D.C. Skin Conductance Variation at Acupuncture Loci

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Abstract: Skin conductance was measured in 10 subjects with a DC Wheatstone bridge in 10 areas purportedly containing acupuncture loci on the Triple Burner (TB) and Lung (Lu) meridians. When the results were compared to those from anatomically similar locations devoid of acupuncture loci, local conductance variation was found to be significantly different ($p < 0.05$) in most acupuncture locus locations.

IN VIEW OF THE CURRENT REVIVAL of interest in acupuncture, it would appear to be necessary to examine the question of the objective reality of the acupuncture system as a whole as well as its possible therapeutic efficacy.

It has been generally assumed that acupuncture loci are DC skin conductance maxima (resistance minima) [1,2], although Noordergraaf and Silage [3] recently disputed this claim for the loci on the fingers. We have reported that many acupuncture loci, while not necessarily *absolute* maxima, are nonetheless significant *local* conductance maxima [4,5].

In our preliminary report [5], we described a bootstrap method used to locate the acupuncture loci more precisely than was possible using standard charts. The present study was designed to examine the question of the existence of acupuncture loci without the necessity of precisely locating them prior to the conductance measurement.

Methods

Skin conductance was measured with a previously described Wheatstone bridge circuit [5]. The hand-held reference electrode was a stainless steel cylinder 10 cm long and 3 cm in diameter. The measuring electrode assembly was a teflon square supporting 36 stainless

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Informed consent was obtained from all of the volunteers included in this study after the nature of the procedure had been explained.

steel rods in a 6 x 6 array, as shown in Figure 1. When in place, each rod exerted a pressure of 3.12×10^4 dynes/cm^2 on the skin. All conductance measurements were made with 2 volts DC across the subject.

The approximate location of a particular acupuncture locus was determined in advance using standard charts and anatomical reference points (6,7). Two anatomically similar squares of side 2.5 cm were then delineated on the subject. One enclosed the acupuncture locus, while the other was devoid of acupuncture loci. The two areas were located as closely together as was feasible. Areas containing cuts, abrasions, or pigmented moles were excluded from the study. The subject was not informed of which area contained the acupuncture locus. The skin was cleaned with 90% alcohol and moistened with tap water.

The 36-electrode grid was positioned over the purported acupuncture locus (X) and lowered until all the electrodes rested on the skin. The conductance at each electrode was recorded in succession by means of a switching circuit. The measurement, which took an average of 20 seconds, was then repeated for the control (Y) area. This procedure was repeated a total of 8 times, always alternating X and Y recordings.

A total of ten acupuncture loci on the Triple Burner (TB) and Lung (Lu) meridians were studied (see Figure 2). Each locus was measured on ten subjects.
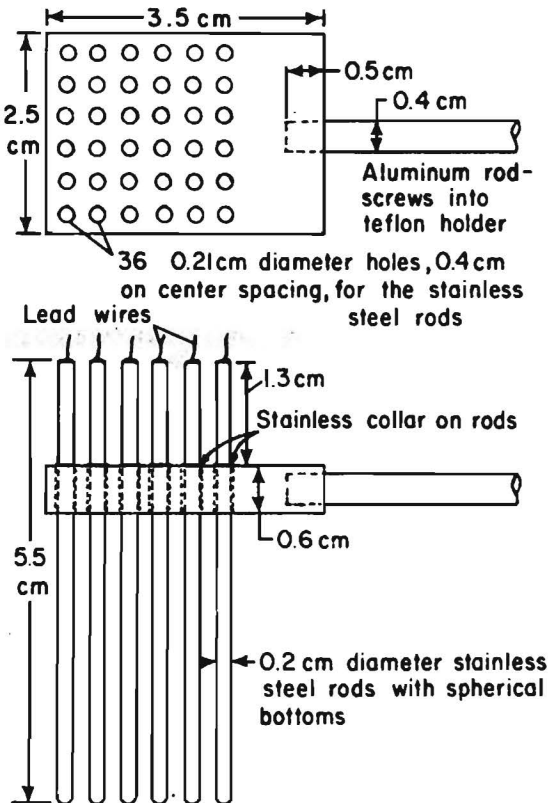

Figure 1. Multi-electrode probe for conductance measurement. The probe was centered over a purported acupuncture locus, then lowered into place so that each electrode rested on the skin. The electrodes were supported by a teflon holder and could move freely in a vertical direction. A rack-and-pinion arrangement provided for 3-dimensional positioning of the device. The conductance was recorded at each electrode in turn through a switching circuit.
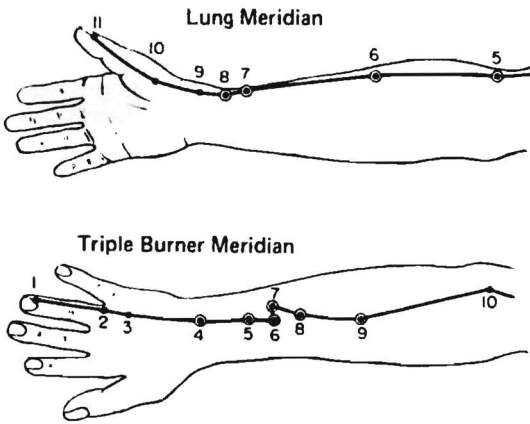
Figure 2. Triple Burner (TB) and Lung (Lu) meridians on the hand and forearm. The circled acupuncture loci were used in this study.

Results

For the purpose of determining the objective existence of an acupuncture locus, we had determined previously (5) that the relative increase in conductance was more significant than the value of the conductance *per se.* Therefore, the data were analyzed for conductance variation within each array, and the results for each X-Y pair were compared individually.

The sums of the conductance readings over all 2 x 2 arrays contained in each 6 x 6 array were computed and normalized with respect to the smallest sum in the array. The normalized sums in each X-Y pair were compared to find the magnitudes M_X of any X-sums which were greater than all of the corresponding Y-sums, or alternatively the magnitudes M_Y of the Y-sums greater than all X-sums. This was repeated for all X-Y pairs for a particular test, and the total numbers of such points (N_X and N_Y) were found.

In our earlier study (5) we computed the increase in conductance at a total maximum relative to its immediately adjacent minima. The distance covered in each measurement varied considerably, but was generally smaller (1-2 cm) in areas where the acupuncture loci were closely spaced and greater (up to 5 cm) where they were more widely separated. Here, the area covered by the electrode array was fixed (4.84 cm^2), and did not always include the minima around a local conductance maximum. Therefore, we decided that it would be sufficient to demonstrate that the X and Y areas were dissimilar in order to establish the objective existence of an acupuncture locus within area X. The null hypothesis, confirmed by separately testing a subgroup of the subjects, was that two such areas would be similar (i.e. $N_X = N_Y$ and $M_X = M_Y$) if neither contained an acupuncture locus. A 2-tailed Wilcoxon test (8) was done on the numbers N_X and N_Y and the magnitudes M_X and M_Y for each subject and acupuncture locus. The results appear in Table 1.

Of the 100 measured areas purportedly containing acupuncture loci, 76 exhibited significantly different ($N_X \neq N_Y$ and $M_X \neq M_Y$, $p < 0.05$) local conductance variation than did anatomically similar control sites. By these criteria, all of the ten acupuncture loci tested appeared on at least one-half of the subjects tested; loci TB-4, TB-5, TB-6, Lu-5, and Lu-7 were found on at least eight out of ten subjects.

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Acupuncture Locus	N_1	N_2	N_3*
TB-4	5	3	2
TB-5	6	3	1
TB-6	8	1	1
TB-7	2	3	5
TB-8	3	3	4
TB-9	4	3	3
Lu-5	8	2	0
Lu-6	6	1	3
Lu-7	6	3	1
Lu-8	4	2	4

*Testing the null hypothesis $N_3 = 10$ for each acupuncture locus, we find that $\chi^2 = 60.20$ (df = 9), or $p < 0.005$ (9) that this result could have been obtained by chance.

TABLE 1. Results of a 2-tailed Wilcoxon test ($p < 0.05$). For each of 10 acupuncture loci, N_1 subjects exhibited more local conductance variation in the experimental than in the control areas, N_2 subjects the reverse, and N_3 subjects showed no significant difference between the two. Each locus was measured on 10 subjects. Of a total of 100 acupuncture locus sites tested, 76 were found to be significantly different from anatomically similar control areas.

Conclusions

The local DC skin conductance variation in the neighborhood of the purported acupuncture loci tested was found to differ significantly from that of matched, anatomically similar control areas. This substantiates our earlier report (5) that many acupuncture loci are distinct local conductance maxima and thus have an objective existence.

Not all of the classical acupuncture loci we tested were found on all subjects. We feel that this result should be considered in the context of the current interest in the effectiveness of acupuncture therapy. The protocol of a clinical study should take into account the probability that all acupuncture loci may not be objectively measurable on all subjects at all times, and utilize only such loci as can be precisely located before treatment by non-invasive electrodermal measurements.

References

1. Frost, E. and W.R. Orkin Localization of acupuncture sites. *Proc. NIH Acupuncture Research Conf.*, DHEW Publication No. (NIH) 74-165: 121 123, 1973.
2. Saita, H.S. Modern scientific medical acupuncture. *J. Am. Osteopath. Assoc.*, 72:685 696, 1973.
3. Noordergraaf, A. and D. Silage Electroacupuncture. *I.E.E.E. Trans. on Biomed. Eng.*: BME-20: 364 366, 1973.
4. Becker, R.O., M. Reichmanis, A.A. Marino and J.A. Spadaro A possible biological basis for acupuncture. *Psychoenergetic Systems* (in press).
5. Reichmanis, M., A.A. Marino and R.O. Becker Electrical correlate of acupuncture points. *I.E.E.E. Trans. on Biomed. Eng.* BME-22: 533 535, 1975.
6. Mann, F. *Acupuncture: the Ancient Chinese Art of Healing.* Second Edition. London: Wm. Heinemann Medical Books Ltd., 1971.
7. Tan, L.T., M.Y.C. Tan and I. Veith *Acupuncture Therapy: Current Chinese Practice.* Philadelphia: Temple University Press, 1973.
8. Conover, W.J. *Practical Nonparametric Statistics.* New York: John Wiley & Sons Inc., 1973. pp. 206 208, 366, 383.
9. Shelby, S.M. (Ed.) *CRC Standard Mathematical Tables.* 21st Edition. Cleveland: CRC Press 1973, p. 618.