Skin Impedance at Acupuncture Point Dingchuan in Subjects with and without Asthma

Ngai Shirley Pui-ching, BSc[1] Jones Alice Yee-men, PhD, FACP[1]

Abstract Objective: Asthma can be a disabling disease and despite advances in pharmacology, the prevalence of this condition globally remains high and accounts for a significant proportion of public health care costs. While pharmacology is the mainstay of asthma management, drug side effects have promoted alternative therapeutic interventions, such as acupuncture. Acupuncture points have a lower skin impedance compared to non-acupuncture points. Health impairment is associated with changes in skin impedance at system-specific acupuncture points. Detection of skin impedance changes may assist in the early diagnosis of asthma and monitoring the effectiveness of therapeutic interventions for this condition. **Method:** This study compared skin impedance at acupuncture point Dingchuan (EX-B1), in 92 subjects with normal health (47 subjects, age 32.6±1.67yr) and those diagnosed with asthma (45 subjects, age 42.4±1.80 yr). Skin impedance was measured using a 2-electrode impedance meter bilaterally at EX-B1, 0.5 "cun" lateral to the lower border of 7th cervical vertebra. **Result:** The study showed that skin impedance was significantly higher at acupuncture point EX-B1 in subjects with asthma (29.4 ± 21 kΩ) compared to subjects with normal health (13.8±7.9 kΩ) (P=0.013). Skin impedance was negatively correlated to forced expiratory volume in 1 second (FEV_1, r=-0.59, P=0.012 in females; and r=-0.68, P=0.015 in males). A receiver operator characteristic (ROC) curve revealed an optimum cut-off point of 35 kΩ for male and 10 kΩ for female subjects. **Conclusion:** We conclude that EX-B1 skin impedance is higher in patients with asthma and skin impedance might be a possible adjunctive parameter for assisting diagnosis and monitoring asthmatic status.

Key words asthma; acupuncture; skin impedance

Despite significant advances in the pharmacological management of asthma, the prevalence of this condition remains high[1] and accounts for significant health care costs[2]. Whilst pharmacological therapy remains the mainstay of management of this disease, the side effects of asthmatic medication has driven the search for alternative remedies.

The free flow of energy, commonly known as qi or chi, maintains the balance between yin and yang and results in good health according to Traditional Chinese Medicine (TCM) principles. Meridians are channels through the body along which qi passes and acupuncture points located on the meridians are believed to mark gateways whereby the free flow of qi can be restored, should illness occur. An association between acupuncture points with skin resistance[3-6] and temperature[7] has been investigated, as has the relationship between acupuncture effect and brain activity through analysis of fMRI signals [8-9]. Acupuncture points have high conductivity (i.e. lower skin impedance) when compared with the non-acupuncture points [10-11] and body dysfunction such as diabetes mellitus, inflammation and pain, alter skin impedance at acupoints located along an organ-related meridian [12-15]. Acupuncturists may choose acupoints which do not lie along organ-related meridians to manage a particular condition. Changes in skin impedance over these so-called "extra points" have not been reported.

Should a relationship between acupoint skin impedance and the asthma condition exist, changes in skin impedance could possibly be used to assist diagnosis and monitor progress of the disease. This current study aims to compare skin impedance measured at Dingchuan(EX-B1), a commonly used "extra" acupoint for the management of asthma, in subjects with and without asthma.

1 MATERIALS AND METHODS

1.1 Subjects

Ethics approval was obtained from the Human Subjects Research Committee of the involved university and informed consent was obtained from all subjects prior to data collection. Subjects aged 18 or above diagnosed with asthma but without a known history of cardiovascular, musculo-skeletal, neurological or endocrine disorders, were recruited from the respiratory clinic of a large district hospital. Subjects diagnosed with asthma and attending follow up at the clinic for more than 3 years, were invited to participate

1 Department of Rehabilitation Sciences, The Hong Kong Polytechnic University, Hong Kong

Correspondence:Professor Alice Jones Department of Rehabilitation Sciences,The Hong Kong Polytechnic University,Hung Hom, Kowloon, Hong Kong

E-mail: rsajones@polyu.edu.hk

in the study. Another group of subjects, matched for age and with no known history of skin disease, allergy, respiratory, cardiovascular, musculo-skeletal, neurological or endocrine disorders was also recruited.

All subjects were asked to complete a medical history questionnaire (including the duration of disease and medication taken, if any) to ensure no subject had any signs and symptoms of upper respiratory tract infection during the 4 weeks prior to data collection. Subjects with asthma were also asked to complete the Asthma Quality of Life Questionnaire (HK Chinese version)[16—17].

1.2 Procedures

Upon arrival at the laboratory, all subjects rested in the sitting position for 20min before measurements. Demographic data including age, body mass index, percentage of body fat and lean mass (measured by the Body composition analyzer, InBody, 3.0, Korea) were recorded. Forced expiratory volume in 1 second (FEV1) and forced vital capacity (FVC) of all subjects were measured by a Spirometer (Pony, Cosmed, Italy) following the recommendation by the American Thoracic Society [18]. The acupuncture points (EX-B1 Dingchuan, 0.5 "cun" lateral to the lower border of 7th cervical vertebra), were marked by a registered physiotherapist who had attained a diploma in clinical acupuncture. (A "cun" is a Chinese measurement unit used to locate an acupuncture point and is the distance between the medial ends of the creases of the middle and distal interphalangeal joints of the middle finger).

The skin area over these points was cleaned with a 70% isopropyl alcohol swab, followed by the placement of Red Dot™ (3M™) electrodes. These electrodes were used because they are almost non-polarizable and have negligible series resistance and pressure effect. The skin impedance was measured using a 2-electrode impedance meter (IMP, Rochester Electro-medical Inc., USA) which delivered a 60Hz AC sinusoidal output current of 2μA. Prior to data collection, the meter output was validated using a known resistor and a mixed signal oscilloscope MSO6014A at 100MHz (Agilent Technologies, USA). All measurements were conducted in a university laboratory at constant temperature and humidity.

1.3 Statistical analysis

Data are presented as mean±standard error of the mean (SEM). Nominal data were compared using Chi's square analysis. Between group comparison of skin impedance data used independent t test. Any correlation between skin impedance and FEV_1, FVC and percentage of body fat was determined using Pearson's analysis. A receiver operating characteristic (ROC) curve was constructed to analyze the discriminative validity between the healthy and asthma groups, and to determine the magnitude of an optimal "cut-off" skin impedance score. The Type I error level was set at $\alpha=0.05$. All statistical analysis was conducted using SPSS ver. 16 statistical software.

2 RESULTS

Ninety-two subjects (47 with normal health and 45 with asthma) were recruited to the study. The demographic data of these subjects are displayed in Table 1. The predicted FEV_1 was significantly lower in the subjects with asthma but the skin impedance was higher ($P<0.001$)(Table 1). Pearson analysis revealed no significant correlation existed between skin impedance and the variables measured in subjects under 35 years of age, but over 35 years of age, the skin impedance was negatively correlated with the percentage predicted FEV_1 ($r=-0.311$, $P=0.042$). Further sub-group analysis showed that in subjects with asthma, the skin impedance was negatively correlated with FEV_1 and positively correlated with percentage of body fat, in both male and female subjects (Table 2).

The area under the ROC curve for all subject data was 0.835. The ROC curve suggested an impedance level of 25kΩ will accurately identify 80% of asthmatic subjects. The cut off score for male subjects was 35kΩ and that for females was 10kΩ, which suggests a predictive accuracy of 100% in males and 70.4% in female subjects (Table 3).

Table 1 Demographic data of the 92 subjects*

	Subjects with normal health (n=47)	Subjects with asthma(n=45)	P value
Gender (Male:Female) at age under 35 years	13:17	6:10	0.762
Gender (Male:Female) at age 35 years or over	7:10	12:17	1.000
Height(m)	1.64±0.01	1.62±0.01	0.175
Weight(kg)	61.82±1.56	62.01±2.06	0.939
BMI(kg/m²)	22.89±0.49	23.59±0.60	0.368
Skin impedance (kΩ)	13.62±1.64	29.78±2.96	0.000①
% body fat	25.14±1.09	27.32±1.55	0.256
% predicted FEV_1 (%)	90.06±1.55	75.73±2.11	0.000①
% predicted FVC (%)	89.11±1.51	86.28±2.26	0.299

*Data are presented as mean ±SEM unless otherwise indicated. FEV_1=Forced expiratory volume in 1 sec; FVC = forced vital capacity, ① denotes $P<0.05$

Table 2 Relationship between skin impedance and FEV_1 and percentage body fat in subjects at age ≥35 years

Skin resistance with	Subjects at or over 35 years with asthma			
	Male(n=12)		Female(n=17)	
	Coefficient value (*r*)	*P* value	Coefficient value (*r*)	*P* value
FEV_1	−0.680	0.015①	−0.594	0.012①
% Body fat	0.939	0.018①	0.834	0.003①

FEV_1=Forced expiratory volume in 1 sec; %Body fat= percentage of body fat; ①denotes $P<0.05$

Table 3 Determination of the discriminatory validity between the healthy and asthma groups by the Receiver Operating Characteristic (ROC) curves

	Area under curve (95% CI)	Accuracy (%)	Cut-off point	Sensitivity (%)	Specificity (%)
All subjects (n=92)	0.835(0.74,0.90)	80.65	>25kΩ	55.56	87.23
Male subjects (n=38)	0.910(0.77,0.98)	100.00	>35kΩ	61.11	100
Female subjects (n=54)	0.785(0.65,0.88)	70.37	>10kΩ	70.37	70.37

3 DISCUSSION

Acupuncture-based electrodermal testing was developed by Voll in the 1950s[19]. Higher skin impedance is associated with inflammatory conditions 20. We demonstrated that skin impedance measured at Dingchuan in our subjects with asthma was higher than that found in a comparative group of healthy subjects, suggesting impairment of body function by asthma could be reflected by an increase in skin impedance at this extra acupoint.

Gerosa, et al[15].compared the skin impedance in subjects with immune system disorders and those with normal health, and found a high sensitivity and moderate specificity (91.5% , 58.8%) when using skin impedance as a discriminatory factor to identify chronic autoimmune disease. Similar findings have been reported for cardiovascular, respiratory, gastrointestinal and genitourinary system pathology, with sensitivity and specificity higher than 70%[21]. The sensitivity and specificity for skin impedance indicating an association with asthma in our study were also around 70%.

Electrical impedance is frequency dependent and is also affected by age, gender, temperature, location of measurement and the pressure applied[11,22—23]. The outer layer of the human epidermis (stratum corneum) is semi-permeable to ions and thus has a relatively high skin impedance[22]. These skin factors explain the different cut-off values for males and females observed in our study.

Van Der Valk & Groen[23] found the electrical resistance of the skin to be about 30.5 kΩ in subjects with asthma compared to 19.3 kΩ in subjects with normal health. That study did not measure skin resistance at an acupuncture point and therefore direct comparison with our data is not deemed appropriate, although our data concur with previous studies showing that skin resistance in general is much higher in subjects with dysfunction.

The high correlation between percentage body fat and skin resistance reflects the relatively poor electrical conductivity of lipid compared to electrolyte rich fluids and electrical conductance has been used to monitor obesity[24]. Moist, warm skin is a better conductor of electricity than skin affected by dryness which accompanies aging. To minimize the effect of age on skin impedance we separated our data groups to those subjects over and under 35 years of age. We found no correlation between skin impedance and FEV_1 in subjects less than 35 years. Although the ROC discriminatory validity was over 80%, using skin resistance to monitor asthma would be more appropriate in subjects over 35 years of age.

Limitation of the study:While the total study involved 92 subjects, correlation between skin resistance and FEV_1 was found only in 29 subjects over 35 years of age. The ROC curves analysis should therefore be treated with caution. The rationale for this needs further investigation.

4 CONCLUSION

Our data showed that skin impedance measured over the acupuncture point EX-B1 was higher in subjects with asthma. An impedance level higher than 10 kΩ in females and higher than 35 kΩ in males over 35 years of age may indicate asthma.

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