BRIEF REPORT

Traumatic Complications of Acupuncture

Therapists Need to Know Human Anatomy

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Objectives: To review the traumatic injuries that have been associated with acupuncture and to discuss how these adverse effects may be reduced by increased awareness of normal anatomy and anatomical variations.

Methods: Literature search accompanied by postmortem anatomical studies.

Results: Traumatic lesions after acupuncture have been described in thoracic and abdominal viscera, in the peripheral and central nervous systems, and in blood vessels. Deaths have been recorded from pneumothorax and cardiac tamponade. The anatomical structure of the body at several acupuncture points is such that needles can reach vulnerable structures.

Conclusion: While the frequency of adverse effects of acupuncture is unknown and they may be rare, knowledge of normal anatomy and anatomical variations is essential for safe practice and should be reviewed by regulatory bodies and those responsible for training courses.

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ACUPUNCTURE HAS a reputation among the public of being safe. However, since 1965, publications have repeatedly reported serious and even life-threatening incidents in association with acupuncture treatment. These reports do not usually appear in the journals for acupuncturists but in those of the specialists who manage the complications. Several authors have collated lists of complications caused by or associated with acupuncture.[1-7] In general, the reported adverse effects of acupuncture therapy can be categorized in the following groups: *delayed or missed diagnosis* (ie, orthodox diagnostic categories), *deterioration of disorder under treatment*, *vegetative reactions* (eg, syncope, vertigo, sweating), *bacterial and viral infection* (eg, hepatitis B and C and human immunodeficency virus infection), and *trauma of tissues and organs*.

Treatment with acupuncture consists of the insertion through the skin of solid needles from 15 to 50 mm in length. Depth of insertion varies from a few millimeters to several centimeters. The tip of the needle often lies in a muscle, but many recognized acupuncture points overlie other structures, including the nerves and pleura; therefore, acupuncturists need a working knowledge of anatomy to avoid causing direct trauma. In Japan, one form of acupuncture consists of embedding needles subcutaneously and breaking off the handle.[8] Injury may arise from the migration of needle fragments to distant sites.

The aim of this article is to review the traumatic injuries associated with acupuncture and discuss how these adverse effects may be reduced by increased awareness of normal anatomy and anatomical variations. The system of nomenclature of acupuncture points used in this article is based on the "new Chinese nomenclature" from the World Health Organization Regional Working Group on the Standardization of Acupuncture Nomenclature.[9]

RESULTS

Traumatic lesions can be divided according to the following topographical and structural characteristics: thoracic viscera (ie, pneumothorax, cardiac tamponade), abdominal viscera, peripheral nerves, central nervous system (ie, spinal cord or roots of spinal nerves, medulla oblongata), and blood vessels.

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MATERIAL AND METHODS

First, a literature survey with extensive cross-referencing was performed using several databases, including Pre-MEDLINE and MEDLINE (1966-1998), PSYNDEX (1977-1998), PsycLIT (1974-1998), University of Michigan Dissertation Abstracts (1981-1997), CISCOM (1995-1998), HealthSTAR (1977-1998), and Current Contents (1995-1998). Articles were included if adverse effects, complications, and potentially life-threatening incidents in association with acupuncture treatment of human subjects were reported. All English-, German-, or French-language articles identified were studied in detail. All articles that focused on the traumatic lesions caused by acupuncture were included in the review.

Second, 4 fresh human cadavers were frozen, and cross sections were taken at the level of acupuncture points lying within the identified regions of vulnerable organs (**Figure 1**). Investigations focused on those sites associated with reports of traumatic adverse effects in the literature review. Information on the different distances between the surface of the skin and the anatomical structures was obtained, considering the possibility of needling in different directions.

THORACIC VISCERA

Cardiac Tamponade

To our knowledge, 6 cases of injuries to the heart and the pericardium have been described in the scientific literature,[10-15] 2 of which were fatal.[11,14] One of the fatal cases was caused by lack of awareness of the sternal foramen. This common congenital abnormality (incomplete fusion of the sternal plates) exists in approximately 5% to 8% of the population. It is usually located at the level of the fourth intercostal space (ie, precisely at acupuncture conception vessel point 17 [CV17]) (**Figure 2**). It cannot be identified by standard chest x-ray films. Using computed tomography (CT), Stark[16] found this variation in 4.8% of their sample. Cooper et al[17] detected a sternal foramen in 6.7% of all autopsies they performed. Schratter et al[18] evaluated 100 chest CT scans with reference to the incidence of the sternal foramen and its features. They distinguished 4 types of this anomaly, varying from incomplete retraction of the sternal cortex to complete foraminal defects. A sternal foramen was present in 8% and was of sufficient size in 6% to constitute a risk of complications during medical interventions. The distance between the surface of the skin and the posterior surface of the sternum was estimated to be only about 13 to 19 mm.[11] Palpation prior to using acupuncture cannot reliably detect the abnormality because tendon fibers, thin connective tissue, or bone lamella may conceal the foramen. It is clearly impractical for all patients to undergo CT or magnetic resonance imaging before acupuncture. Therefore, acupuncturists must be aware of this frequent variation when treating patients with asthma or chest pain; points over the sternum have to be needled tangentially and superficially to prevent serious incidents.

Pneumothorax

The most frequently reported injury caused by acupuncture needles is pneumothorax. This chiefly occurs when the needles are placed parasternally or supraclavicularly (for example, to treat lung conditions).[19-29] However, acupuncture to the paravertebral, infraclavicular, and lateral thoracic regions, widely used to treat muscle pain, may also cause injuries to the pleurae and lungs.[24,29-44] Descriptions of more than 90 such incidents can be found in scientific publications; in 2 cases, the incidents resulted in death.[31,45] In a comprehensive epidemiological survey in Japan, Nakamura et al[46] examined 664 cases of pneumothorax in women and came to the conclusion that in 9% of the 255 cases classified as *secondary pneumothorax*, the cause was acupuncture. In a census carried out by Norheim and Fønnebø[4] in 1995, 33 of 1332 Norwegian acupuncturists admitted that pneumothorax had occurred during treatment.

Pneumothorax is a potentially serious adverse effect; avoiding it requires a clear understanding of the actual position and borders of the pleurae and lungs and the thickness of the soft tissue covering them. The most dangerous points, according to the literature, are given in **Figure 3**. In the supraclavicular region, treatment to stomach points 11 and 12 (S11-S12) has caused injuries of the lung; in the infraclavicular region, lung point 2 (L2), stomach point 13 (S13), and kidney point 27 (K27) are potentially risky. Furthermore, the parasternal points on the kidney meridian (ie, K22-K27) and the points of the stomach meridian in the midclavicular line (S12-S18) require particular caution.

From postmortem examinations, we have found that a puncture depth of 10 to 20 mm, either parasternally or in the region of the midclavicular line, can reach the lungs. It should also be noted that, depending on the thickness of the needle and the amount of tissue resistance, a variable degree of compression of the soft tissue takes place, so that the actual puncturing depth may be considerably greater than the length of the needle. In the region of the lateral branch of the so-called bladder main meridian, located approximately in the medial scapular line (bladder points 41 to 54 [B41-B54]), the surface of the lungs is about 15 to 20 mm beneath the skin.

ABDOMINAL VISCERA

Lesions of abdominal viscera are rarely reported. Keller et al[47] found a foreign body in the left kidney that turned out to be an acupuncture needle. Occasional reports deal with lesions of the urinary bladder and the intestine.[48-51]

PERIPHERAL NERVES

Injuries of peripheral nerves are reported infrequently. We found 2 published case reports clearly related to acupuncture. In 1 case, a broken needle in the carpal tun-

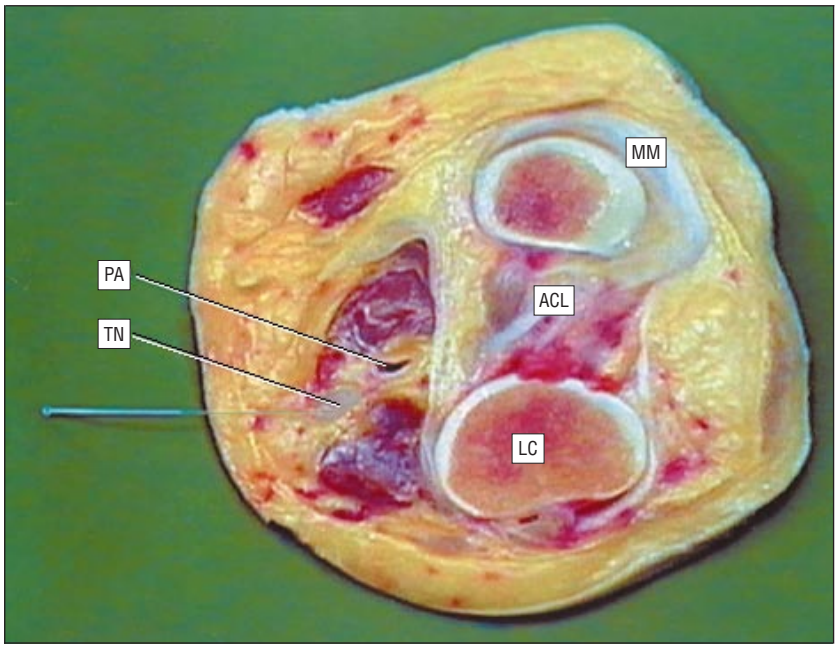

Figure 1. *Tomolevel at the height of acupuncture bladder point 40 (B40) performed on a fresh-frozen right knee, with an acupuncture needle touching the tibial nerve (TN). MM indicates medial meniscus; LC, lateral condyle; ACL, anterior cruciate ligament; and PA, popliteal artery.*

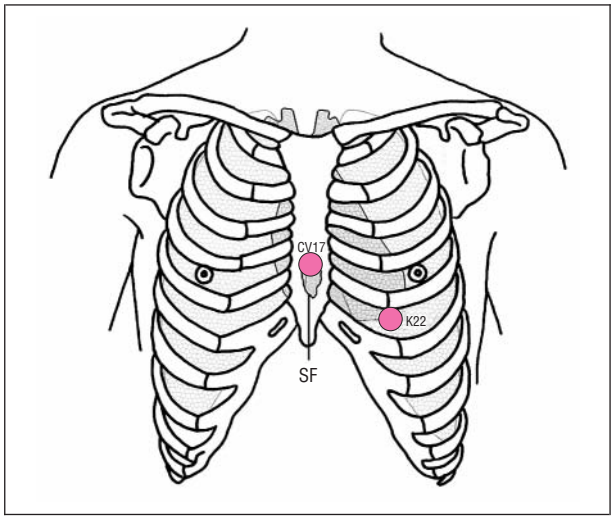

Figure 2. *Scheme of the chest, with a sternal foramen (SF) and the correlation of acupuncture conception vessel (CV) point 17 and kidney (K) point 22 to the heart.*

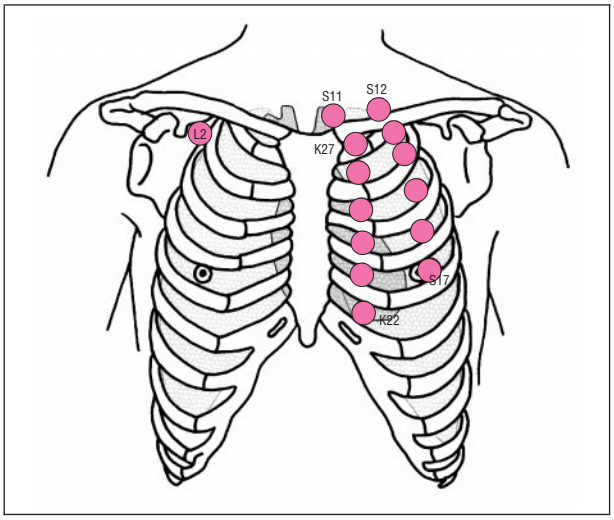

Figure 3. *Scheme of the chest, with the correlation of acupuncture stomach (S) points 11 through 17, kidney (K) points 22 through 27, and lung (L) point 2, the needling of which endangers the lungs.*

nel caused a neuropathy of the median nerve.[52] **Figure 4** illustrates a slightly atypical course of the median nerve, which can be damaged by needling the circulation-sex points 6 and 7 (CX6-CX7) and, in this case, even by puncturing lung point 8 (L8). In the other case, a needle inserted in the region of the fibular head led to a complete paralysis of the fibular nerve and foot-drop.[53]

The fibular nerve is particularly variable in its course. **Figure 5**, left, illustrates the back of a left knee, demonstrating the close topographical relationship of bladder points 39 and 40 (B39-B40) to the fibular and tibial nerves. Figure 5, right, shows the lateral view of another knee. A relatively high course of the fibular nerve close to gallbladder point 34 (G34) can be seen. In view of the vulnerability of many peripheral nerves and their proximity to acupuncture points, it is surprising that transient or persistent nerve injuries are not reported more frequently.

CENTRAL NERVOUS SYSTEM

We found 10 cases of injuries to the spinal cord or the spinal nerve roots. In 4 of the cases, migration of needle fragments was responsible for the lesion; 6 cases were caused by direct injury. The level of the lesion varied from segment C1 through C2 to segment S1 (segment C1 through C2, 4 cases; segment C6, 1 case; segment L4 through L5, 2 cases; and segment S1, 1 case).[54-60] Focal neurological signs as well as general complications up to paraplegia have been reported. Moreover, there have been several cases of arachnoiditis or subarachnoid hemorrhage.

The distance from the surface of the skin to the spinal cord or the roots of the spinal nerves ranges from 25 to 45 mm, depending on the constitution of the patient.

Deep needling of points of the inner branch of the bladder meridian (bladder points 11 to 20 [B11-B20])

and the governing vessel (GV) (**Figure 6**), used for treating back pain, was particularly likely to cause lesions of the spinal cord or the spinal nerve roots.

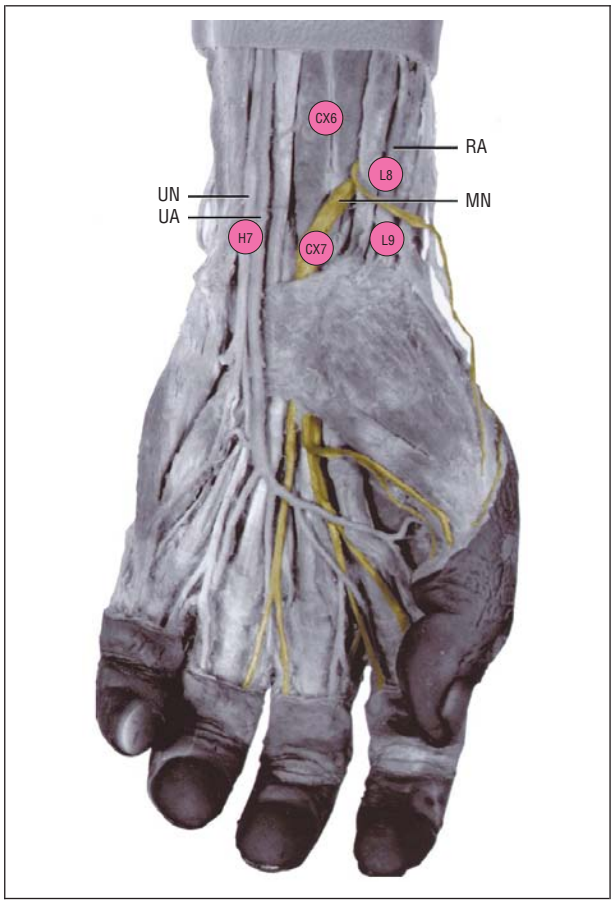

Figure 4. *Left hand with atypical course of the median nerve (MN) and correlated acupuncture points, including heart (H) point 7, circulation-sex (CX) points 6 and 7, and lung (L) points 8 and 9. UN indicates ulnar nerve; UA, ulnar artery; and RA, radial artery.*

BLOOD VESSELS

There are 4 reports concerning lesions of blood vessels associated with acupuncture. A case of pseudoaneurysm of the costocervical artery probably caused by acupuncture was reported in 1994.[61] A woman had been treated for shoulder stiffness several times with 20 to 30 needles around the spines of the scapulae each session. After the fourth session she noticed a nodule at her left shoulder and experienced a sharp pain. After diagnosis with CT and angiography, surgery was performed and a partially thrombosed pseudoaneurysm in the region of the costocervical artery was found. There was another case report on an aneurysm caused by acupuncture in 1996.[62] Deep puncturing of bladder point 40 caused a lesion of the posterior wall of the popliteal artery that led to a false aneurysm. Figure 1 shows the close relationship between the incriminated point and the popliteal vessels. A deep vein thrombophlebitis after acupuncture in the region of the upper calf, with leg pain 48 hours after the treatment, was reported by Blanchard.[63] The anatomical and temporal connection strongly supports a relationship between needle insertion and phlebitis. Another patient, who had been receiving anticoagulant therapy, developed an anterior compartment syndrome in the upper calf after acupuncture.[64] As is the case with peripheral nerves, it seems likely that lesions of peripheral blood vessels caused by acupuncture may frequently be undetected or unreported.

COMMENT

The use of acupuncture is becoming increasingly popular among medical as well as nonmedical therapists. In Germany alone it is estimated that more than 20 000 practitioners provide acupuncture therapy. Nearly 4000 acupuncture practitioners were registered members of the United Kingdom professional acupuncture bodies in 1997[65]; there may be an equal number who were not registered. In 1997, there were about 8700 licensed acupuncturists in the United States; it has been calculated

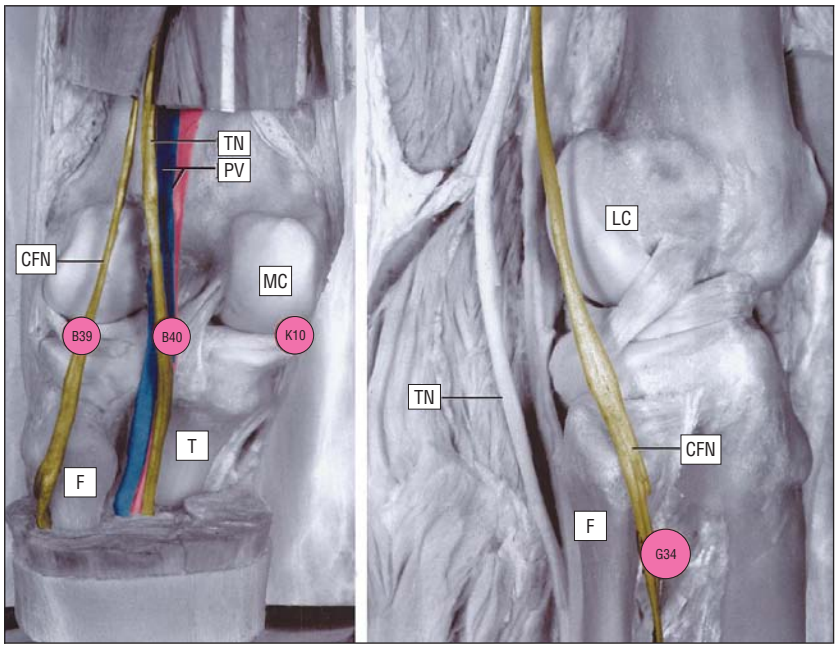

Figure 5. *Left, Posterior view of the left popliteal fossa, with correlation of acupuncture bladder (B) points 39 and 40 to the tibial nerve (TN), common fibular nerve (CFN), and popliteal vessels (PV). F indicates fibula; T, tibia; MC, medial condyle; and K10, acupuncture kidney point 10. Right, Lateral view of the right knee with an atypical high course of the fibular nerve and its correlation to the acupuncture gallbladder (G) point 34 and the lateral condyle (LC).*

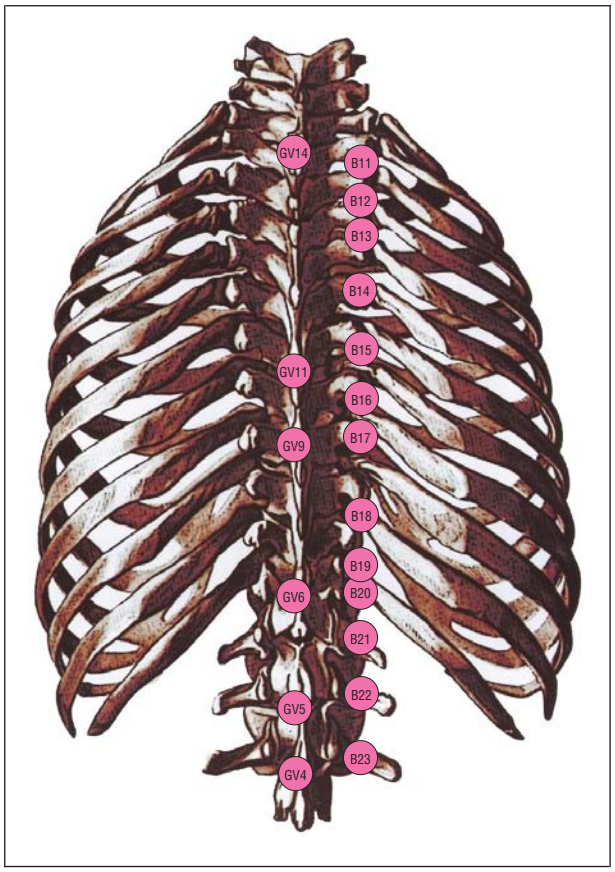

Figure 6. *Posterior view governing vessel (GV) and bladder (B) points of the spine and ribs correlated acupuncture.*

that they perform more than 10 million acupuncture treatments every year.[66]

For this review we located a number of case reports of potentially serious adverse events attributed to acupuncture. Causation is sometimes difficult to determine beyond doubt. Case reports do not produce reliable data on the frequency of adverse events. There are several reasons to suspect underreporting; practitioners without medical training may not identify events, may be unfamiliar with the need to report such events, or may be tempted by their enthusiasm not to advertise negative aspects of the therapy. Patients who suffer adverse events may be reluctant to attribute them to acupuncture because of their belief in its inherent safety. For example, the likelihood of underreporting of peripheral nerve injuries noted above was based on infrequent reports for such a vulnerable tissue. On the other hand, there may be other pressures toward full reporting or even overreporting; orthodox physicians who are antagonistic to acupuncture may be likely to report the event and may also be tempted to attribute adverse events to acupuncture on thin evidence. One attempt to estimate the frequency of pneumothorax, probably the most common serious adverse event, suggested that one pneumothorax might be expected in every 120 years of full-time practice.[4]

It is important to recognize that even one avoidable adverse event is too many. The traumatic injuries described in this review could be avoided if practitioners had better anatomical knowledge, applied existing anatomical knowledge better, or both. It should be emphasized that medical practitioners are not exempt from the need to study anatomy relevant to acupuncture since they are unlikely to have needed this information in conventional medical practice. Courses offering education targeted toward precise objectives in anatomical knowledge are scarce.[67] All training and regulatory organizations of acupuncture, including statutory governmental organizations, have a duty to consider the content and effectiveness of training in anatomy as a priority.[68] Rigorous training curricula with tests of knowledge and refreshment throughout a lifetime of practice are needed. The data presented in this review may provide a basis for deciding what needs to be included in that curriculum, although not all potentially dangerous points have necessarily been described. In particular, the precise topographical relationship of the thoracic viscera to each other and their projection to the thoracic wall, as well as anomalies and variations in the patient's constitution, do not seem to be familiar to all therapists.

In conclusion, many serious injuries associated with acupuncture have been described and are likely to be avoidable with better knowledge and application of anatomy by practitioners.

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Clinical Pearl

Are Albuterol and Ipratropium Similar?

The effects of 1 week of albuterol or ipratropium have similar effects on exercise performance and subjective dyspnea in patients with stable COPD. (*Chest*. 1995;108:730-735.)