Electric Characterization of Skin Near Biological Active Points and Meridians

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Abstract. Electric properties of the skin of eighteen young and healthy volunteers were evaluated around four of the so called Biological Active Points or acupoints (PC6, PC4, Li4, St36) and around a section of the pericarium (PC) meridian. These acupoints show significant lower resistance than the corresponding adjacent points. Additionally, acupoints show lower variability of this parameter than control points. PC meridian was evaluated along 10 cm from the wrist in points separated 0.5 cm. The mean value of the resistance was lower in meridian points than the corresponding resistance of non meridian line points. Nevertheless, comparing the resistance values of only meridian points, only one meridian point (from four PC points covered by the measurements) could be associated with acupoint according to its electrical characteristics that have significant lower resistance compared to neighbor points on the meridian line. Resistance variability was statistically similar in both meridian and non meridian points so this parameter could be valuable only using a non meridian control point for comparison.

Keywords: Acupuncture Points; Meridians; Bioimpedance; Electrical Variability; Skin Resistance

1. Introduction

In 1997 The National Institute of Health from the USA and in 2003 the World Health Organization declared that there is enough evidence to recognize the Acupuncture as an alternative treatment to prevent and cure diverse pathologies [NIH Consensus Statement 1997, WHO; 2003].

The stimulation of Biological Active Points (BAP)'s or acupoints is performed introducing the needles into the skin by internal mechanical stimulation (according to the traditional acupuncture methodology) consisting in the rotation of the inserted needle. Nowadays the BAP are stimulated with many techniques: 1) with electrical stimulation yielding to the so called electro-acupuncture, 2) with thermal stimulation by moxibustion, 3) by optical stimulation as in laser-acupuncture and 4) the external mechanical stimulation known as acu-pressure besides of the magnetic stimulation used in other alternative therapies.

Although acupuncture is “accepted” like an alternative therapy, still non conclusive investigation related to its physical principle of action exists. However, many results have been published in topics related to clinical trials and experiments made by physicians, testing the efficacy of the acupuncture. The scientific conclusions are controversial mainly among the occidental researchers [Ernst 2006]. At the same time, the research on physical properties of these acupoints and their meridians is scarce and again controversial [Ahn 2008].

Among the physical properties of BAP, the electrical properties, mainly electrical resistance or conductance have a relevant role in the characterization of these skin points. The most accepted result about that is the lower electrical resistance of BAP compared with surrounded points. This of course is still under strong controversy as it was mentioned above [Ahn 2008]. Nevertheless the usual BAP technique to localize acupoints uses the high conductance property by surface measurements.

In the surface evaluation of BAP there exists a set of factors that influence the measurement [Ahn 2007]: 1) the stratum corneum, 2) the electrode pressure, 3) the skin hydration, 4) the electrode polarizability, and 5) subcutaneous fat tissue, among others.
In this work we evaluated relative magnitude of electric parameters of skin points taking anatomical similar points as control references to have similar stratum corneum, skin hydration, subcutaneous fat tissue etc. Individual BAP’s and meridian line points were evaluated and compared with their corresponding control points. Resistance differences are discussed among all these points and variability of this parameter is considered.

2. Material and Methods

2.1. Experimental set up

Four BAP’s were selected (Fig. 1); two of them on the inner forearm skin PC4 (Ximen), PC-6 (Neiguan), one on the hand skin Li-4 (Helu), and one on the leg skin St-36 (Suzanli). These are some of the most used acupoints in scientific literature. The location of the acupoints was determined from traditional literature information without any acupuncturist guide and using an electrical locator.

Bio-Impedance evaluation in frequency domain was performed by measuring from the Acupoint to the point placed at the same level but on the other side of the forearm, hand or leg respectively (Fig. 2a). In this way, the electrical field sensitivity is concentrated in the extreme points and the field could penetrate inside the acupoint toward the subcutaneous tissue. As the ground electrode is in the same place for both measurements (acupoint and control point measurements), the differences should come from the surface and near surface region of the positive electrode (Fig. 2b). Disposable 3M “Red Dot” monitoring electrodes were used limiting the contact surface by an adhesive plastic layer with a 2 mm diameter hole in the center embedded with electro-gel. In this way electrical contact is assured and no pressure is necessary to improve this contact. Control points were chosen inside a circle of 1 cm radius around the acupoint avoiding meridian points, cartilage or tendons.

For meridian measurements the PC meridian was evaluated every 0.5 cm in the region from the wrist up to 10 cm toward the arm. In this way, PC7 (Daling) at the wrist, PC6 (Neiguan), PC5 (Jianshi) and PC4 (Ximen) would be evaluated (Fig. 1). In this case, the inter-point distance was determined by proportions between wrist-elbow real length and PC7-PC3 “cun” based length. The electrode configuration and equipment was the same that for Acupoint assessments. Meridian control was a parallel line around 1 cm toward the external part of the forearm avoiding cartilage or tendons.

An impedance analyzer (Solartron 1260) was used together with a biological interface (Solartron 1294) for measurements in the frequency range from 10 Hz to 100 KHz and 500 mV excitation intensity.

![Figure 1. Position of the four acupoints studied (red points) and controls C (green points).](image1)

![Figure 2. Experimental setup for skin point evaluation a) external view, and b) transverse view. The measurements differences should come from the regions near the Acupoint (AP) and control point.](image2)
2.2. Subjects

The volunteers were young and healthy subjects from 20 to 24 years old. A general clinical check up was performed to each volunteer mainly to avoid skin and subcutaneous pathologies. Before participating in the experiment, each subject was abstained from smoking, alcohol consumption, strenuous exercise, and substances containing caffeine for 24 hours before testing and were asked to sleep enough the night before. Also the volunteers were asked to arrive cleaned without cream, lotion, perfumed or any other cosmetic skin treatment. Before and after each bioelectrical measurement, the skin was cleaned with alcohol. The subjects were recruited with a similar arm length to avoid uncertainty in the correlation of the localization of the measured points and the possible localization of the acupoints.

All subjects who participated in this study signed a consent form approved by the Medical Physics Group of the University of Guanajuato. The study was conducted according to the Declaration of Helsinki [12].

2.3. Data Analysis

The dielectric data was analyzed using an elemental electrical circuit model consisting in a resistance in series with a parallel RC circuit with a constant phase element. The parameters obtained in each measurement are Rs (resistance in series), Rp (parallel resistance from RC circuit), CPE-T and CPE-P (magnitude and phase of the constant phase element). Differences in the average parameters from all the subjects were analyzed using T-test for dependent samples. All statistical analyses were performed using Statistica (Stat-Soft, Inc, Tulsa OK), and the threshold for significance was standardized at p=0.05.

3. Results

3.1. Biological Active Points

The resistance Rs is the only parameter with significant differences from Acupoints to their corresponding control point showing the expected statistically significant differences in the four cases (lower resistance for acupoints) as it is demonstrated in Fig. 3 (p<0.05). It is worth mentioning that in all cases we had higher variability when we compared control points with their corresponding acupoints. This result was reported before by Johng HM et al. [Johng HM, 2002].

![Figure 3](image-url)

*Figure 3. Values of the resistance Rs from the whole group for each Acupoint and its control point. P=Acupoint, NP=control point*
3.2. Meridians

The same procedure of averaging Rs values for the whole group was performed in each of the 21 meridian points (Fig. 4) showing the following global behavior: The average resistance of the entire 21 points region is higher in the control line points than in the meridian line points. Comparison of each meridian point with its corresponding non-meridian point (neighbor points) gives differences in points located at 0.5, 3-6 and 9-10.5 cm.

In Fig. 5, each filled dot represents statistically significant difference (p<0.05) between the skin points corresponding to the dot coordinates. Taking points only from non meridian line, only one point seems to have statistical differences with other points of the same line. This is observed around the third point from the wrist (Fig. 5a). This difference however, is obtained by comparing with points far from its adjacent points (points far from the diagonal line in Fig. 5a).

The meridian points seem to have more differences among them and especially with their surroundings points (points near the diagonal in Fig. 5b). The more promising points are those located at 2.0, 3.5, and 6.5 cm. Nevertheless is worth mentioning that the only acupoint with a resistance lower than its surroundings is the one placed at 3.5 cm from the wrist. In this case the average variability of the two sets of points is similar.

4. Discussion

One of the limitations of this study was the apparent contradiction that we localized the acupoints using an electrical locator and then the measurements of electrical properties were performed. The result of lower resistance of acupoints could be considered irrelevant. However, our principal claim in this first part of the evaluation is the confirmation that the variability of the measurements are lower in the acupoint than in the corresponding control point as was pointed out before. We claim that resistance variability could be a valuable parameter to characterize acupoints independently of the locator procedure.
The methodology used to measure electrical properties of skin and subcutaneous tissue assured that the differences founded are not only due to skin surface differences but also includes possible nearby subcutaneous differences (Fig. 2b) because the grounded electrode point was the same for acupoint and control point.

We did not found differences in other electrical parameter as the electrical capacity as was mentioned in some works.

The meridian determination was performed using the localization of the two PC acupoints considered in the first part of this work and anatomical references. The difference founded between meridian and non meridian corresponding points (lower resistance for meridian points) indicates that a mistake in acupoint localization along the meridian could lead to the same result of lower resistance compared with a control point localized out of the meridian. In fact, roughly at the corresponding position of the four PC points that could be located in that part of that meridian we found differences but there are more meridian points showing similar differences. On the other hand if the control point would be in the meridian line, the probability of statistical differences could decrease even if we are in the correct acupoint position.

The comparison among meridian line points gives many differences (dots in Fig. 5b) but only one case indicate statistically significant lower resistance compared to neighbor line points. Therefore this point, located at 3.5 cm, is the only one that could fix the requirements to be an acupoint.

Just for comparison, the corresponding acupoints, in the section of the PC meridian considered, are roughly placed at 0.0 cm (PC7), 4.0 cm (PC6), 6.0 cm (PC5) and 10.0 cm (PC4). The nearest acupoint to our point candidate is the PC6 point. It should be mentioned than PC6 is one of the acupoints most used in scientific works.

Finally, contrary to the individual point evaluation, the variability of resistance parameter in meridian line points is of the same level of that for control line points. This reinforce the possibility to have the variability as a parameter to localize acupoints even with a meridian near points comparison.

5. Conclusions

Four low resistance skin points analyzed, presumably corresponding to four acupoints, show lower variability on the resistance parameter than the control points located out of the corresponding meridian line. This variability differences in not found in meridian versus non meridian lines assessments. Meridian points showed in average higher resistance than non meridian points which could explain the differences found in individual points but also could make confuse the traditional resistance evaluation to localize acupoints. When line points (meridian or non-meridian) are compared among them, we found more differences among meridian points than among the control line points but these differences not always represent lower resistance than surroundings points. Only the PC6 acupoint could probably be associated to a point evaluated in this work because the statistical significant lower resistance and a roughly correct position in the meridian line evaluated.

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