Lecture at the 1st International Ryodoraku Congress

Oct 9, 1988—Miyazaki—

ELECTRICAL SKIN RESISTANCE MEASURING THE INFLUENCING FACTORS SIMULTANEOUSLY

Authors : Dr. Gabriella HEGYI*
Dr. Ajándok EÖRY, PhD.**

Introduction

In his recently published paper / 1 / Tiller asks the question : “What do electrodermal diagnostic acupuncture instruments really measure?” To answer this question authors had made more than 12,000 measurements on 30 healthy volunteers taking into account the influencing factors : some of them was eliminated e. g. electrode polarisation, others were measured simultaneously, e. g. skin temperature, room humidity, etc. The preparation of the skin was standardized as well as the hour of the day of the measurements, the age, sex and race of the volunteers. Let us give some informations on the most important influencing factors now.

Methodological considerations

Electrode polarization may significantly influence the accuracy of measured skin resistance values. The error due to this effect may exceed 100%. Electrode polarization is the result of change in the potential of the electrodes, while current is conducted away. The effect of polarization appears as a plus resistance, i. e. it causes the measured value to be larger, then the real value.

The best arrangement for the measurements eliminating polarization is the so called “four electrode” technique. The four electrodes are placed on the skin in the form of two electrodes, both having two concentric elements. / Fig. 1 / The outer, ring shaped electrodes are for the penetration of the current onto the skin and the inner, disk shaped ones are used for monitoring the potential drop between the two sets of electrodes connecting them to an amplifier.

/ Fig. 2 . /

In the simplest case the circuit resistance “R” is determined by Ohm’ Law, i. e.

$$R = \frac{V}{I}$$

where V is the potential difference of the source and I is the current.

The resistance may be measured by the

a. / Constant Current Method when a constant current is passed into the circuit Fig. 3. /, in the present case into the electrodes on the skin and we measure the resulting potential drop.

b. / Constant Voltage Method, when a constant potential difference is applied to the skin / through the electrodes / and we measure the resulting current. / Fig. 4. /

Either method may be used as long as parameter values of the measurement, i.e. voltage and current are chosen very carefully. However from the point of view of the circuitry for elimination of electrode polarization the constant current method is preferable. In this case the resulting potential drop is linearly proportional to the skin resistance, and a constant current density is maintained over the skin.

In the case of the "3 Electrode Technique", the constant intensity current is introduced onto the skin through electrodes A and B. The voltage drop at the "A" active electrode can be measured by using electrode "C" in conjunction with a high input impedance amplifier. / Fig. 5. /

The high input impedance insures that only negligible current flows in the "A—amplifier—C—A" circuit eliminating the electrode polarization. This technique can be used only in the unipolar electrode system, that is when a "neutral" electrode with greater surface is fixed and an "active" electrode with smaller surface is applied.

The experimental procedure

Before each measurement the soap and water cleaned surface was also carefully cleaned by alcohol in a solution of 10%. After having the electrodes wet / by a 0.05 mol NaCl solution, which is isotonic with human sweat /, the sensor was placed on the skin. First the resistance, next the temperature value of the skin was registered. The sensor allowed all measurements to be performed under constant electrode pressure.

Considering a bipolar electrode system, the resistance value that was measured between the two electrodes, that were placed on the skin was divided by two. This way the average resistance value of the skin under one of the electrodes was obtained. A normalizing factor of 0.38 was used, i. e. normalizing to 1 cm², since the individual electrode surface area was 38 mm².

The skin resistance value, as it was normalized to 1 cm², gets further modified by including the effect of the relative humidity of the experimental environment. The normalized resistance value is reduced by 2.8% for each 1 % increase in relative humidity / 2 /.

Maulsby and Edelberg / 3 / showed that there is a linear relationship between the logarithm of the skin resistance and the skin temperature / Fig. 6. /. From their result it was simultaneously measured and the skin resistance was further corrected to a standard 30°C skin temperature.

To compare the resistance values obtained at the same point on different individuals, the most appropriate method seems to be by using weighted averaging according to the following formula :

$$n = \frac{\sum R_i \cdot R_{i, \text{ave}}}{\sum R_{i, \text{ave}}}$$

where

$$R_{ave} = \frac{\sum Ri}{n}$$

Let us take an example. The measured skin resistance value was 542 kohm. Under one of the electrodes therefore 271 kohm. To express this skin resistance in terms of resistance per unit area : $271 \times 0.38 = 103$ kohm. To take into account the measured 56% relative humidity : $103 \times 0.972 = 100$ kohm. To include the effect of the skin temperature, which was simultaneously measured to be 32.2°C , the skin resistance is normalized to 30°C temperature by : $100 \times 1.107 = 110$ kohm. According to the above algorithm the data processing was done by a computer program.

Results

Fig. 7. illustrates the measurements carried out on the dorsal part of the hand as an example. The data are starting from the nails and going inward the resistance values increase. By connecting the measured values obtained at the same heights, one can see that the dorsal side of the forefinger and the dorsal part of the hand close to the forefinger have the highest skin resistance values. This is in contrast with the resistance drop measured at Hegu area.

The data illustrated on Fig. 7. are summarized in Table 1.

Measured at approximately 300 points we have sought the answer to the following question, too : –How the skin resistance varies to the different parts of the body ? We believe that our approach by this exact skin resistance mapping is an important contribution to Ryodoraku practice and science.

References

1. Tiller, W. A. : What Do Electrodermal Diagnostic Acupuncture Instruments Really Measure Am. J. of Acupuncture, 15 / 1 /, 15 – 23, 1987.
2. Eőry, A. , Kuzmann, E. and Ádám, Gy. : Exact Mapping Of Skin Resistance Relationships When The Simultaneous Action Of Influencing Factors Are Considered / in Hungarian / Hung. Psychological Review of Hung. Acad. Sci. , 27 / 4 /, 514 – 527, 1970.
3. Maulsby, R. L. and Edelberg, R. : The Interrelationship Between The Galvanic Skin Response, Basal Resistance, and Temperature J. of Comparative and Physiological Psychology, 53, 475 – 479 – 1960.

[Figures have not been received.]

× Address : Dr. G HEGYI

Budapest, IX.

Zoltán u. 16. HUNGARY

× × Address : Dr. AEÓRY

H- 1131 Budapest, XIII.

Sollner u. 24. HUNGARY