

Safety aspects of electroacupuncture



EDITOR'S
CHOICE

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This issue of *Acupuncture in Medicine* includes three papers that describe adverse events related to the use of electroacupuncture (EA) (see articles on pages 88, 143 and 147).¹⁻³ There are few reports in the literature of such adverse events, and this is likely to be as a result of relative under-reporting of the minor events. More serious adverse events were summarised in 2004,⁴ and include cardiac problems (angina, cardiac arrest, interference with a demand pacemaker) and deaths related to needle trauma during EA. It seems timely to review the theoretical and practical risks associated with the application of EA.

NEEDLING FOR EA

Increased depth and altered angulation

Depth and angulation of needles is often modified for the application of EA in order to ensure that the needles can support the weight of the electrical leads and clips for the period of stimulation without falling out. EA is often applied for 20–30 min and may involve strong muscle contraction. Under these circumstances, needles need to be angled so that the weight of the attached leads and clips opposes the tendency of the contracting muscle to push the needle out. The use of increased depth of insertion and the need to alter angulation from the more familiar orientation at certain points require the practitioner to have a greater knowledge of anatomy for safe needling.⁵⁻⁷

Muscle contraction and needle movement

During strong, low-frequency electrical stimulation of needles in muscle,

vigorous muscle contraction can occur. Often this movement is entirely safe; however, in some locations it may be wise to take precautions to reduce needle movement, for both the safety and comfort of the patient. If a needle is placed close to a motor nerve unusually strong muscle movement will occur quite abruptly on increasing stimulation between about 0.5 and 0.9 mA. Under these circumstances it is best to reposition the needle concerned. Under most circumstances, muscle contraction will result in the needles being gradually extruded, but very occasionally the movement can result in a needle being drawn deeper into the body or dramatically changing angulation. Needles have been reported to move deeper without electrical stimulation of contractions,⁸ presumably through repeated voluntary contractions.

EA to abdominal muscles

When a patient is lying on a treatment couch the abdominal muscles are relaxed and on stretch, allowing more needle movement. This movement can be considerable in patients who tolerate strong EA (generally over 6 mA). To reduce this, the needles can be relocated to the non-muscular tissues of the linea alba (eg, CV points) or linea semilunaris (eg, SP14, 15, 16).

EA over the rib cage

Muscles of the shoulder girdle can have a large dynamic range of movement (eg, rhomboid major, pectoralis major and latissimus dorsi). Strong EA to one of these muscles may result in involuntary movement of the shoulder girdle and, consequently, a significant change in angulation of the needles, particularly if the latter have been placed obliquely, as they often are over the ribcage. Under these circumstances it may be preferable to use shorter needles and place them

perpendicular to the skin surface. Positioning the patient so that the muscle is on stretch may also be useful in limiting the movement.

EA through multiple muscle layers

The electrical field strength is greatest at the tip of the needle, so the maximal contraction tends to occur in the muscle where the tip of the needle is placed. However, it is possible for more superficial muscles to be stimulated as well, if the needle shaft passes close to the motor nerve innervating that muscle. The author has only seen this occur in the anterior hip girdle with a needle passing close to the sartorius and rectus femoris before entering the iliopsoas muscle. The resultant muscle contractions occurring in different directions in the two layers of muscle during the high-frequency phase of a dense-dispersed pattern of stimulation resulted in the needle appearing to bend through nearly 90° inside the tissues. Needle fracture is clearly a risk if this is allowed to occur repeatedly throughout a treatment session.

ELECTRICAL STIMULATION

Excessive current

The current used for therapeutic EA ranges from about 0.5 to 20 mA, although the majority of treatments will use currents below 6 mA. In an otherwise healthy subject with no implanted electrical devices (see paragraph below—'Implanted medical devices'), where needles are not placed close to particular anatomical structures (see paragraph below—'Special anatomical locations'), current applied to the soma becomes potentially risky at around 50 mA (see table 1).⁹ The main risk of excessive current is cardiac arrest through ventricular fibrillation. For this to occur, the current must pass through the thorax, and so although normal stimulation currents are an order of magnitude less than the level associated with this risk, we still advise that EA should not be applied so that currents pass across the chest.

Some EA devices have a dual function, and allow stimulation to be applied through surface electrodes (as in transcutaneous electrical nerve stimulation (TENS)). Because of the high

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Table 1 Effects of different currents on the human body

| Current (mA) | Effect on the human body |
|--------------|---|
| 0.5–1 | Threshold of sensation |
| 1–10 | Tingling through to discomfort |
| 10–50 | Pain, intense muscle contraction, through to extreme breathing difficulties |
| 50–250 | Ventricular fibrillation and death |
| >250 | Severe burns, breathing stops |

Modified from ref⁹.

resistance of the dry skin layers, TENS devices produce an output about three times greater than that of EA devices. It is important that the settings of such dual-function devices are carefully checked before applying stimulation through needles. The author has measured currents as high as 60 mA when deliberately applied across needles placed in his own tibialis anterior when testing such a device. Appropriate feedback was subsequently given to the relevant manufacturer.

EA devices should never be used while plugged into the mains electrical supply. A fault in the wiring in such a situation could result in mains current (up to 13 A or 13 000 mA) being passed through tissues.

EXCESSIVE CHARGE

Most modern EA devices use bipolar waveforms, meaning that the charge (quantity of electrons) passes from one needle to the other and then back in the opposite direction. Some devices deliberately produce monopolar waves or produce unbalanced bipolar waves. The result of this is that charge will tend to accumulate around the needles and promote certain chemical reactions (often referred to as electrolysis).¹⁰

¹¹ If the charge imbalance is great enough and lasts sufficiently long then macroscopic tissue damage may be seen. This effect is likely to be the cause of the skin changes reported in a couple of the papers in this issue—one from use of a device with an unbalanced bipolar waveform,² and the other from repetitive use of direct current EA (ie, a monopolar waveform).¹

Special anatomical locations

There are some anatomical areas where application of EA within normal parameters may cause undesirable effects. It goes without saying that direct stimulation of the central nervous system or cardiac tissues may have serious adverse effects; however, there are areas that are close to commonly used acupuncture points that may pose a risk if strong EA is used.

Anterior triangle of the neck

Carotid sinus

The carotid sinus is a swelling at the lower end of the internal carotid artery that acts as a baroreceptor. Nerve endings in this region react to stretch caused by rises in arterial blood pressure above 60 mm Hg,¹² and the resulting baroreceptor reflex causes peripheral vasodilatation of arterioles and veins, and decreased heart rate and strength of heart contraction. Direct electrical stimulation of these nerves could potentially result in a dramatic drop in blood pressure and heart rate.

The acupuncture point that lies closest to the carotid sinus is SI17—in the depression between the angle of the mandible and the anterior border of sternocleidomastoid. Needling here would also risk damage to the carotid artery and jugular vein.

Laryngeal muscles

Direct stimulation of the nerves that supply the laryngeal muscles (superior laryngeal and recurrent laryngeal nerves) may be possible from the point ST9—in the depression between the anterior border of the sternocleidomastoid muscle and the lateral border of the thyroid cartilage at the level of the tip of the laryngeal prominence (the carotid artery is palpated and held laterally to needle the point). Clearly there is a risk to the laryngeal airway from uncoordinated stimulation of the intrinsic muscles of the larynx. Although this has not been reported from EA, it has been observed from the application of TENS over the anterior neck (JW Thompson, personal communication)—vocalisation and stridor occurred and the patient appeared panicked until the TENS was disconnected.

Vagus nerve

The vagus nerve descends within the carotid sheath and lies between the carotid artery (internal then common carotid) and the internal jugular vein. It would only be conceivable for it to be stimulated directly using points that lie medial to the carotid artery—that is, SI17, ST9 and ST10, otherwise the needle insertion towards the nerve would pierce one of the major vessels in the neck. Direct electrical stimulation of the vagus could result in a profound bradycardia.

Implanted medical devices

ICDs and pacemakers

An implantable cardioverter defibrillator (ICD), also sometimes known as cardiac resynchronisation therapy-defibrillator (CRT-D; which includes both an ICD and a biventricular pacemaker), and some forms of pacemaker, or CRT-P (the P here is for pacemaker), have the ability to sense the electrical activity of the heart, and thus detect the need for defibrillation or pacing respectively. Such devices can be affected by small electric currents such as produced by the application of EA across the chest. One case has been reported where a pacemaker appeared to be inhibited by low-frequency EA,¹³ and in another case, an ICD was caused to discharge twice during EA treatment across the chest.¹⁴ A further case of ICD discharge related to 10 Hz EA has been published, but the position of the stimulation in this case was not reported.¹⁵ This is easily avoided, of course, by not connecting needles so that the current passes across the chest, and pairs of needles placed in the same limb, for example, do not appear to be associated with the same level of risk (see figure 1, taken from a paper that estimated this risk of EA).¹⁶ So the presence of an ICD or pacemaker is not necessarily a contraindication to the use of EA; however, it is always wise to take advice from the patient's cardiologist, and if there is a potential cause for concern, and the patient has previously had great benefit from EA, a trial of treatment in a controlled environment is recommended.¹⁷

Devices with implanted leads

The most important electrical safety issue related to implanted leads is what is referred to as 'microshock'. A current

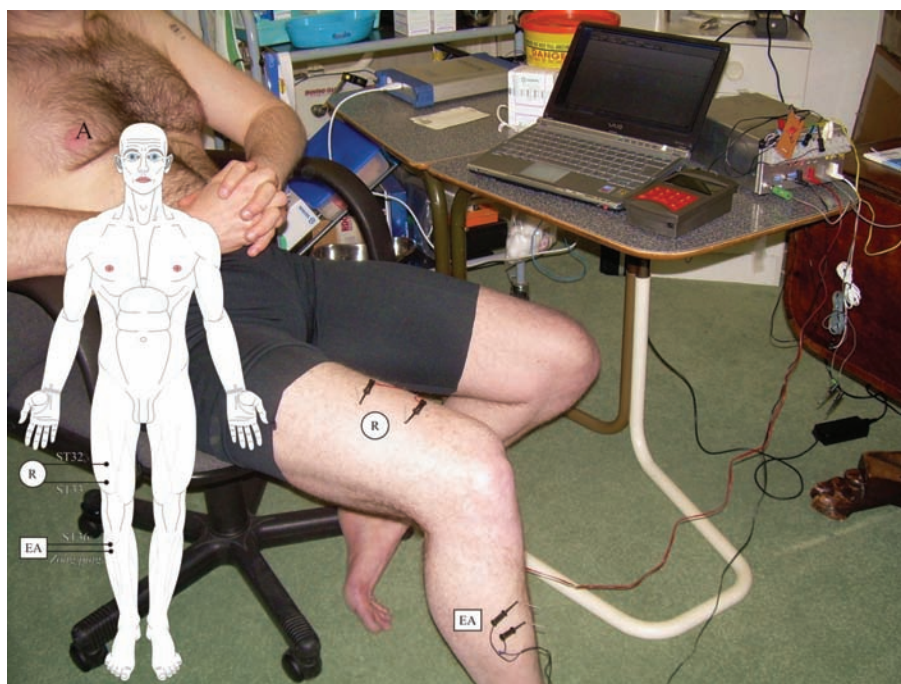


Figure 1 This image shows the author making measurements from inside his own muscle tissue during the application of EA when investigating the safety of EA with Prof John W Thompson. The results have been reported previously in *Acupuncture in Medicine*.¹⁶

as low as 0.1 mA could be enough to cause ventricular fibrillation if it passes along a lead that makes contact with cardiac tissue, for example.⁹ It is important, therefore, that an adequate history is taken regarding implanted devices, leads and tubes, and that needles are not placed close to them during EA.

Other implants

Concerns are often expressed by acupuncturists over using EA near to metallic prostheses, such as replacement joints. The electrical fields created by EA are unlikely to be powerful enough to have any effect in this setting; however, needling itself may pose some risk. Infection through inoculation is theoretically a greater risk in these circumstances. There is only one case of infection in a metal implant reported (a tibial plate for internal fixation of a fracture) for which acupuncture was the likely cause.¹⁸ Joint infection has been reported, and this may occur through inoculation or bloodborne spread.^{19–23}

Seizures

Intense somatic sensory stimulation under some circumstances may trigger a seizure and convulsion.^{19–22 24} There are no reports that link EA stimulation to

such events; however, it seems prudent to use EA with consideration in patients with epilepsy, and those in the recovery phase after a stroke. Since EA treatment generally involves needle retention for 20–30 min, it would be unwise to leave a patient with unstable epilepsy alone during treatment,^{19–22 25} and the position, depth and angulation of the needles should be carefully considered to avoid excess injury if a convulsion was to occur during the treatment.

CONCLUSION

Most of the safety implications related to the application of EA are theoretical, and there are few reports in the literature of serious adverse events that relate to the electrical stimulus as opposed to the trauma of needling. Practitioners should not be discouraged from using this technique, but should take account of the issues detailed in this article.

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