T1-T6	**Middle cervical ganglion:** Supplies the neck and heart (via the cardiac pulmonary plexus)	ST 10 GV 14[177]
T1-T7	**Inferior cervical ganglion (may fuse with the T1 ganglion to form the stellate ganglion):** Supplies the heart, caudal neck, arm, and posterior region of the head	ST 11
T1-T12	**Thoracic sympathetic ganglia (paravertebral and prevertebral)** • T2-T5 supply the heart and lungs • T5-T9 form the supply the stomach and proximal gut (fibers synapse in the celiac ganglion) • T8 to L2 supply the adrenal gland • T7 to L1 supply the superior mesenteric ganglion • T9-T11 supply the superior mesenteric ganglion • T9-T10 supply the inferior mesenteric ganglion • T12 supplies the renal ganglion • T12 fibers may also synapse in the aorticorenal ganglion (the combined superior mesenteric, renal, and inferior mesenteric ganglia) which supplies the kidney	GV or BL points at related spinal levels[178]
L1-L5	**Lumbar Sympathetic Ganglia** Axons from all lumbar ganglia region spinal nerves supplying the abdominal wall and pelvic limbs. Axons from most lumbar ganglia also join the abdominal plexuses. Fibers from lower lumbar sympathetic nerves migrate along the iliac arteries and branches to innervate pelvic vessels.	
S1-S4	**Sacral Sympathetic Ganglia** The pelvic sympathetic chains fuse in the midline, anterior to the coccyx, to form the ganglion impar. Postganglionic branches supply the wall of the pelvis and the pelvic limbs. Branches destined for the distal colon or pelvic viscera form the superior and inferior hypogastric plexuses. The superior hypogastric plexus lies below the origin of the common iliac arteries. The inferior hypogastric plexus is also called the pelvic plexus, and is located deep within the pelvis, close to the pelvic nerves.	S1: BL 31; BL 27 S2: BL 32; BL 28 S3: BL 33; BL 29 S4: BL 34; BL 30

Table 2-5
Linkage of Autonomic Structures and Acupuncture Points -- Parasympathetics[179,180]

	Parasympathetic Structures Near Acupuncture Points and their Function	Points
Cranial Parasympathetic Nerves	**Ciliary ganglion, CN III** Pupillary constriction.	ST 1 for CN III
	Sphenopalatine/pterygopalatine ganglion, lacrimal gland, CN VII Sends secretomotor signals to the lacrimal gland to stimulate tear production. Innervates the mucosal glands of the nose and mouth.	TH 23; GB 1
	Submandibular ganglion, submandibular and sublingual glands, CN VII Causes the submandibular and sublingual salivary glands to secrete saliva.	ST 5 for submandibular ganglion
	Otic ganglion, parotid gland, CN IX Causes the parotid gland to secrete saliva.	ST 7 for otic ganglion
	Carotid sinus nerve, CN IX Supply the carotid sinus and body	CV 23 ST 9 for carotid sinus
	CN X Vagal input to the thoracic and abdominal viscera	TH 17; SI 16; ST 9 CV 22; ST 9 for recurrent laryngeal nerve
Sacral Parasympathetic Nerves	**Sacral Nerves (S2-S4)** Supply the lower gut and the pelvic viscera. Modulate smooth muscle activity and stimulate pelvic glands to secrete	S2: BL 28, BL 32 S3: BL 29, BL 33 S4: BL 30, BL 34

brainstem nuclei[172,173,174] that participate in long-loop reflexes between the acupuncture point and internal organs. These nuclei, most notably the nucleus tractus solitarius (NTS) and its partner, the dorsal motor nucleus of the vagus (DMNV) as well as the rostral ventral lateral medulla (rVLM), modulate autonomic tone based on somatoautonomic input converging on the NTS and rVLM.[24,25,26]

The Nucleus Tractus Solitarius

The NTS interconnects numerous central nervous system networks. It acts as an important relay center for sensory afferents from diverse sources. Afferent signals arising from peripheral chemoreceptors, baroreceptors, the gastrointestinal tract, cardiovascular system, lungs, and the airways terminate in the NTS.[27] Some of these afferents reach the NTS by hitchhiking on cranial nerves III, VII, IX, and X, i.e., the cranial nerves that carry parasympathetic fibers.[28]

The NTS also receives input from afferents innervating the skin, subcutaneous tissues, and muscle in an ongoing fashion. Adding somatic afferent stimulation through acupuncture augments or otherwise modifies this input.[286]

For example, acupuncture points on the face (supplied by the trigeminal nerve) and limbs (such as ST 36, supplied by the fibular (peroneal) nerve), influence gastrointestinal motility, blood pressure, cardiopulmonary function, and pain. In one study, researchers used the cellular marker of neural activity, c-fos, to identify activated neurons in the CNS after gastric distension and electroacupuncture. They stimulated points on the face (GB 14, ST 2, and ST 6). Their results showed that both noxious visceral information and non-noxious somatic afferent stimulation (i.e., acupuncture) converged in the NTS. This suggested that the NTS mediates EA analgesia through neuromodulation.[29,287]

Receptors from the cardiovascular and respiratory systems also send messages into the NTS. Baro- and chemoreceptors living in the bifurcation of the carotid artery help the body autoregulate blood pressure and blood chemistry.[30] Impulses from the carotid body and sinus artery travel to the NTS by way of the glossopharyngeal nerve (CN IX). There, they converge with input from the reticular formation and the hypothalamus as well. The NTS assembles this information and determines the appropriate reflex autonomic responses.[31]

Impaired sensing capability from dysfunctional baro- and chemoreceptors triggers sympathetic bias that could conceivably lead to myocardial infarction, heart failure, and stroke.[32] Carotid body and carotid sinus electromodulation may help prevent or treat cerebrovascular events by restoring autoregulation.[33] The idea of externally influencing the carotid sinus is not new; carotid sinus massage has been used to determine the cause of syncope and also to terminate supraventricular tachycardia through alterations in autonomic tone.[34,35] The acupuncture point ST 9 (located near the carotid body and sinus) has long received attention as a point that is valuable for treating “shortness of breath”, “asthma”, “sudden turmoil disorder”, “pulseless syndrome”, “hypertension”, and “hypotension”.[36] This indicates that the ancient Chinese recognized the role of structures stimulated by needling ST 9 in cardiopulmonary problems, even though they were unaware of the actual neurophysiological mechanisms involved.

Far and away, the largest body of research exploring the impact of acupuncture on NTS has focused on its role in restoring normal gastrointestinal motility.[288] This results from communication with its neighbor, the dorsal motor nucleus of the vagus (DMNV). Together, the NTS (a site that receives afferent information) and the DMNV (an efferent structure) form the dorsal vagal complex, or DVC. The DVC thus comprises sensory and motor aspects, creating a conduit for somatovagal and vagovagal reflexes.[49] In this manner, the DVC is a parasympathetic preganglionic center that modifies visceral output based on convergent, somatoautonomic input.

The Rostral Ventral Lateral Medulla

The rostral ventral lateral medulla (rVLM), like the NTS, receives convergent input from both visceral and somatic sources. The rVLM also assists the NTS in the baroreceptor reflex.[37] The rVLM affords the main source of tonic excitatory input to cardiovascular sympathetic preganglionic neurons in the spinal cord.[38] It modulates cardiovascular responses according to the signals it receives from the gut and soma. The neurotransmitters nitric oxide, opioids, and nociceptin are a few examples of the chemicals involved in its activity.[39,40,41,42]

EA influences cardiovascular function at least in part by affecting rVLM activity.[43,44,45] Physiologic investigations demonstrate point- (i.e., nerve-) specific cardiovascular responses in the rVLM.[46] EA at points associated with deep nerves (such as the median (PC 5, PC 6) or deep radial (LI 10, LI 11)) produce stronger and longer-lasting modulation of visceral reflex pressor responses than does EA over superficial cutaneous nerves, such as at the terminal branches of the tibial nerve (KI 1, BL 67).[47] Cardiovascular responses to EA also demonstrate frequency specificity. Research shows that both EA at 2 Hz and MA (dry needling) inhibit reflexive excitatory cardiovascular responses caused by visceral afferent stimulation, but EA at 40 Hz or 100 Hz does not.[48]

The rVLM influences gastrointestinal motor function, too. Compared to somatic afferent stimulation at ST 36, which, after reaching the NTS, increases gastric contractions (a parasympathetic effect), stimulation at ST 25 predominantly influences the rVLM, resulting in gastric relaxation (a sympathetic effect).[289]

Somato-somatic Reflexes

Each acupuncture point delivers a panoply of effects. Some influence both somatic and autonomic function simultaneously. ST 36, for instance, treats not only constipation and diarrhea through the mechanisms just described, but also helps alleviate back pain and pelvic limb dysfunction.

MA at ST 36 activates afferent fibers belonging to groups I, II, III, and IV.[196] Group II and III afferents elicit acupuncture analgesia; afferents belonging to groups II, III, and IV also impact various autonomic processes,[197,198] while activation of Group I afferents more clearly influence motor neuron activity.[199]

All of these afferents connect to the fibular nerve, supplied by lumbosacral spinal cord segments. Patients with disk disease or back pain in the low back may derive relief from ST 36 stimulation at least in part because of the spinal segmental analgesia it provides. From a supraspinal perspective, EA at ST 36 regulates beta-endorphin and adrenocorticotropic hormone (ACTH) levels in the hypothalamus and pituitary, bestowing generalized analgesia and anti-inflammatory effects.[201,202,290]

EA at ST 36 also affects structures in the limbic system, i.e., brain structures involved in processing pain, memory of pain, and its emotional qualities.[291,292] Furthermore, ST 36 neuromodulation leads to changes in cerebral blood flow in the frontal lobes, brainstem, and thalami. These alterations occur as a consequence of acupuncture treatment and relate to pain-relief.[200] Thus, even considering this one point's effects, one sees how acupuncture alleviates pain through a multiplicity of mechanisms.[192,193,194]

While needling points such as ST 36 can help patients with conditions such as back pain through generalized analgesic mechanims, direct treatment of painful regions is usually also necessary for successful treatment. Palpation and postural evaluation of the back, neurologic testing, and mobility assessments all lend vital information about the specific problems plaguing the patient. The medical acupuncturist then considers ways in which to stimulate sites related to the myofascial and neuroanatomic matrix in order to optimize relief, especially when medication has failed to do so.[208,209]

This is where somato-somatic reflexes through acupuncture neuromodulation perform vital roles in prompting recovery. In the case of back pain, for example, stimulation of paravertebral somatic afferent fibers at acupuncture points along the spine suppresses activity in spinal nociceptive neurons.[195] This alleviates muscle tension, fascial restriction, and local nerve irritation and inflammation, ultimately reducing spinal cord facilitation. Reduction in facilitation (wind-up) helps dampen pain transmission, efferent motor activity and sympathetic tone, leading to analgesia, muscle relaxation, and improved circulation. Obtaining a twitch in the muscle through electrical stimulation, similar in ways to the needling of trigger points, provides significantly greater immediate and sustained relief of myofascial low back pain than stimulating only the muscle or overlying skin.[215]

As an illustration of how somato-somatic reflexes connect acupuncture points to painful sites, Table 2-6 lists groups of acupuncture points often used for spinal pain, their location, and the nerves they most intimately impact. Not included are peripheral points such as BL 40, BL 60, ST 36, SI 3, and others that provide additional analgesia, depending on the patient's pain problem(s). In general, it is standard practice to focus not only on the specific spinal segment or vertebral level involved in the pain problem, but also on points associated with spinal segments above and below. This takes into account the multisegmental somatic nerve supply to spinal structures as well as the discrepancy that appears between the vertebral level and dermatomal nerve supply in the caudal spine. One should not neglect the sympathetic contribution to the pain problem. Therefore, one should consider selecting points along paraspinal locations that provide autonomic input to the region.[244,245]

Table 2-6 Acupuncture Points Commonly used for Spinal Pain

Acupuncture Points (Medial to Lateral)	Location	Related Nerves[246]
Governor Vessel (GV) points and additional interspinous points along the midline	Between spinous processes of adjacent vertebrae, on the dorsal midline	Medial branch of the dorsal (posterior) primary ramus
Huatojiaji points[247,248,249,250]	0.5 cun lateral to the midline, from C1 to L5	Medial branch of the dorsal primary ramus
Facet joint points	1.0 cun lateral to the midline, from C1 to L5	Medial branch of the dorsal primary ramus
Inner Bladder line	1.5 cun lateral to the midline	Lateral branch of the dorsal primary ramus
Outer Bladder line	3.0 cun lateral to the midline	Ventral branch of the dorsal primary ramus
Myofascial Trigger points	Variable	Variable
Front Mu points (for organ relationship)	Variable	Variable

Table 2-7 associates structures often implicated in spinal pain such as intervertebral disks, facet joints, and spinal muscles.[251] Inflammation, compression, developmental anomalies, or degeneration of these tissues can all lead to spinal pain. The table includes mention of particular acupuncture point groupings that may most directly influence pain transmission in the affected nerves.

Controlled trials and systematic reviews in human research provide increasingly strong supportive evidence indicating that acupuncture effectively treats chronic spinal pain.[222,223,224,225,226,227,228,229,230,231] Several uncontrolled studies have reported that acupuncture also reduces spinal pain in dogs and horses.[232,233,234,235,236,237,238] According to Adrian R. White, MD, the author of several systematic reviews on acupuncture, "Acupuncture treatment should be considered for anyone who has nonspecific mechanical back pain that has persisted for 6 weeks or more despite standard treatment."[239,240] In humans, ten sessions of acupuncture produced stable, long-term effects lasting at least six months according to a recently published prospective cohort study.[241] A 2005 paper systematically reviewing acupuncture for chronic low back pain echoed the findings of earlier work, concluding that adding acupuncture plus conventional treatment produced better analgesia and functional improvement than conventional treatments alone.[242,243] Acupuncture saves money; results from a 2011 study in Canada suggest that patients with low back pain were less likely to visit physicians if they had received acupuncture, thereby lowering costs spent on healthcare for these patients.[293]

Assembling Acupuncture Points to Impart a Meaningful Neuromodulatory Input

Whether treating back pain, irritable bowel syndrome, trigeminal neuralgia, or radiation-induced xerostomia, a medical acupuncturist can simplify the neural input protocol by asking three simple questions:

1. What is the problem and how is it expressing itself in the soma with myofascial dysfunction, pain, tenderness to palpation, etc.?
2. How did the problem affect neurophysiologic activities in the periphery, CNS, and ANS?
3. Which acupuncture points will influence these affected nerve pathways both specifically and comprehensively?

The physician acupuncturist will find the answers to question 1 when taking the patient's history, performing the physical examination, and pursuing an appropriately detailed workup. The answers to questions 2 and 3 require a solid foundation in neuroanatomy, neurophysiology, and scientifically based medical acupuncture. Acupuncture point anatomy, such as that presented in the chapters that follow, informs the physician about the local, regional, and system-wide impact of stimulating each site.

Summary

Whether a clinical problem involves pain, visceral disturbance, or a psychological or somatic dysfunction, numerous neural networks participate in the problem. This is due to the widespread interactions between the nociceptive and autonomic systems not only in the periphery, but also in the spinal cord, brainstem, and several sites in the cerebrum and cerebellum.[280] Fortunately, acupuncture can influence many of these loci, including, most notably, the medulla, pons, periaqueductal gray, hypothalamus, amygdala, insular cortex, and anterior cingulate gyrus. These sites serve to regulate autonomic outflow, balance endocrine function, and blunt pain.[281] The key is knowing which nerves and regions to target. Hence, the fundamental premise of this book.

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Table 2-7
Potential Sources of Back Pain, Their Innervations, and Related Acupuncture Points[252,253,254]

Structural Source of Back Pain	Related Neural Elements	Acupuncture Points Influencing Nerves Related to the Pain Source – Select Points at One to Three Spinal Segments Above and Below the Lesion, as Well as Those Located at the Pertinent Level From Which Sympathetic Contributions Arise
Intervertebral disc	The outer third of intervertebral disks contains nociceptors and mechanoreceptors. • The sinuvertebral nerve innervates the dorsal (posterior) aspect of lumbar intervertebral disks.[255] The sinuvertebral nerves consist of somatic and sympathetic fibers. When they return to the spine, they can ascend or descend for up to 5 segmental levels.[256,257] Sympathetic fibers supplying disc in the lumbar spine will arise from the thoracolumbar level. Low back pain caused by the sinuvertebral nerve is often diffuse because of its unique anatomic pathway and sympathetic components.[258] The dorsal portion of the lower lumbar disks receives innervation from sensory fibers arising from the T13 to L2 DRG's.[259] • Branches of the ventral rami and the gray rami communicantes supply the lateral aspects of the disks in the lumbar spine.[260,261] The lateral portion of the L5-L6 intervertebral disc (in rats) arise from both ipsilateral and contralateral dorsal root ganglion (DRG) neurons from the T13, L1, and L2 levels.[262] • The ventral (anterior) portion of the L5-L6 intervertebral disc (in rats) receives innervation from the L1 or L2 spinal nerves. This may explain why patients with lower lumbar disc problems may also experience pain in the inguinal region, which corresponds to the L1-L2 dermatome.[263,264,265] • "Paradiscal rami" from the rami communicantes cross intervertebral disks and course through the connective tissue of the disc deep to the origin of the psoas muscle. These rami also likely provide discal innervation.[266] • Severely degenerated lumbar intervertebral disks exhibit more extensive disc innervation than do normal disks.[267]	Huatojiaji points,[1] "facet joint points"[268]
Facet joint capsule	The joint capsule is richly innervated by proprioceptors and nociceptors. The synovial membrane of the lumbar facet joint (in rats) is supplied by sensory and sympathetic fibers.[269] The dorsal rami supply the lateral portions of the facet joints. The sinuvertebral nerves supply the medial portion of the facet joints. Facet joints in the low back receive both segmental and nonsegmental innervation, due to the innervation from sympathetic postganglionic neurons in the thoracolumbar region and the multisegmental nature of spinal innervation.[270] In rats, the L5/L6 facet joint receives multisegmental innervation from the L1 to L5 DRGs.[271]	Huatojiaji points, "facet joint points"[272]
Costovertebral joints (thoracic spine only)	Dorsal rami and sympathetic fibers supply the costovertebral joints.	Huatojiaji points, "facet joint points"
Dorsal root ganglion (DRG)	Mechanically sensitive nociceptors (i.e., mechanonociceptors) in the nervi nervorum of the epineuria surrounding the DRG may contribute to pain if compression or tension affects the DRG.	Points along the inner Bladder channel

Table 2-7 Potential Sources of Back Pain, Their Innervations, and Related Acupuncture Points, Continued

Spinal ligaments: **1) Longitudinal ligaments – dorsal/posterior and ventral/anterior** **2) Supraspinal ligaments** **3) Interspinous ligaments**	These ligaments contain free nerve endings that have been implicated as potential contributors to back pain. • The sinuvertebral nerve supplies the dorsal (or posterior) longitudinal ligament. • Recurrent branches of the rami communicantes innervate the ventral (or anterior) longitudinal ligament.[273] • The grey rami communicantes supply the anterior (ventral) longitudinal ligament. • Medial branches of the lumbar dorsal rami supply the interspinous ligaments	Points along the Governor Vessel channel
Vertebral periosteum	The periosteum contains an extensive plexus of nerve fibers that exhibits the lowest pain threshold of any of the deep tissues.	Huatojiaji points or points along the Governor Vessel channel
Meninges	The dura is sensitive to mechanical and noxious stimulation; meningeal irritation may contribute to back pain. The sinuvertebral nerve supplies the dura mater. The dura mater of the lower lumbar spine receives sensory fibers from the upper lumbar ganglia; these fibers may interact with sympathetic nerves and mediate pain in the low back.[274]	Points along the Bladder channel
Muscles attaching or referring to the back	Myofascial pain is characterized by palpable, taut bands occurring lengthwise along muscles that contain exquisitely tender regions. Lateral branches of the dorsal rami supply the iliocostalis lumborum muscle; intermediate branches of the lumbar dorsal rami supply the longissimus muscle. Medial branches of the lumbar dorsal rami supply the multifidus and the short intersegmental muscles (intertransversarii mediales and interspinales).	Local, direct needling into the taut band or trigger point[275]
Thoracolumbar fascia	Cutaneous branches from dorsal rami of lumbar spinal nerves innervate the thoracolumbar fascia. The thoracolumbar fascia may be involved in a neurosensory capacity in controlling the lumbar spine mechanism.[276] Nerves supplying the thoracolumbar fascia in humans with chronic mechanical back pain may undergo degeneration secondary to ischemia or inflammation.[277]	Points along the Governor Vessel, Bladder, or Gallbladder channels, depending on the area affected by pain, as determined by palpation
Sacroiliac joint	Sensory innervation to the sacroiliac joint arises from neurons in the DRGs ipsilateral to the joint from L1 to S2; sensory fibers from the L1 and L2 DRG's course through the paravertebral sympathetic trunk.[278]	
Dysfunctional viscera causing or resulting from central sensitization[279]	Address both the myofascial and visceral components.	Points along the Governor Vessel, Bladder, or Gallbladder channels, depending on the area affected by pain, as determined by palpation

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Section 2::

Acupuncture Points and Channels

Chapter 3:: Introducing the Points and Channels

The point tables that follow group acupuncture points according to channel. Although the organ-based naming system for the channels no longer makes sense (if it indeed ever did), it has been retained in order to remain consistent with the World Health Organization (WHO) Standardization of Acupuncture Nomenclature. While retaining this common terminology facilitates communication between those in teaching, research, and clinical practice, it causes confusion because few, if any, points on a given channel have any association with their namesake organ.

Designations of the alphanumeric names of acupuncture points may not include a space between the two-letter channel designation and the point number or, instead, a dash. All are acceptable. For example, the fifth point on the Lung channel may appear as LU 5, LU5, or LU-5. The style selected to denote points in this book utilizes a space between the channel abbreviation and point number.

The indications listed for each point in the chapters of this book provide a glimpse of potential clinical applications and neuroanatomically justifiable or evidentially supported combinations. When available, published trials or experimental evidence pertaining to that point are included. However, medical judgment regarding the appropriate interventions for each patient may necessitate treatment other than acupuncture. For example, although a classical application of LU 4 is chest pain and shortness of breath, patients experiencing these symptoms should receive emergency evaluation and treatment without delay.

The evidential support selected for each point, when available, includes case reports, case series, and uncontrolled trials, along with randomized controlled trials when available. More research, with treatment controls based on a neuroanatomic understanding of acupuncture instead of an energy basis, is certainly needed. Otherwise, research methodology suffers and studies lead to conflicting or confusing results. For example, belief in the energy-meridian concept may prompt a metaphor-based researcher to select verum and sham points too close together. When two points share innervation, one can expect to find non-significant differences between the treatment and control groups, leading skeptics to claim that the effects of acupuncture are essentially those of placebo.

Each point will have listed the alphanumeric code for the channel and individual point number, the Pinyin name of the point, and the English translation of the Pinyin point name. Instead of referring to the San Jiao or Triple Energizer channel by its Chinese name or English name, the term "Triple Heater" was chosen.

The order of channel presentation along with their abbreviations appear below:

Lung (LU)
Large Intestine (LI)
Stomach (ST)
Spleen (SP)
Heart (HT)
Small Intestine (SI)
Bladder (BL)
Kidney (KI)
Pericardium (PC)
Triple Heater (TH)
Gallbladder (GB)
Liver (LR)
Governor Vessel (GV)
Conception Vessel (CV)

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Chapter 4:: Locating Points on the Body

Chapter Highlights

Safe acupuncture requires a solid grasp of anatomy.
Precision and consistency in point location is a precursor to clinically effective and predictable neuromodulation.
Inaccurate and variable point locations may produce to unexpected results in clinical and research settings.[1,2]

As important as precise, neuroanatomically accurate point location is, the two traditional methods of point location, i.e., proportional and directional systems, do not always lead to the same locus.[3,4] Instead, the emerging recommendation encourages acupuncturists to employ these techniques as rough estimates but to finalize site selection through touch.

Remember, too, that the targets for neuromodulation are not dots imagined on skin but neurovascular passageways, muscle components, or fascial elements. With experience, the ability to visualize layered anatomy during palpation expands as reliance on standard dictated measurements recedes.

One of the main problems pertains to the fact that acupuncture point location relies on a system of anthropometry designed for a monoethnic population from a distant era.[5] Even in Asia, the length and girth of today's patients' limbs and torsos reflect idiosyncrasies of life style, nutrition, adiposity, and genetics. Anthropometric assessments from millennia ago did not foresee or predict today's diverse populations. The mismatch becomes more extreme when one extrapolates the human points and channels onto other species.[6]

Both the proportional and directional methods of locating points utilize the Chinese anatomical inch called a "cun" (pronounced "tsun"); the plural form is also "cun".

Finding a point begins by defining the length of an anatomical segment as a certain number of cun.[7] Cun are relative to a patient's size, allowing for flexibility across individuals and throughout growth stages. For example, the cun count on the forearm remains twelve regardless of its actual length; from infancy to young adulthood and old age, the forearm remains 12 cun long. See Table 4-1 for a complete list of cun distances.

Proportional Method of Point Location

The proportional approach estimates point locations by dividing the distance between two reference points or topographical landmarks into equal-sized components based on conventionally accepted predetermined anthropometric values. For example, in order to locate TH 5, which can be found at roughly 2 cun proximal to the wrist on the dorsal surface, the proportional method would begin by subdividing the 12-cun antebrachium into six segments, each 2 cun long. The proportional method tells us that TH 5 lands between the distal two sixths, as illustrated in Figure 1.

Table 4-1 Cun distances employed for finding points according to the proportional method.[9]

Region	Cun Measurement Between the Following Landmarks	Cun count	Figure
Head/Neck	Right and left ST 8	9	5
	Middle of the eyebrow to the anterior hairline	3	6
	Anterior to posterior hairlines	12	6
	Posterior hairline to the inferior border of C7 spinous process (GV 14)	3	6
	Right and left mastoid processes	9	7
Trunk	Right and left ST 17 (at the nipple)	8	8
	Suprasternal notch (CV 22) to the xiphisternal synchondrosis (or xiphisternal joint) (CV 16)	9	9
	Xiphisternal synchondrosis (joint) (CV 16) to the umbilicus (CV 8)	8	10
	Umbilicus (CV 8) to the superior border of symphysis pubis (CV 2)	5	10
	Center of axilla (HT 1) to the tip of the 11th rib (LR 13)	12	11
	Medial border of the scapula to the posterior midline	3	12
	Inferior border of spinous process of T1 (GV 13) to the tip of the coccyx	30	13
Arm	Superior end of the anterior axillary crease to the cubital crease	9	14
	Cubital crease to the distal wrist crease	12	15
Leg	Superior border of symphysis pubis (CV 2) to the superior tip of the patella	18	16
	Lateral prominence of the greater trochanter to the popliteal crease	19	16
	Popliteal crease to the lateral malleolus	16	17
	Medial tibial condyle to the medial malleolus	13	17
	Gluteal fold (BL 36) to the middle of the popliteal crease (BL 40)	14	18

Directional Method of Point Location

The directional method employs a side-by-side line-up of cun, meted out as thumb widths that each measure out 1 cun. Other digit-based measurements can provide "shorthand" cun counts, as shown below. This approach requires calibration of the practitioner's hands against the patient's; it is the patient's hand size that determines the cun width, but the acupuncturist's hand finds the points. Therefore, before beginning a treatment, it is common for the practitioner to match her or his hand size against the patient's. If the two measure about the same, then no adjustments are required. On the other hand, if the practitioner's hand dimensions differ from the patient's, one needs a "fudge factor" when measuring cun. Patient adiposity can also complicate cun measurement with the direct method.[8]

Cun "Shorthand"

- 1 cun = the width of the thumb at the interphalangeal joint (Figure 2) or the distance between the proximal and distal interphalangeal joints of the middle finger (Figure 3).
- 1 cun = the width of the apposed index and middle finger measured at the level of the interphalangeal joint of the index finger (Figure 4).
- 3 cun = the width of all four fingers measured at the level of the proximal interphalangeal joint of the index finger (Figure 4).

Summary

As they say in the real estate business, "Location, location, location." For acupuncture, we might add, "Anatomy, anatomy, anatomy."

Figure 1. The **proportional method** approximates cun distances by divvying up parts of the body into separate sections and then specifying the relative position of a point in terms of those sections. For example, TH 5, shown in this image, lands 2 cun proximal to the dorsal wrist crease. The cun measurement for the antebrachium equals 12. Therefore, TH 5 falls between the last two sixths, 10 cun distal to the elbow or 2 cun proximal to the wrist. In practice, in order to determine the length of each of the six segments, one first divides the antebrachium into halves and then subdivides each half into thirds, yielding six equal portions. Contrast this method with the **directional approach**, which utilizes the distance of two of the patient's thumb widths from the dorsal wrist crease. The examiner should arrive at roughly the same region with both methods. However, final point selection should result from palpation for a depression, a report of tenderness from the patient, and/or specification of the exact site for stimulation. In the case of TH 5, this may include the extensor digitorum or extensor digiti minimi tendon, the extensor indicis or extensor pollicis longus muscle, the posterior interosseous nerve, or one of the other structures in the vicinity.

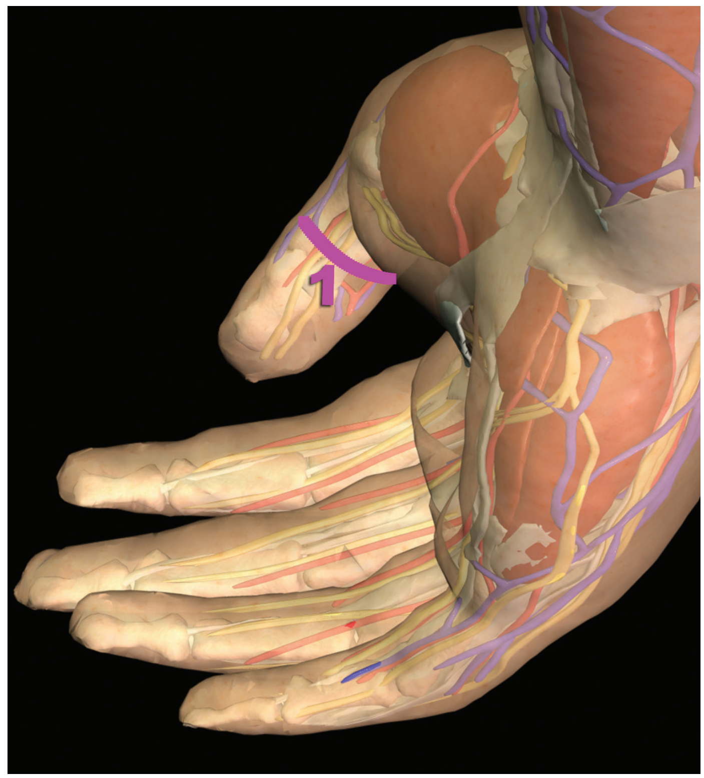

Figure 2. The width of the thumb at the inter-phalangeal joint equals 1 cun.

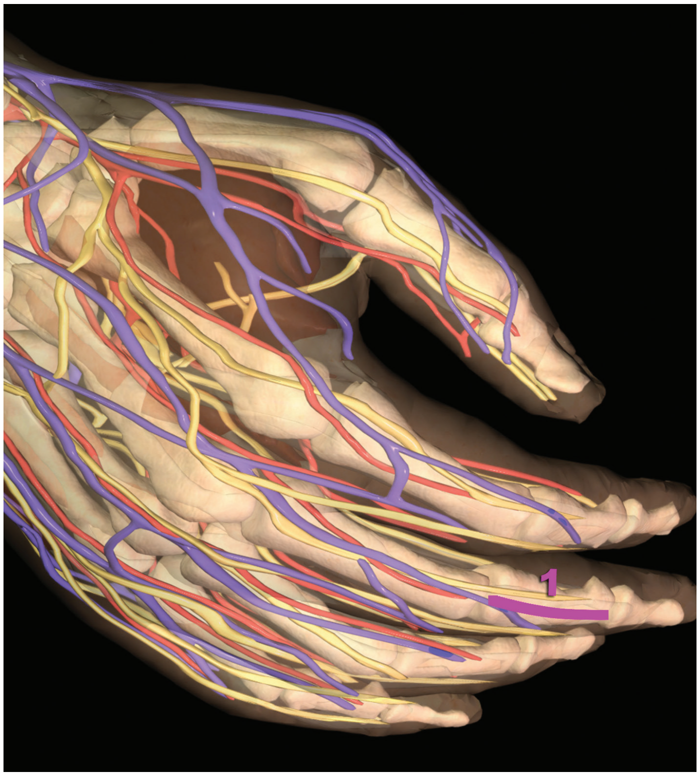

Figure 3. In addition to the thumb width, one can utilize the length of the middle phalanx on the third finger to measure a cun.

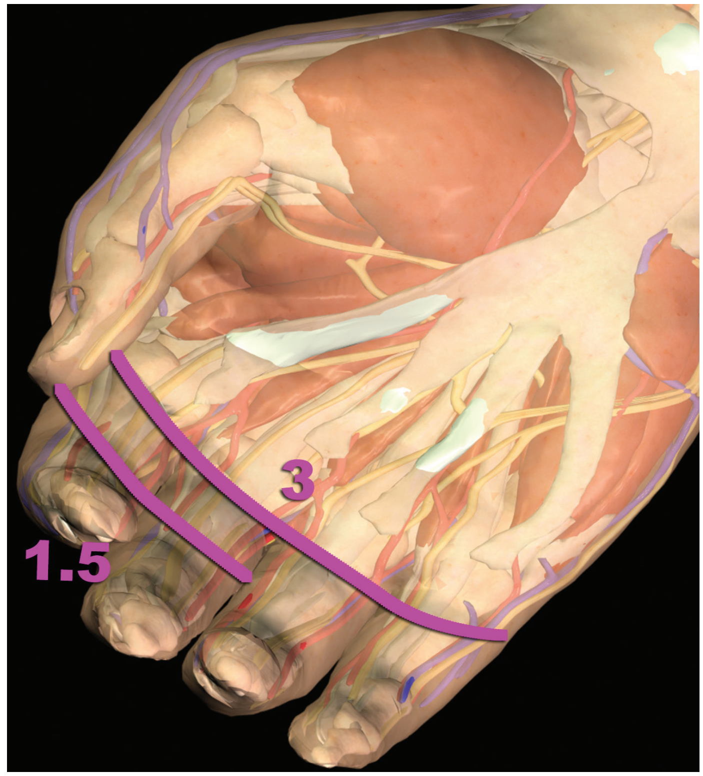

Figure 4. The patient's index and middle fingers held closely together measure 1.5 cun. The width of all four fingers held together counts as 3 cun at the level of the proximal interphalangeal joints.

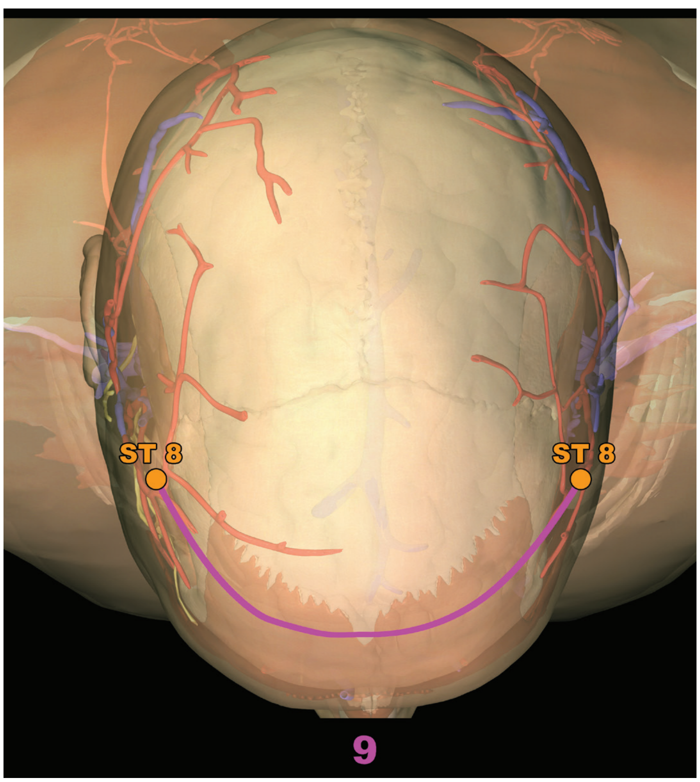

Figure 5. The distance from the right ST 8 to the left equals 9 cun.

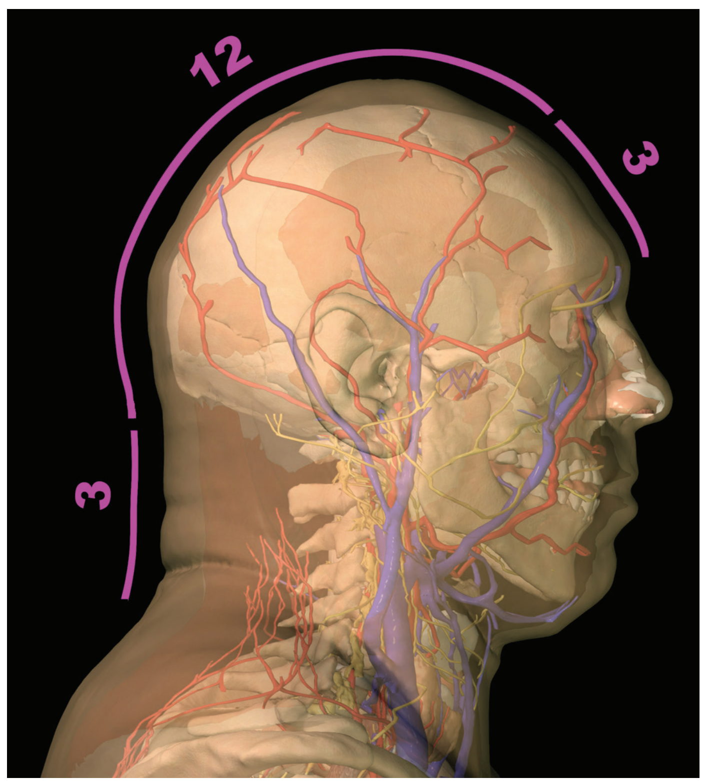

Figure 6. Along the sagittal plane, the distance from glabella to the anterior hairline measures 3 cun. There are 12 cun between the anteior and posterior hairlines and 3 cun from the posterior hairline to the inferior border of C7.

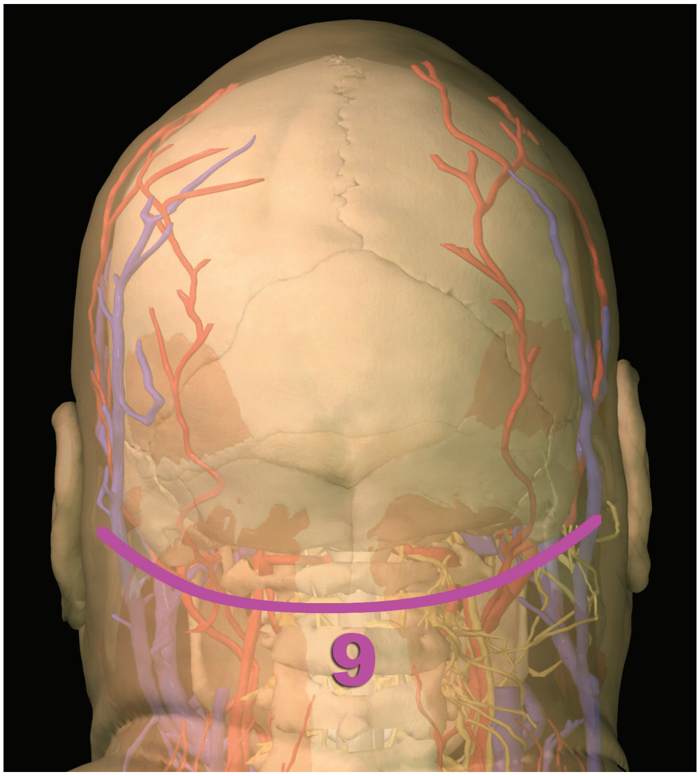

Figure 7. The distance between the right and left mastoid processes approximates 9 cun.

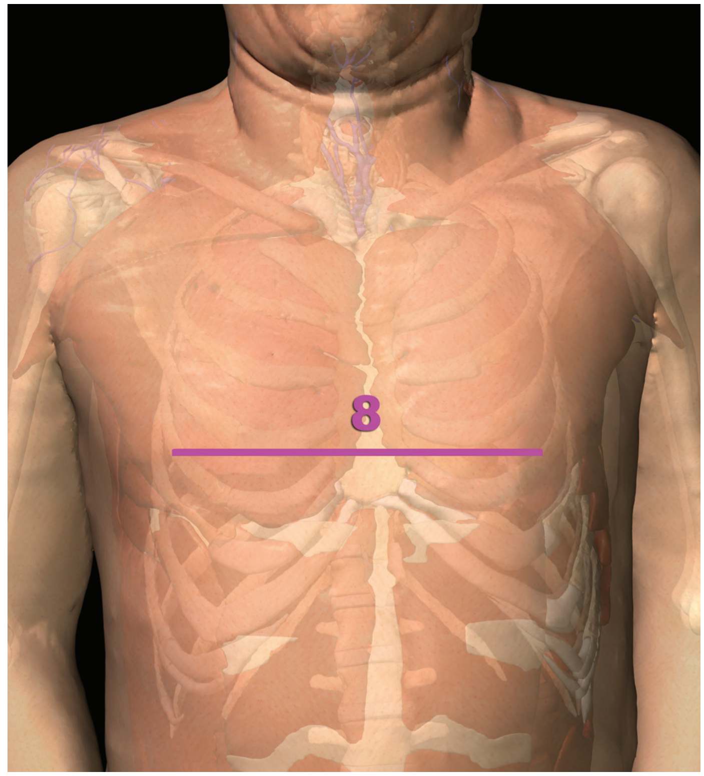

Figure 8. The distance between the two nipples equals 8 cun.

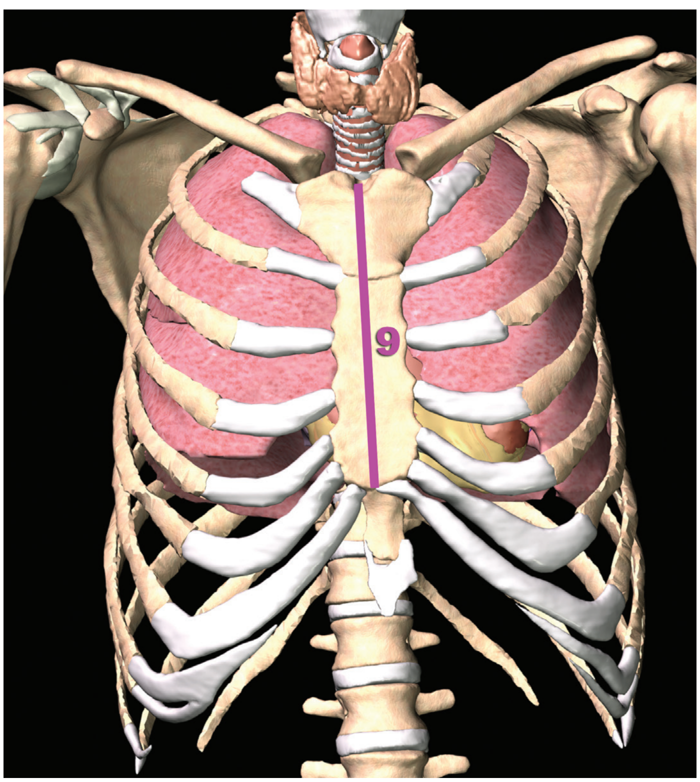

Figure 9. The suprasternal notch to the xiphisternal synchondrosis measures 9 cun.

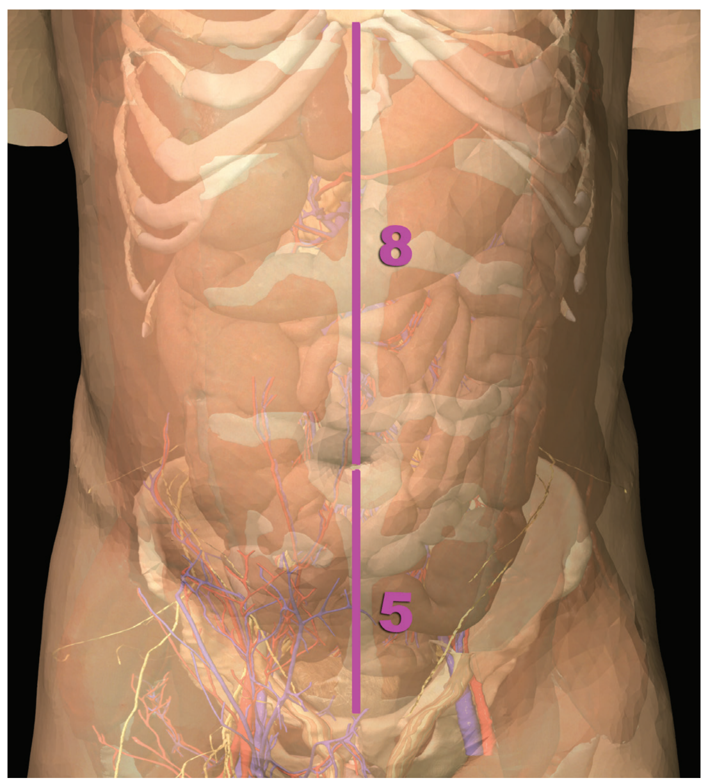

Figure 10. The absence of bony landmarks over the abdomen encourages more reliance on the proportional method of point location when demarcating the location of points on the anterior torso. The distance from the xiphisternal synchondrosis to the umbilicus is 8 cun, but it is only 5 cun from umbilicus to the superior border of the symphysis pubis.

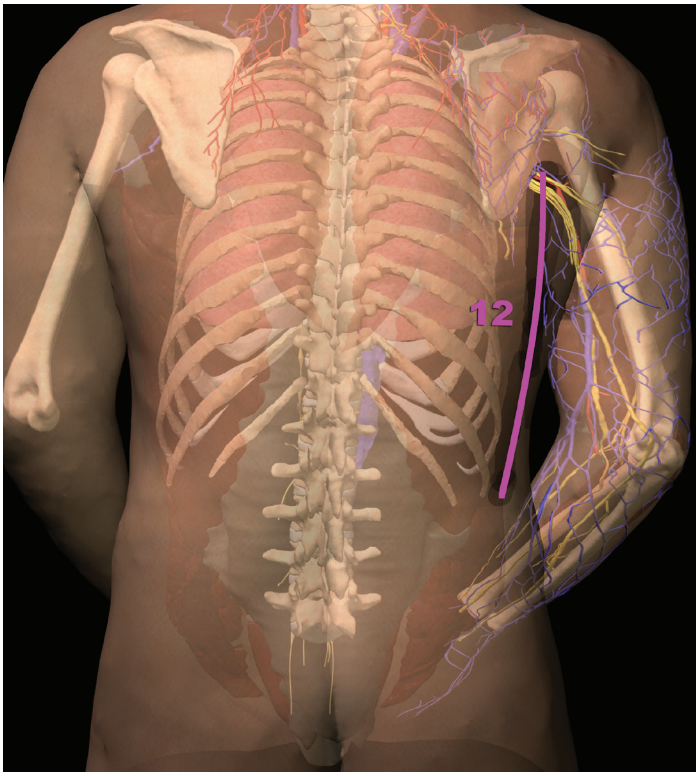

Figure 11. 12 cun cover the distance between the center of the axilla and the tip of the 11th rib.

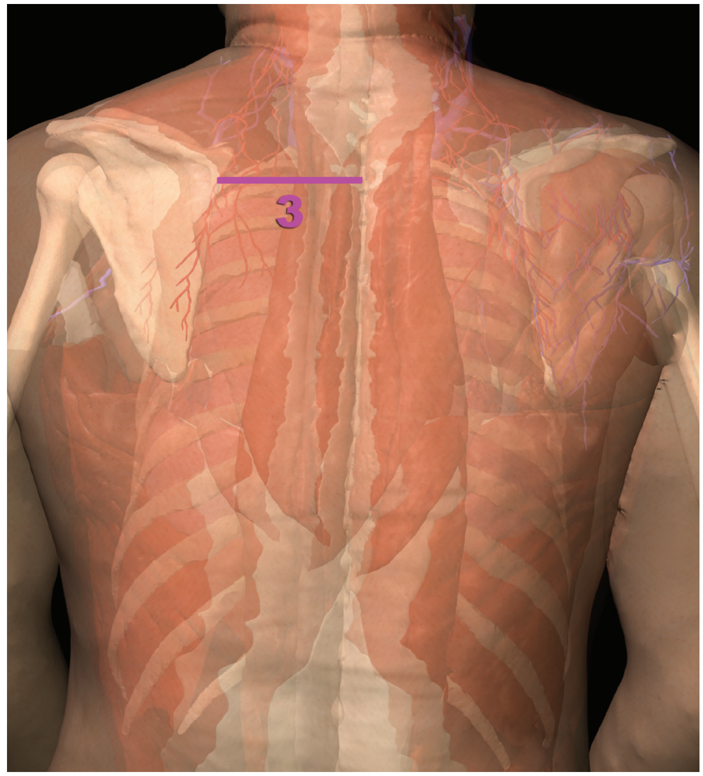

Figure 12. The distance between the medial border of the scapula and the midline is often given as 3 cun. However, the spatial relationship of the scapula and the spine depends on the position of the scapula.

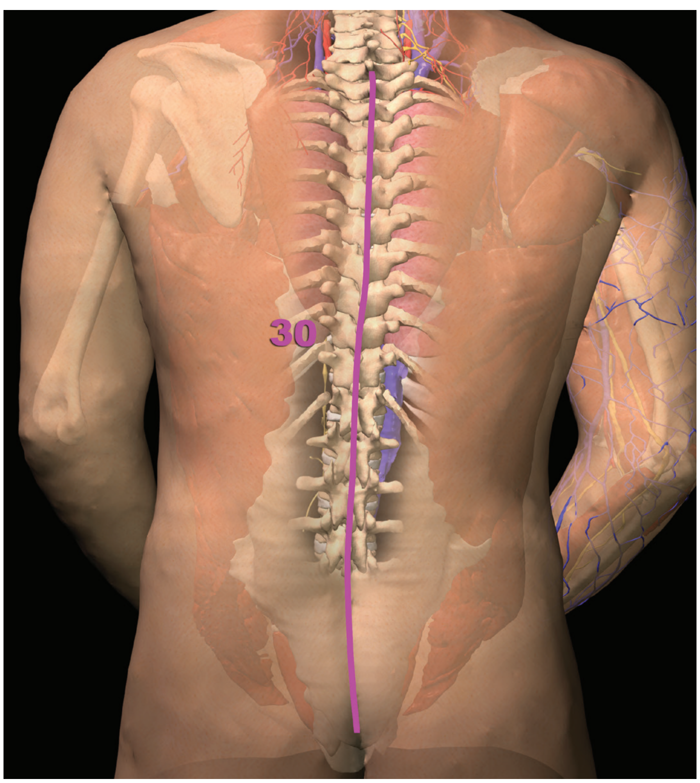

Figure 13. The length of the spine from T1 to the tip of the coccyx equals 30 cun. Note that this individual is missing the 1st rib on the right.

Figure 14. The brachium measures 9 cun from the superior limit of the anterior axillary crease to the elbow.

Figure 15. The cun count on the antebrachium is 12. Given the density of acupuncture points located on the antebrachium, this number frequently comes in handy.

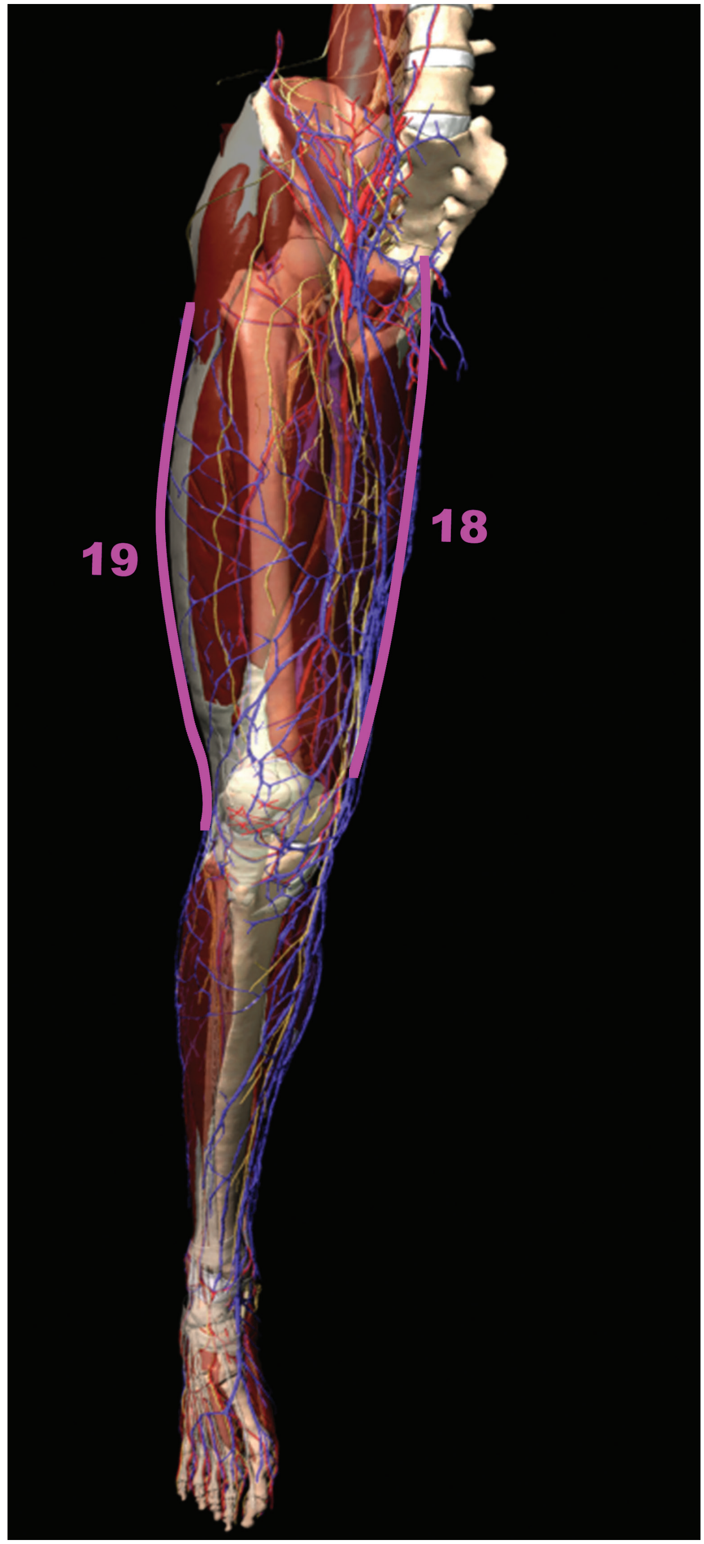

Figure 16. Pelvic limb cun measurements differ on the medial and lateral aspects of the limb, as indicated here for the thigh as well as in the following figure for the crus. This variance arises because the landmarks used in their calculation fall at different heights. On the thigh, the distance between the superior border of the pubic symphysis and the superior tip of the patella measures 18 cun. In contrast, the length of a line drawn from the lateral prominence of the greater trochanter to the popliteal crease equals 19 cun.

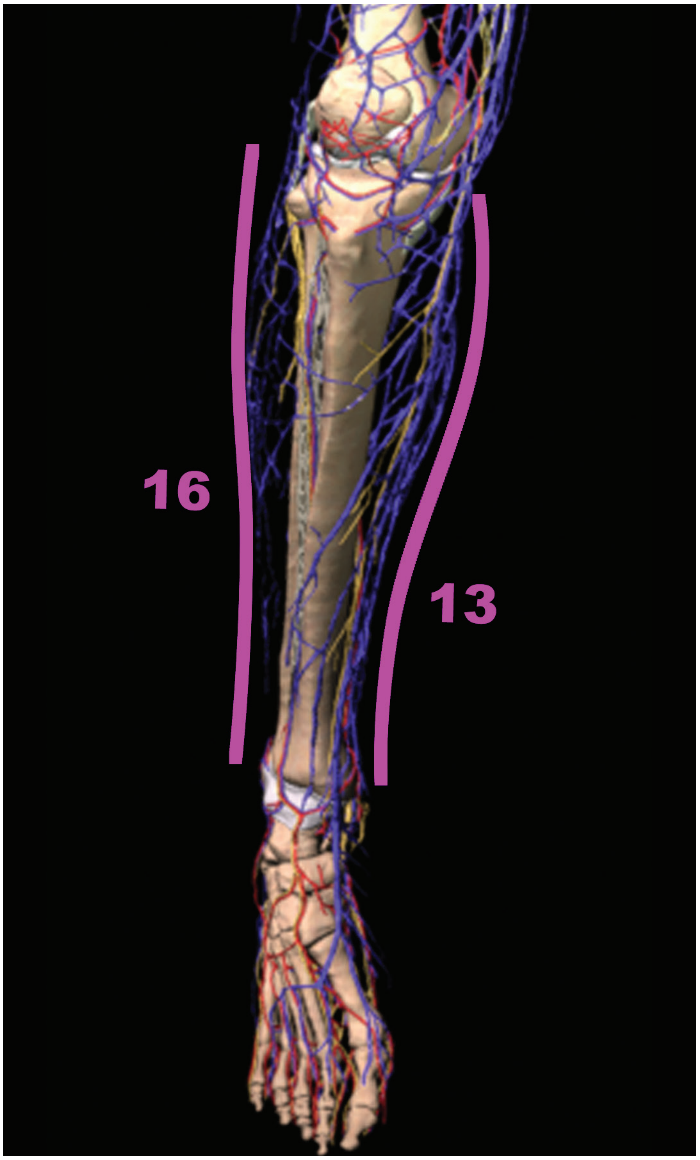

Figure 17. As with the thigh, the cun count on the crus depends on whether one is looking for points on the medial or lateral aspect of the limb. That is, the distance between the popliteal crease and the lateral malleolus is 16 cun while it is only 13 cun from the medial tibial condyle to the medial malleolus.

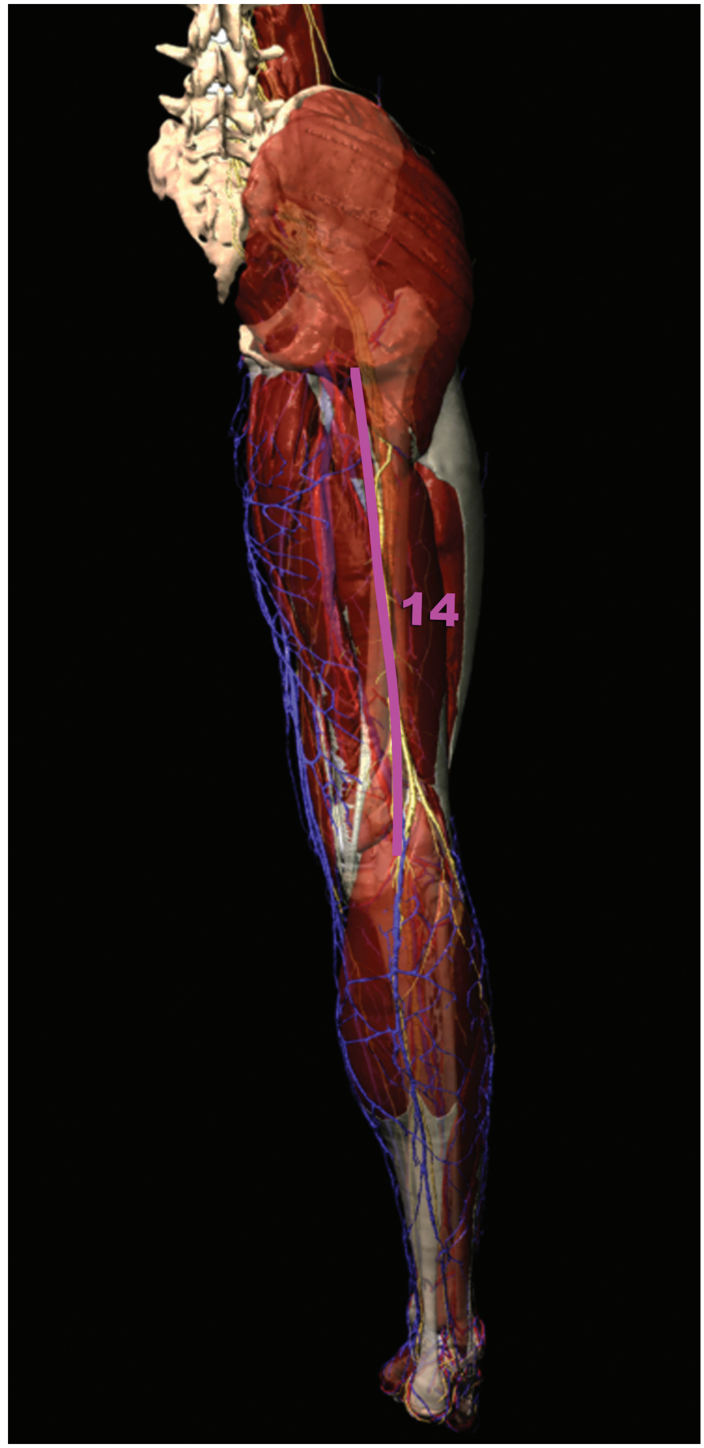

Figure 18. The cun count from gluteal fold to popliteal crease amounts to 14 cun.

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Chapter 5:: Acupuncture Safety