Summary
Acupuncture has a reputation among the public of being safe. Although recently performed prospective studies on the frequency of adverse effects of acupuncture found no severe complication, since 1965 many case reports of serious or even life-threatening incidents caused by acupuncture have appeared in the scientific literature.

The most frequently reported complications are pneumothorax and lesions of the spinal cord. Severe injuries of peripheral nerves and blood vessels due to acupuncture seem to be very rare.

Although case reports do not produce reliable data on the frequency of adverse events, information on sources of application errors can be extracted to increase the quality of acupuncture in education and therapy.

All traumatic injuries described in this article could be avoided if practitioners had better anatomical knowledge, applied existing anatomical knowledge better, or both.

Keywords
Adverse effects, risk, traumatic complications, anatomy.

Introduction
Acupuncture has a reputation among the public of being safe. Recently, some prospective studies on the frequency of adverse effects from acupuncture have been performed and were published in the BMJ. In more than 60,000 interventions performed by skilled acupuncturists no serious complications were found. Since 1965, however, publications have repeatedly reported serious and even life-threatening incidents in association with acupuncture treatment. Several authors have collated lists of complications caused by or associated with acupuncture. In general, the reported adverse effects of acupuncture therapy can be categorized in the following groups:

delayed or missed diagnosis (ie, orthodox diagnostic categories);
derioration of disorder under treatment;
vegetative reactions (eg, syncope, vertigo, sweating);
bacterial and viral infection (e.g. hepatitis B, C and human immunodeficiency virus infection);
trauma of tissues and organs.

Depth of insertion of the acupuncture needles varies from a few millimeters to several centimeters. The tip of the needle often lies in a muscle, or overlies other structures, including the nerves and pleura; therefore, acupuncturists need a working knowledge of anatomy to avoid causing direct trauma.

Traumatic lesions can be divided according to the following topographical and structural characteristics:
thoracic viscera;
abdominal or retroperitoneal viscera;
peripheral nerves;
central nervous system;
blood vessels.

The aim of this article is to review the reports of traumatic injuries associated with acupuncture and discuss how these adverse effects may be reduced by increased awareness of normal anatomy and anatomical variations.
Thoracic viscera

Cardiac Tamponade

To our knowledge, six cases of injuries to the heart and the pericardium have been described in the scientific literature so far; we were notified of two more cases during the last year by colleagues from France and Canada. Two of the reported cases ended fatally. Another case-report, which is often cited in reviews of fatalities in acupuncture, describes the self-insertion of a sewing-needle in the heart, which clearly has nothing to do with acupuncture. One of the fatal cases was caused by lack of awareness of the sternal foramen.

The sternal foramen is a congenital abnormality due to an incomplete fusion of the sternal plates. It exists in approximately 5% to 8% of the population, and is usually located at the level of the fourth intercostal space (ie, precisely at the acupuncture point conception vessel 17 (CV17). It cannot be identified by standard chest x-ray films. Using computed tomography (CT), Stark found this variation in 4.8% of their sample. Cooper et al detected a sternal foramen in 6.7% of all autopsies they performed. Schratter et al evaluated 100 chest CT scans with reference to the incidence of the sternal foramen and its features. They distinguished four 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. In our own studies on cadavers of adult people we found distances with a range between 15 and 25 mm. Palpation prior to using acupuncture cannot reliably detect the abnormality because tendon fibres, 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. Some authors consider this complication to be regularly seen by emergency physicians. Pneumothorax chiefly occurs when the needles are placed in a parasternal or supraclavicular site; the latter without taking notice that the borders of the pleura and lung are situated well above the clavicles. Acupuncture to the paravertebral, infraclavicular, and lateral thoracic regions may also cause pneumothorax. Descriptions of more than 90 such incidents can be found in scientific publications; in two cases, the incidents resulted in death. In a comprehensive epidemiological survey in Japan, out of 255 cases of secondary pneumothorax, 9% turned out to be caused by acupuncture. In a census carried out in Norway in 1995, 33 of 1332 Norwegian acupuncturists admitted that pneumothorax had occurred during treatment. In a systematic review of the Japanese literature, Yamashita et al found 25 cases of pneumothorax in 89 articles which reported 124 incidents of acupuncture. In 2001, Odsberg and colleagues published a prospective study on adverse effects of acupuncture. In more than 9000 treatments the Swedish group found no major complication. Between completion of the survey and the publication date, three cases of pneumothorax due to acupuncture were reported to the National Board of Health and Welfare in Sweden.

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 as follows: in the supraclavicular region, treatment to ST11 and 12 has caused injuries of the lung; in the infraclavicular region, LU2, ST13, and KI27 are potentially risky. Furthermore, the parasternal points on the kidney meridian (KI22 to 27) and the points of the stomach meridian in the midclavicular line (ST12 to 18) require particular care when needling.
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 line of the bladder meridian, located approximately on the medial scapular line (BL41 to 54), the surface of the lung is about 15 to 20 mm beneath the skin.

**Abdominal viscera**

In principal the needling of points on the stomach, spleen, kidney and conception vessel meridians on the front of the body, and the bladder meridian on the back, can lead to injuries of abdominal or retroperitoneal organs. Lesions of abdominal viscera, however, are rarely reported. One paper reported the finding of a foreign body in the left kidney that turned out to be part of an acupuncture needle. Occasional reports deal with lesions of the urinary bladder and the intestine. A poll of participants of our acupuncture courses showed that the respective points are needled rather seldom. Perhaps therapists assume the abdominal regions as particularly vulnerable. We found that the thickness of the soft tissue in the regions of the kidney and the stomach meridian, in adults with normal weight, was between 2 and 4 cm. Provided that a proper needling technique is performed there should be minimal risk of reaching the abdominal cavity.

**Peripheral nerves**

Injuries of peripheral nerves are reported infrequently. We found two published case reports clearly related to acupuncture. In one case, a broken needle in the carpal tunnel caused a neuropathy of the median nerve. It has to be noted that the median nerve may be damaged by needling the points PC6 or 7. In the other case, a needle inserted in the region of the fibular head led to a peroneal nerve palsy resulting in drop foot. The common peroneal nerve is particularly variable in its course. In 10 to 20% it takes a rather high course and intersects the acupuncture point GB34. The bladder meridian points BL39 and 40 have a close topographical relationship to the common peroneal and the tibial nerve, which may be reached in 2 to 3 cm depth. Standard textbooks of acupuncture recommend a needling depth of 0.5 to 1 Cun (approximately 1 to 2.5 cm in most adults).

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. On the other hand the needling of epineural structures is likely to be an important principle in the effectiveness of several acupuncture points, e.g. BL54 (sciatic nerve) or KI3 (posterior tibial nerve).

**Central nervous system**

We found 10 cases of injuries to the spinal cord or spinal nerve roots in the scientific literature. In four of the cases migration of needle fragments was responsible for the lesion, and six cases were caused by direct injury. The level of the lesion varied from segment C1 through C2 to segment S1 (segment C1 to C2, four cases; segment C6, one case; segment L4 to L5, two cases; and segment S1, one case). Focal neurological signs as well as general complications up to paraplegia have been reported. Moreover, there have been several cases of arachnoiditis or subarachnoid haemorrhage. 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 line of the bladder meridian (BL11 to 20) was particularly likely to cause lesions of the spinal cord or the spinal nerve roots.

In Germany many acupuncturists are timid in needling points on the neck, especially GB20 and BL10. Most textbooks of acupuncture remind their readers to needle these points carefully because of the assumed proximity to the vertebral artery and the medulla oblongata. Our own investigation on cadavers of normally built adult people indicated difficulties in reaching these
structures with normal acupuncture needles. They lie at a depth of about 4 to 6 cm. We found no case-reports that described a lesion of the vertebral artery, however, there has been a report that suggests direct needling of the medulla from the point GV16 resulting in a haemorrhage into the fourth ventricle. This point has been used in western medicine for cisternal puncture.

**Blood vessels**

There are four reports so far concerning lesions of blood vessels associated with acupuncture. A case of pseudoaneurysm of the costocervical artery probably caused by acupuncture was reported in 1994. A woman had been treated for shoulder stiffness several times with 20 to 30 needles around the spines of the scapulae at 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 of an aneurysm caused by acupuncture in 1996. Deep puncturing of BL40 caused a lesion of the posterior wall of the popliteal artery that led to a false aneurysm. A deep vein thrombophlebitis after acupuncture in the region of the upper calf, with leg pain 48 hours after the treatment, has also been reported. 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 lower leg after acupuncture. Needling was performed about 5cm below the lateral aspect of the knee - probably at the point GB34 or ST36.

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. We understand that stimulation of the perivascular networks of autonomic nerves at some points may be important to achieve a therapeutic effect, e.g. LU9 (radial artery) or HT7 (ulnar artery).

**Comment**

The use of acupuncture is becoming increasingly popular among medical as well as non-medical therapists. Causation of adverse effects is sometimes difficult to determine beyond doubt. Case reports do not produce reliable data on the frequency of adverse events. There are several reasons for suspecting underreporting. Few people admit their own mistakes and even fewer tend to publish them. The cases that do appear are generally reported by those professions that handle the complications (for example emergency physicians in the case of pneumothorax). Unfortunately, these specialists often lack specific knowledge of acupuncture points and theory, so their reports may not always include the specific needling details that are important to acupuncturists. Furthermore, the papers usually appear in the journals of the specialists who manage the complications, rather than in acupuncture journals. The scientific journals themselves generally only publish reports on rare events, and it appears that some countries – perhaps for political reasons – do not publish reports of adverse events at all.

It is important to recognize that even one avoidable adverse event is one too many. All of the traumatic injuries described in this article could have been avoided if practitioners had 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. All training and regulatory organisations of acupuncture, including statutory governmental organisations, have a duty to consider the content and effectiveness of training in anatomy as a priority. 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 such a
Reference list


Rare but serious complications of acupuncture: traumatic lesions

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