Skin rubdown with a dry towel, ‘kanpu-masatsu’ is an aerobic exercise affecting body temperature, energy production, and the immune and autonomic nervous systems

Mayumi Watanabe, Osamu Takano, Chikako Tomiyama, Hiroaki Matsumoto, Takahiro Kobayashi, Nobuatsu Urahigashi, Takeo Madarame, and Toru Abo

Department of Immunology, Niigata University School of Medicine, Niigata, Japan; Urahigashi Veterinary Clinic, Osaka, Japan; School of Health Sciences, Faculty of Medicine, Niigata University, Niigata, Japan; and Aoyama Madarame Clinic, Tokyo, Japan

ABSTRACT

Skin rubdown using a dry towel (SRDT) to scrub the whole body is a traditional therapy for health promotion. To investigate its mechanism, 24 healthy male volunteers were studied. Body temperature, pulse rate, red blood cells (RBCs), serum levels of catecholamines and cortisol, blood gases (PO2, sO2, PCO2 and pH), lactate and glucose, and the ratio and number of white blood cells (WBCs) were assessed before and after SRDT. After SRDT, pulse rate and body temperature were increased. PO2, sO2 and pH were also increased and there was no Rouleaux formation by RBCs. Lactate level tended to increase, whereas that of glucose did not. Adrenaline and noradrenaline levels increased, indicating sympathetic nerve (SN) dominance with increase in granulocytes. WBC number and ratio were divided into two groups according to granulocyte ratio (≤ or < 60%) before SRDT: a normal group and a SN group. Only in the SN group did the granulocyte ratio decrease and the lymphocyte ratio and number increase after SRDT. It is suggested that SRDT is a mild aerobic, systemic exercise that might affect the immune system via the autonomic nervous system.

Skin rubdown using a dry towel (SRDT) to scrub the whole body, called ‘kanpu-masatsu’ is popular in Japan. It is said that it became common in 1940 as a prevention against infectious respiratory diseases in elementary educational institutions; however, its origin is unknown (6). At present, officer candidates in the Japanese Maritime Self Defense Force practice it every morning, as do students in elementary schools and kindergartens, where it is required as part of the winter daily schedule to prevent asthma and colds. SRDT thus remains popular nationwide as a health promoting therapy.

SRDT has parallels with other traditional oriental therapies such as acupuncture, moxibustion and massage, all of which stimulate the skin. These therapies have much supporting evidence for their effects in preventing colds, enhancing immunity, increasing blood flow, activating natural killer cells via somato-autonomic reflexes, and improving metabolism via the autonomic nervous system (ANS) (5, 8, 9, 12, 22–24). However, there have been insufficient studies of the effects of SRDT. There is a report that SRDT activates natural killer cells (6), but the subjects of that study were limited to bedridden elderly patients, and SRDT was performed not by the subjects themselves but by their nursing personnel. In the present study, healthy volunteers were investigated. We assessed body temperature.

*These authors contributed equally to this work.

Address correspondence to: M. Watanabe, Department of Immunology, Niigata University School of Medicine, 1-757 Ashihimachi-Dori, Chuo-Ku, Niigata 951-8510, Japan
Tel: +81-25-227-2133, Fax: +81-25-227-0766
E-mail: immunol2@med.niigata-u.ac.jp
RESULTS

Pulse rate and body temperature (hypoglossal)
The pulse rate and body temperature (hypoglossal) of 24 healthy male volunteers were measured before and after SRDT. Both were increased after SRDT in almost all subjects. The pulse rate showed a prominent increase (73.1 ± 7.3 → 77.9 ± 11.1 /min, P < 0.01), while that of body temperature was not statistically significant (36.6±0.5 → 36.8±0.4°C, P > 0.05). No such changes were seen in the control group (Fig. 2).

Blood gases: PO$_2$, sO$_2$, PCO$_2$ and pH
To determine whether SRDT is an aerobic exercise, the oxygen level of venous blood was measured. In addition, the results of blood gas analysis (PO$_2$, sO$_2$, PCO$_2$ and pH) were compared before and after SRDT. Levels of PO$_2$ and sO$_2$ were significantly elevated after SRDT (24.6 ± 7.0 → 30.1 ± 13.5 mm Hg, P < 0.05 and 40.1 ± 16.9 → 50.4 ± 27.6 %, P < 0.05, respectively). pH also tended to increase, however, it was not statistically significant (7.34 ± 0.06 → 7.38 ± 0.05, P > 0.05). PCO$_2$ showed no statistically significant change. No prominent change was observed in any parameter in the control group (Fig. 3A).

Rouleaux formation by RBCs
After SRDT although the oxygen level of venous blood significantly increased, the number of RBCs, which deliver oxygen, stayed almost the same level during the experiment (control group: 5.1 ± 0.3 → 5.1 ± 0.1; SRDT group: 5.3 ± 0.2 → 5.3 ± 0.3 × 10$^4$/μL). Therefore the formation of RBCs was observed by microscope before and after SRDT. Rouleaux formation was seen in many subjects before

MATERIALS AND METHODS

Subjects. Twenty-four healthy male volunteers, 24–60 years of age, participated in this study. Written informed consent from all subjects and IRB/IEC approval from Niigata University were obtained.

Performing SRDT. A bleached cotton cloth was used for SRDT, which was performed by the subjects themselves. The extremities were rubbed down relatively strongly in a distal to proximal direction and from lateral to midline (Fig. 1). This was conducted approximately 10 times at each site, resulting in a slightly reddish appearance of the skin. The rest of the body was rubbed down in a similar manner. The total time required for this procedure was about 5 minutes.

Selection of subjects for assessment. One-half of the subjects were selected randomly for assessment before and after SRDT (n = 12; 37.0 ± 13.7 years of age). Age matched healthy controls (n = 12; 35.8 ± 11.5 years) were also examined. For assessments other than body temperature and pulse rate, six subjects (36.3 ± 14.2 years) were selected randomly. Six age matched healthy controls (38.5 ± 15.1 years) were also examined.

Assessment of parameters. Body temperature (hypoglossal) was measured with a mercury clinical thermometer (FA VOR; Nihon Keiryoki Kogyo Co., Ltd., Chiyoda, Japan). Fresh venous blood was obtained before and after SRDT for the analysis of lactate, glucose, PO$_2$, sO$_2$, pH and PCO$_2$ using an i-STAT 300F (i-STAT Corporation, East Windsor, NJ, USA) and for the assessment of the hematological parameters, WBCs and RBCs using a hemocytometer and the May–Grünwald Giemsa stain method. Concentrations of catecholamines (adrenaline, noradrenaline and dopamine) and cortisol were measured by HPLC (SRL, Inc., Tokyo, Japan).

Statistical analysis. Differences between values were determined using the paired t-test and Wilcoxon signed-ranks test. P values less than 0.05 were considered to be statistically significant.
Skin rubdown with a dry towel

As mentioned above, elevation of catecholamines, which indicates SN dominance, was observed after SRDT. Mori et al. reported that acupuncture, which stimulates the surface of the body as does SRDT, affected ANS status and had an immunomodulatory effect (9). Therefore, to determine the effect of SRDT on immune and ANS status, the subjects who

SRDT, but was eliminated after SRDT (Fig. 3B). No such change was observed in the control group.

**Levels of lactate and glucose**
Glucose is oxidized to either lactate or pyruvate, depending on oxygen level; that is, on whether conditions are aerobic or anaerobic. Under anaerobic conditions, glucose consumption and lactate production increase (19). Thus, measurement of lactate and glucose can be used to determine whether SRDT is aerobic or anaerobic. The SRDT group tended to increase in lactate level without statistically significant difference (1.1 ± 0.5 → 1.6 ± 0.5 mmol/L, \( P > 0.05 \)), whereas the control group did not. Glucose level showed no prominent change in either group (Fig. 3C).

**Levels of catecholamines (adrenaline, noradrenaline and dopamine) and cortisol**
It is known that catecholamine and cortisol levels reflect the status of the ANS (14, 16, 22, 23); thus, these were measured before and after SRDT. After SRDT, the serum level of noradrenaline was significantly elevated (313.3 ± 207.6 → 380.3 ± 181.4 pg/mL, \( P < 0.05 \)); that of adrenaline tended to increase however, it was not statistically significant (53.3 ± 23.0 → 61.3 ± 29.1 pg/mL, \( P > 0.05 \)). Dopamine and cortisol showed no prominent changes (Fig. 4).

**WBC ratio and number**
As mentioned above, elevation of catecholamines, which indicates SN dominance, was observed after SRDT. Mori et al. reported that acupuncture, which stimulates the surface of the body as does SRDT, affected ANS status and had an immunomodulatory effect (9). Therefore, to determine the effect of SRDT on immune and ANS status, the subjects who
served, due to the increase of PO$_2$ and sO$_2$ as seen in our previous studies (10, 18, 23). Of interest was the change in RBC conformation (Fig. 3B), which is thought to occur due to membrane potential changes caused by the alkalization of venous blood (17). Eliminating Rouleaux formation is advantageous for RBC oxygen binding and delivery. Thus, SRDT may induce a “virtuous circle” of improved systemic respiration similar to that achieved by aerobic exercise.

Second, the levels of adrenaline and noradrenaline were increased (Fig. 4), indicating that SRDT induced a light SN dominant state. As indicated in our previous studies, catecholamine secretion is increased in such states (16, 22), and it has been conserved, due to the increase of PO$_2$ and sO$_2$ as seen in our previous studies (10, 18, 23). Of interest was the change in RBC conformation (Fig. 3B), which is thought to occur due to membrane potential changes caused by the alkalization of venous blood (17). Eliminating Rouleaux formation is advantageous for RBC oxygen binding and delivery. Thus, SRDT may induce a “virtuous circle” of improved systemic respiration similar to that achieved by aerobic exercise.

Second, the levels of adrenaline and noradrenaline were increased (Fig. 4), indicating that SRDT induced a light SN dominant state. As indicated in our previous studies, catecholamine secretion is increased in such states (16, 22), and it has been conserved, due to the increase of PO$_2$ and sO$_2$ as seen in our previous studies (10, 18, 23). Of interest was the change in RBC conformation (Fig. 3B), which is thought to occur due to membrane potential changes caused by the alkalization of venous blood (17). Eliminating Rouleaux formation is advantageous for RBC oxygen binding and delivery. Thus, SRDT may induce a “virtuous circle” of improved systemic respiration similar to that achieved by aerobic exercise.

DISCUSSION

SRDT is a mild aerobic exercise

The results of the present study suggest that SRDT is a mild aerobic exercise.

First, body temperature and pulse rate were increased after SRDT (Fig. 2) in parallel with elevations of PO$_2$, sO$_2$ and pH (Fig. 3A). It is proposed that stimulation of body muscle by SRDT improves venous blood circulation and accelerates internal respiration. As a result, pH alkalization was observed, due to the increase of PO$_2$ and sO$_2$ as seen in our previous studies (10, 18, 23). Of interest was the change in RBC conformation (Fig. 3B), which is thought to occur due to membrane potential changes caused by the alkalization of venous blood (17). Eliminating Rouleaux formation is advantageous for RBC oxygen binding and delivery. Thus, SRDT may induce a “virtuous circle” of improved systemic respiration similar to that achieved by aerobic exercise.

Second, the levels of adrenaline and noradrenaline were increased (Fig. 4), indicating that SRDT induced a light SN dominant state. As indicated in our previous studies, catecholamine secretion is increased in such states (16, 22), and it has been conserved, due to the increase of PO$_2$ and sO$_2$ as seen in our previous studies (10, 18, 23). Of interest was the change in RBC conformation (Fig. 3B), which is thought to occur due to membrane potential changes caused by the alkalization of venous blood (17). Eliminating Rouleaux formation is advantageous for RBC oxygen binding and delivery. Thus, SRDT may induce a “virtuous circle” of improved systemic respiration similar to that achieved by aerobic exercise.

Second, the levels of adrenaline and noradrenaline were increased (Fig. 4), indicating that SRDT induced a light SN dominant state. As indicated in our previous studies, catecholamine secretion is increased in such states (16, 22), and it has been conserved, due to the increase of PO$_2$ and sO$_2$ as seen in our previous studies (10, 18, 23). Of interest was the change in RBC conformation (Fig. 3B), which is thought to occur due to membrane potential changes caused by the alkalization of venous blood (17). Eliminating Rouleaux formation is advantageous for RBC oxygen binding and delivery. Thus, SRDT may induce a “virtuous circle” of improved systemic respiration similar to that achieved by aerobic exercise.

Second, the levels of adrenaline and noradrenaline were increased (Fig. 4), indicating that SRDT induced a light SN dominant state. As indicated in our previous studies, catecholamine secretion is increased in such states (16, 22), and it has been conserved, due to the increase of PO$_2$ and sO$_2$ as seen in our previous studies (10, 18, 23). Of interest was the change in RBC conformation (Fig. 3B), which is thought to occur due to membrane potential changes caused by the alkalization of venous blood (17). Eliminating Rouleaux formation is advantageous for RBC oxygen binding and delivery. Thus, SRDT may induce a “virtuous circle” of improved systemic respiration similar to that achieved by aerobic exercise.
firmed that SN dominance is induced by exercise (16).

Third, SRDT increased the level of lactate while that of glucose showed no prominent change (Fig. 3C). Recently, other investigators reported no change in glycogen or lactate after massage (3). Lactate is produced from glucose through glycolysis. Under aerobic conditions it is converted into pyruvic acid, a reversible reaction that is found in humans and other living organisms. Two systems produce ATP: the anaerobic glycolysis system and the aerobic mitochondrial system. The former can produce ATP 100 times more quickly than the latter (1, 7, 19). The level of lactate in the body reflects the difference between production by glycolysis and consumption by the mitochondrial system (4). In the present study, the level of lactate did not reach the threshold of lactate. It is possible that, at the start of SRDT, a mild SN dominant state was induced and energy was supplied promptly by glycolysis. The mitochondrial system then consumed lactate to produce ATP after a time lag, being promoted by the elevated oxygen level as shown in Fig. 3A. Thus, SRDT may be considered a mild exercise linked to the metabolism of oxygen (i.e. aerobic).

**SRDT effects on the immune system**

WBC data were divided into two groups according to WBC profile before SRDT. Only the SN group, with an abnormal WBC profile (granulocytes > 60%), showed any change, converging on the normal profile (granulocytes ≤ 60%) (Fig. 5A). A similar normalization of abnormal WBC profile via stimulation of the ANS has been observed in acupuncture (9), which stimulates the surface of the body as does SRDT. The number of lymphocytes was elevated in SN group with abnormal WBC profile (Fig. 5B). Thus, SRDT may have an effect on the immune system via the ANS in case WBC profile is deviated.

**Continuous daily SRDT, self-care therapy, is most effective**

In a pilot study, we observed the effect of daily SRDT on post-surgical patients and depressed patients as well as healthy male volunteers for 2 weeks. In the patients the increases of body temperature, pulse rate, PO₂ and glucose were all more prominent than in the healthy male volunteers after 2 weeks of practice. Interestingly, the increases on the last day (14th day) were greater than those on the first day (data not shown), indicating that the volunteers’ muscles could now produce and use energy more effectively both in patients and healthy male volunteers. Iwama et al. reported that natural killer cell activity recovered to the pre-experiment value 5 days after completion of a program of SRDT (6). Thus, daily stimulation of the skin might be effective and important in promoting health.

Professional somato-autonomic reflex therapies such as acupuncture, moxibustion and massage need experts and special equipment to avoid malpractice and reduce problems such as infection, tissue breakdown and hyperstimulation (20, 21). In contrast, SRDT can be self-applied at any time and in any place, and may raise awareness of the importance of regular habits and self-management for the individual’s physical and mental state. This may be considered the reason why physicians, especially pediatricians, often recommend light exercise for health promotion (2, 11, 13, 15). Continuous daily SRDT, self-care therapy, is most effective.

The results of the present study suggest that SRDT is a mild aerobic, systemic exercise that might have an effect on the immune system via the ANS.

**Acknowledgements**

The authors thank Mr. Taiki Hashimoto and Ms. Kaori Yamamoto (Yushima-Shimizuza clinic) and Dr. Eisuke Kainuma (Kainuma Shinkyuin) for arranging the clinical research.

**REFERENCES**

7. Kainuma E, Watanabe M, Tomiyama-Miyaji C, Inoue M, Kuwano Y, Ren H and Abo T (2009) Proposal of alternative Professional somato-autonomic reflex therapies such as acupuncture, moxibustion and massage need experts and special equipment to avoid malpractice and reduce problems such as infection, tissue breakdown and hyperstimulation (20, 21). In contrast, SRDT can be self-applied at any time and in any place, and may raise awareness of the importance of regular habits and self-management for the individual’s physical and mental state. This may be considered the reason why physicians, especially pediatricians, often recommend light exercise for health promotion (2, 11, 13, 15). Continuous daily SRDT, self-care therapy, is most effective.

The results of the present study suggest that SRDT is a mild aerobic, systemic exercise that might have an effect on the immune system via the ANS.

**Acknowledgements**

The authors thank Mr. Taiki Hashimoto and Ms. Kaori Yamamoto (Yushima-Shimizuza clinic) and Dr. Eisuke Kainuma (Kainuma Shinkyuin) for arranging the clinical research.

**REFERENCES**


