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Transient Decrease in Skin Resistance Response and Level at the *Deh-Chi* Stage Caused by Manual Acupuncture

TEN-JEN LIAO, SHIGERU URATA and HIROYASU NISHIKAWA

Department of Physiology, Meiji University of Oriental Medicine, Kyoto 629-0392

LIAO, T.-J., URATA, S. and NISHIKAWA, H. *Transient Decrease Skin Resistance Response and Level at the* ***Deh-Chi*** *Stage Caused by Manual Acupuncture.* Tohoku J. Exp. Med., 1998, **186** (1), 19-25 —— *Deh-chi* is described as a kind of soreness, numbness, or heavy swelling in deep tissues during manual acupuncture. This finding is important in acupuncture therapy, although the mechanism of this phenomenon remains unclear. Skin resistance response (SRR) and skin resistance level (SRL) are expressed as a component of alternating current and direct current changes in electrodermal activity (EDA) respectively. In the present study, we recorded SRR and SRL, skin blood flow and perspiration simultaneously in an attempt to determine the relationship between skin sympathetic nerve activity and EDA at the *deh-chi* stage. We found that SRR, SRL and skin blood flow decrease, and that perspiration increases transiently at the *deh-chi* stage. Our findings indicate that manual acupuncture causes an increase in vasomotor and sudomotor activities, a decrease in skin blood flow, and increased perspiration. These SRR and SRL recordings may be taken as an indicator of *deh-chi*. ———— *deh-chi*; manual acupuncture; skin resistance response; skin resistance level; skin sympathetic nerve activity

Although much effort has been invested into discovering the major effects of acupuncture and many studies have been published over the past three decades (Pomeranz and Stux 1987; Liao 1992; Liao et al. 1993; Milanov and Toteva 1993), the mechanism of acupuncture remains unclear and controversial; specially, *deh-chi*, which is described as a kind of soreness, numbness, or a heavy swelling in the deep tissues beneath the acupuncture point caused by acupuncture stimulation (Chang 1978). *Deh-chi* is apparently a prerequisite for the analgesic and therapeutic effects of acupuncture (Chang 1978; Liao 1992). Several reports describe the phenomenon of *deh-chi* (Funakoshi and Kawakita 1980; Liao 1992), but no relationship between *deh-chi* and expression of the emotion can be found

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Address for reprents: Dr. T.-J. Liao, Department of Physiology, Meiji University of Oriental Medicine, Hiyoshicyo, Funaigun, Kyoto 629-0392, Japan.

e-mail: t_nakayama@muom.meiji-u.ac.jp

in these studies. *Deh-chi* is a complex and rather unpleasant feeling, and may be generally classified as a kind of dull pain. It is known that various emotional states can change the activity of the autonomic nervous system, and can be recorded as electrodermal activity (EDA) (Nimi and Suzuki 1986). Visual, auditory and somatosensory stimuli can also cause a variety of emotion and produce transient EDA changes on human skin (Burstein et al. 1965; Nimi and Suzuki 1986). Acupuncture is a kind of somatosensory stimulus that may cause transient EDA changes. Skin resistance response (SRR) and skin resistance level (SRL) are expressed as a component of alternating current (AC) and direct current (DC) changes in EDA respectively. Usually, both of these SRR and SRL are used as indices for studying activities of autonomic nervous system.

We sought to determine the activity of EDA at the *deh-chi* stage. Accordingly, we recorded SRR and SRL during manual acupuncture stimulation, and analyzed the data to try to find the propensity and relationship between *deh-chi* and the activity of skin sympathtic nerves.

Materials and Methods

Twenty healthy volunteers (comprising 2 females and 18 males) of university students and staff, ranging in age from 22 to 36 years old, participated in this experiment. Informed consent was obtained from each subject after a full explanation of the experiment was given.

The subjects laid in the supine position on a bed in an electrically shielded room at a temperature of between 24 and 26°C. Electrodes were placed on the abductor digiti minimi muscle of the right palm and were connected to a GSR bridge (MA1002A, NEC, Tokyo), a differential amplifer and a VC11 oscilloscope (Nihonkoden, Tokyo) to obtain SRL and SRR recordings. The skin blood flow was recorded by a laser flowmeter (ALF21, Advance, Tokyo) at a time constant of 1 second and with a probe placed on the right palm near the recording electrodes then the apparatus was calibrated after setting the level to zero. Perspiration was recorded by a ventilated capsule method which using a 1 cm diameter capsule placed on the center of the palm through nitrogen gas was passed, and the probe connected to a hydrometer (Hydrograph AMU-3, Foushon, Tokyo). SRR, SRL and skin blood flow were simultaneously recorded in 20 subjects, and SRR, SRL, skin blood flow and perspiration were simultaneously recorded in 10 subjects.

A disposable stainless-steel acupuncture needle (200 μm, 40 mm, Seirin Kasei, Sizuoka) was inserted into the right *Shousanli* (LI12, with the elbow flexed, on the radial side of the dorsal surface of the forearm and on the line connecting *Yanxi* (LI5) and *Quchi* (LI11), 2 *cun* body inch of patient, using to measure the distances on the body in China, the breadth of the distal phalanx of the thumb is also equal to 1 *cun* distal to *Quchi*) acupoint (Pomeranz and Stux 1987; Yan 1992) at a depth to produce *deh-chi*, then by lifting and thrusting down the needle (Yan 1992), *deh-chi* was obtained immediately. We call this stimulation "effective acupunc-

ture stimulus (EAS)".

The intensity of *deh-chi* expressed by each subject was recorded via a load transducer (9E01-L43, NEC San-ei, Tokyo). The stronger the *deh-chi*, the higher the load recorded. The subjects practiced this measurement method several times before the experiment began. The propensity of *deh-chi* was then checked by a questionnaire. The acupuncturists' EMG when the acupuncture needle was manipulated was recorded by surface electrodes placed on the right musculi manus thenaris. These electrodes were used to signal each stimulus, and were filtered from 50 Hz to 300 Hz. All data were recorded by a data recorder (XR-9000, TEAC, Tokyo) for off-line analysis.

Spearman's correlation coefficient (r) was calculated (Statistica 4.1J, Statsoft Inc., Tulsa, OK, USA) and the level of significance (p) of the value r was evaluted.

Results

Fig. 1 shows the acupuncturists' immediate EMG appearance after lifting and thrusting down the acupuncture needle. When *deh-chi* was indicated (Force), SRL and SRR changed transiently on the palm skin within 3 seconds after manipulating the acupuncture needle. No transient change of SRR and SRL was observed during the stage of retaining the needle when no manipulation took place. Since *deh-chi* expression may cause enough emotional variation to produce transient SRL and SRR changes (Seals 1989), EMGs were used as an indicator signal of stimuli only in this study. Fig. 2 shows SRL, SRR, skin blood flow and

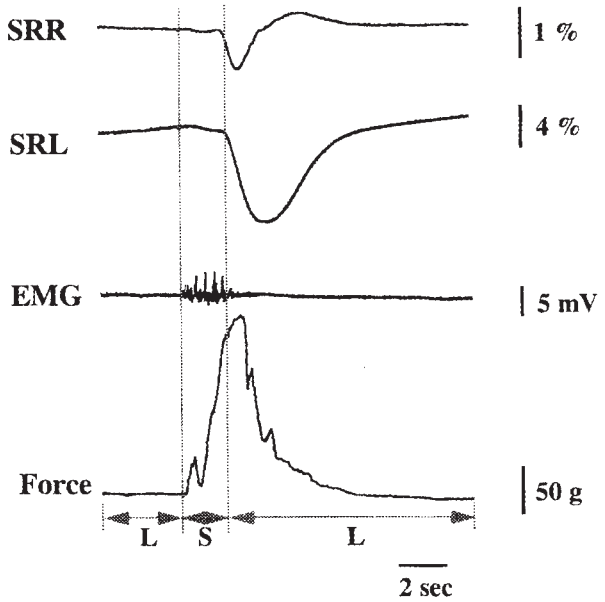

Fig. 1. Typical changes in SRR (first trace), SRL (second trace), EMG (third trace), and force (fourth trace) waves recorded simultaneously at the *deh-chi* stage. *S* represents the perid of manual acupuncture stimulation, and *L* represents the retaining of the needle with no manipulation.

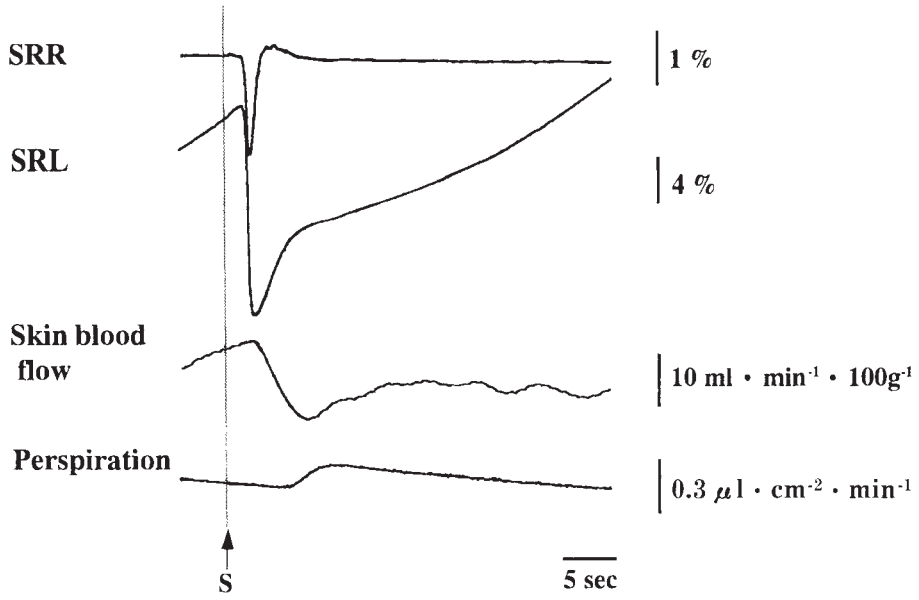

Fig. 2. Typical changes in SRR (first trace), SRL (second trace), skin blood flow (third trace), and perspiration (fourth trace) waves on palm skin recorded simultaneously at the deh-chi stage. *S* represents the start of manual acupuncture stimulation.

perspiration changes to the palm at the *deh-chi* stage. At this stage, the peak amplitude of SRL and SRR decrease transiently after EAS. SRR is a component of SRL in that the peak of the former is smaller than the latter. The skin blood flow began to decrease at the peak latency of SRR and persisted to the SRL recovery stage.

Fig. 3 shows the mean values of SRR and SRL peak latencies measured at the deh-chi stage as 2.1 ± 0.5 seconds and 3.3 ± 1.2 seconds respectively. Fig. 4 shows the mean values of SRR and SRL peak amplitudes decreased ($0.94 \pm 0.40\%$ and $11.39 \pm 5.88\%$) during the *deh-chi* stage respectively, the latter was 11.2 times above the former.

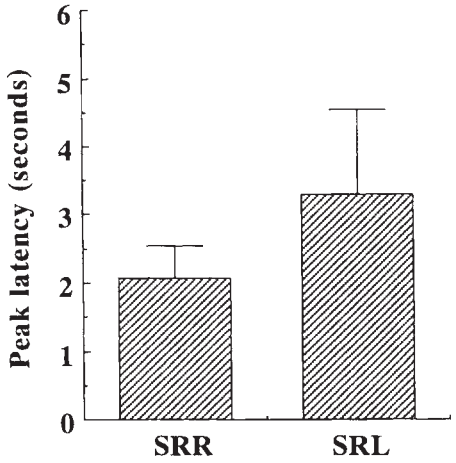

Fig. 3. The peak latency changes in SRR and SRL during *deh-chi*. Mean ± S.E. ($n = 20$)

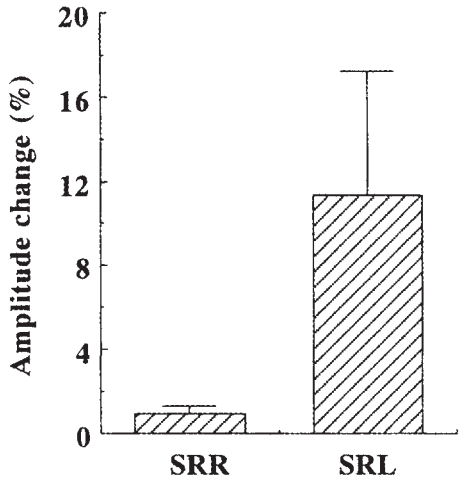

Fig. 4. The amplitude changes in SRR and SRL during *deh-chi*. Mean±S.E. ($n=20$)

TABLE 1. *Maximal skin blood flow decrease and perspiration volume change at one* ***deh-chi*** *stage*

Subject	Maximal skin blood flow decrease (%)	Perspiration volume change ($\mu l \cdot cm^{-2} \cdot min^{-1}$)
K. D.	61.7	0.094
K. Y.	70.0	0.055
A. M.	60.0	0.035
I. K.	42.1	0.025
I. T.	24.9	0.030
A. J.	68.7	0.119
S. N.	67.8	0.015
A. H.	26.4	0.114
Y. D.	48.2	0.038
K. M.	37.5	0.033
Mean±S.D.	50.7±17.3	0.051±0.036

Maximal skin blood flow decreases were calculated by the formula of {1-(the value of maximum response/the value before EAS immediately)}×100.

Perspiration volume changes were obtained by EAS. The correlation coefficient of maximal skin blood flow decrease and perspiration volume changes is $r=0.27$ ($p=0.45$).

Table 1 shows the data and the mean values of skin blood flow decrease and the perspiration volume change at one *deh-chi* stage, and the mean values were recorded as 50.7±17.3% and 0.051±0.036 $\mu l \cdot cm^{-2} \cdot min^{-1}$ respectively. There was no significant correlation between the maximal skin blood flow decreases and the perspiration volume changes.

DISCUSSION

It is known that external nociceptive and non-nociceptive stimuli will

activate emotion to elicit transient changes in SRL and SRR (Nimi and Suzuki 1986). Acupuncture is a kind of nociceptive stimulus which may cause transient SRL and SRR changes. In this study SRR, SRL, skin blood flow and perspiration underwent transient changes during *deh-chi*. Skin blood flow decreased immediately after SRR and SRL decreases, and then it recovered during the SRL recovery stage. Perspiration increased after these three signals decreased and at the end of the SRL recovery stage. Skin blood flow decreases and perspiration increases were in relation to the increase in sympathetic nerve activity (Wallin and Stjernberg 1984; Iwase and Mano 1989; Mano 1990; Tsunoda and Shiozawa 1992). Specially, the somatosensory-sympathetic reflex which is considered to be a pathway in manual acupuncture.

In addition to this pathway, somatic signals excited by manual acupuncture included the brainstem, the hypothalamus and the thalamus and reached the sensory cortex mediated anterolateral, spinothalamic, spinorecticular and spinomesencephalic tracts (Chang 1978; Kendall 1989). It takes 16-18 milliseconds to convey the signals to the thalamus by means of electrical median nerve stimulus. The time course of the somatosensory-sympathetic reflex caused by manual acupuncture stimulus must be longer than that, for *deh-chi* possessed a slow conductive velocity that suggests that it is conveyed by a thin fiber, such as Aδ or C.

Perspiration was produced by the sudomotor activity of the skin sympathetic nerves, which when activated caused transient SRR changes (Bini et al. 1980). In the present study, the transient decrease in palm skin blood flow suggests increased vasomotor activity, which in turn suggests that increases in sudomotor activity delays activation of the sweat glands at the *deh-chi* stage. This change was observed in both the ipsilateral and contralateral side simultaneously. The latency and amplitude of SRL were longer and larger than SRR, this suggests that SRR is a component of SRL, and acupuncture stimulus caused changes of both the AC and DC components. According to the time course of changes in skin blood flow and perspiration, SRL may accurately reflect EDA of the *deh-chi* stage.

In conclusion, recording the signals of SRR and SRL can express the variety of skin sympathetic nerve activity during *deh-chi*. We consider that this can be useful method for monitoring the efficiency of acupuncture treatment.

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