Electrophysiological Diagnosis at Terminal Points of Acupuncture Meridians

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Abstract

Small electrical potentials can be recorded on the skin at the terminal points of acupuncture meridians; the results are replicable under controlled experimental conditions. In an experimental group of 10 subjectively healthy subjects, these potentials averaged 16 ± 17 mV (SD). As a result of these potentials, the current produced ranges from a few to several hundred nanoamperes, which can be recorded by an external measuring device. This method of detecting electrical current is different from using an external voltage source in the measurement of conductance. For this reason, it is especially useful for diagnostic electroacupuncture.

Introduction

Electrical potentials of several millivolts can be detected on the surface of the skin.[1] The body's conductivity determines the amount of current produced by the electromotive force resulting from differences in these tiny potentials. If both potential and current can be measured in a replicable manner free of external interference, the result could be useful to functional medicine.

In the spring of 1997, Thomas Hermanns, Erich Krämer, Dieter Schäfer, and Helmut Schimmel (with technical assistance from Erich Rasche of the MedTronic Company, Friesenheim, Germany) successfully implemented a new method of measuring currents at acupuncture points (Figure 1). The use of electronic equipment supported by a microprocessor made it possible to measure millivolts, nanoamperes, and nanowatts at acupuncture points.

A long series of experiments has demonstrated that endogenous electrical currents measured in nanoamperes (10^{-8} to 10^{-7}A) are most predictive of the electrical status of acupuncture points. The electromotive force producing these endogenous currents results from electrical potentials at the acupuncture points on the skin. While recording such potentials is not new,[2] for the past 50 years all electroacupuncture readings have been based on skin resistance and feeding in external currents. Thus, any method permitting readings to be taken in nanoamperes at acupuncture points without feeding in additional external voltage would be diagnostically useful.

Historically, electroacupuncture according to Voll,[3] bioelectronic function diagnostics,[4] and the Autonomic Resonance Test[5] depended exclusively on measuring externally induced currents. These external currents applied to measure skin resistance can be influenced and disrupted by many factors, making it difficult to achieve objective and replicable results. Presumably, this difficulty is why these methods have not been recognized by mainstream science.

The present study is concerned with the basis of endogenous potentials and currents at terminal points of meridians and with recording them in a replicable manner.

Methodology

Potentials were recorded using a high-ohm operations amplifier (initial resistance, 40 MW), while currents were recorded with a Performance 2001 apparatus (distributed by Quadromed, Königswinter, Germany) set for the appropriate measuring mode.

Technological Requirements

Currents were expected to fall in the range of 10^{-8} to 10^{-7}A, i.e., several nanoamperes. As a result of using technical alternating current (50 Hz - always present on the body's surface and in switched equipment circuits), these currents had to be filtered out. With suitable operation amplifiers, actual measurement of the currents was accomplished. To arrive at consistent values, however, multiple measurements were taken at intervals of 50 to 500 milliseconds and a value was displayed numerically only when the current stabilized, thus reducing the probability of errors due to inadequate electrode contact. Quadromed's Performance 2001 apparatus met these requirements.

Electrode Materials and Contacts

Measurement of potentials in the millivolt range is reliable only if Type 2 electrodes are used (i.e., nonpolarizing silver/silver chloride or calomel electrodes). Mistakes in measurement can be expected to increase at higher currents and current

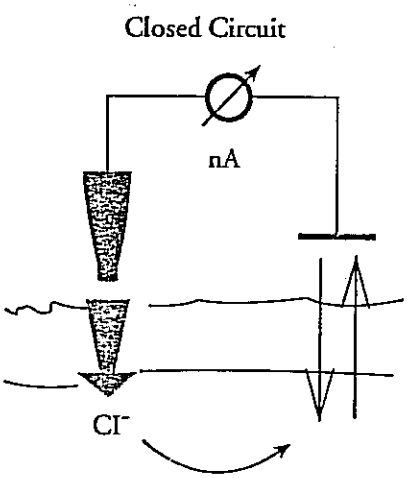

Figure 1: Schematic representation of current measurement without use of an external voltage source. A pointed electrode placed on an acupuncture point taps the current, which may develop as a result of the conductivity of chlorides. A reference electrode with a large surface area rests on the subject's forearm.

densities if pure metal electrodes are used. Generally, silver electrodes coated with silver chloride prove to be sufficiently sturdy and give consistent results over time. Contact occurs via a salt bridge, in the simplest instance, by moistening the electrodes with a specific electrolyte medium such as physiological saline solution.

Subjects

Readings were taken of potentials and currents at terminal points of acupuncture meridians in 10 subjectively healthy volunteers ranging in age from 12 to 41 years. The majority of tests took place in the afternoon after a period of at least 5 minutes of physical inactivity. The electrode in contact with the terminal point was a silver rod 2 mm in diameter electroplated with silver chloride. A 2- x 4-cm chloride-coated silver plate applied to the subject's right volar forearm served as the reference electrode. Both electrodes were moistened with physiological saline solution.

Results

Potentials Recorded

Electrical potentials averaging 16 ± 17 mV (SD) are typically found at terminal points of meridians. That is, small positive potentials are present in most cases, although these potentials also frequently approach 0. In isolated cases, potentials of more than 100 mV or less than -20 mV are recorded. The magnitude of the potentials we recorded was independent of pressure, i.e., not manipulable. We also expected to find potentials that were measurable but generally lower than those registered on the actual acupuncture points close to but not on the acupuncture points described by Voll. As a rule, however, the apparatus registers a reading only on the actual acupuncture point itself, presumably because of the low initial impedance (1 MW) and higher conductivity of the point compared with the surrounding skin; however, this was beyond the scope of our study.

Currents Recorded

If a difference in potential exists between the contact point on the terminus of the meridian and the broad reference electrode, electric currents are produced that either flow over the surface of the skin or can be registered on an apparatus if a closed circuit is created. In fact, noteworthy currents are recorded even when symmetrical electrodes are used, but only when the potential is above or below 0. The currents recorded in a manner analogous to the recording of potentials ranged from -350 to +230 nA.

Values frequently fell into the range around 0, however. In this range, readings become unreliable and an electronic feature of the apparatus shuts down the display. For this reason, we introduced a voltage-producing electrode pair that adds a constant force of 130 mV, substituting a flat electrode made of gold while retaining the pointed electrode of silver/silver chloride. As a consequence, pronounced negative potentials (e.g., -60 mV) led to reductions in voltage while positive potentials and smaller negatives increased the voltage between the two electrodes. Without exception, the resulting currents were positive, averaging 187 ± 71 nA (SD).

Before medical applications can be considered, the question of replicability must be resolved. For this reason, we studied the consistency of the currents over time for 90 minutes. Results are shown in Figure 2, which demonstrates that no significant change in current amplitudes was found during this period with regard to either individual points or their averaged values.

Sources of Current

The magnitude of the current flowing through the circuit to the measuring device (I) is dependent on the difference in potential (E) and conductivity (g) at any given potential. I = Eg, whereby conductivity is generally not constant but dependent on the voltage applied. The cause of the electrical potential is presumed to be ionic conductivity, which may also correspond to conductivity (g).[6] More research on this point is warranted.

Discussion

The present study shows that both electrical potentials and the resulting currents can be measured at meridian terminal points in a replicable manner. This method must be distinguished from the use of external voltage sources in measuring conductivity. The magnitude of the currents recorded has significance for diagnosis; a very low or very high reading of the current at the terminal point of a meridian indicates a functional disturbance of the organ related to the meridian.

The methods described here are different from the procedures of classic electroacupuncture. External currents are

Commentary by
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In principle, acupuncture points consist of bundles of vasomotor nerves wrapped in loose, well-hydrated connective tissue. At acupuncture points, such bundles emerge through narrow openings 2 to 8 mm in diameter. These openings may include, among others, perforations in the body's superficial fascia, channels in the bone, and pacinian corpuscles.

The electrical currents recorded by the authors at terminal points of acupuncture meridians ranged from 10^{-8} to 10^{-7}A independent of the pressure of the electrodes. Since voltage was approximately 16 mV, the resistance was in the range of 10^{4} W, a value comparable to results obtained by other authors.

The method presented here attempted to avoid feeding external currents into the acupuncture points, as happens in conventional Voll electroacupuncture. When the voltage approached 0, however, as it has done in many cases, the readings became so unreliable that a pair of voltage-producing electrodes had to be introduced so that a slight external current was induced. Thus, the problem of eliminating external currents when taking diagnostic readings at acupuncture points has not been completely solved.

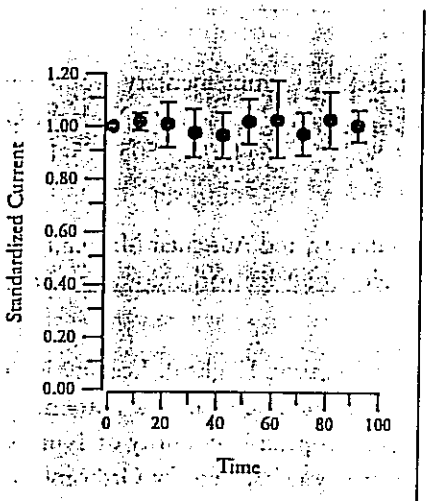

Figure 2: Consistency of current measurements over time. Detectable current was measured repeatedly at 3 endpoints on the feet of 3 subjects at 10 minute intervals. The first recorded value was taken as the norm for purposes of monitoring deviations over a period of 90 minutes. The chart presents mean values and standard deviations. There were no significant differences among the points.

problematic in electroacupuncture for the following reasons.

- External currents at strengths of approximately 10 mA are required if skin resistances are to be used as diagnostic parameters. The use of invasive external currents for diagnostic purposes, however, is not approved in some places, including the United States. The exact effects on the human organism of applying external currents of even a few microamperes to acupuncture points are not known.
- If the pressure of application exceeds 200 g, traumatization of test points occurs through repeated application of the test electrodes. This causes substantial errors in original resistance values. The Autonomic Resonance Test developed by one of the authors (Schimmel) attempts to reduce traumatization by using lower pressures.[7]
- It is difficult to eliminate the possibility that the tester may influence the testing process through unconscious variations in pressure. The researchers' diagnostic impressions are more or less integral to the testing process.

Despite these disadvantages, electroacupuncture procedures have provided profound insights into pathogenesis, especially in cases of chronic illness. This is particularly true of subclinical toxicities, chronic viral infections with no clinical findings, and subclinical chronic, systemic fungal, or bacterial infections.[8] In particular, the pathogenetic sequences revealed by electroacupuncture have been of great help to many practitioners, permitting better diagnostic classification of the symptoms that appear in chronic illnesses involving functional disorders.[8]

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