Relationship between Toe Temperature and Lower Urinary Tract Symptoms

Hiroo INOUE, Osamu ISHIZUKA,* Tetsuya IMAMURA, Takahiro YAMAGISHI, Wataru NOGUCHI, Hitoshi YOKOYAMA, Yoshiki KURIZAKI, and Osamu NISHIZAWA
Department of Urology, Shinshu University School of Medicine, Matsumoto, Japan

Objective: Cold stress can elicit increases in urinary urgency and frequency. We determined if there was a relationship between finger and toe temperatures and lower urinary tract symptoms (LUTS).

Methods: We studied 50 people who visited a public health management seminar. The participants were divided into two groups according to self-described sensitivity to cold stress. The cold non-sensitive (CNS) group consisted of 3 males and 20 females (66.9 ± 10.8 years old), and the cold sensitive (CS) group consisted of 4 males and 23 females (65.8 ± 8.01 years old). Each participant was assessed to determine international prostate symptom score (IPSS), overactive bladder symptom score (OABSS), and quality of life (QOL) score. They were then instructed on lifestyle changes and exercises that could improve peripheral blood flow and provide relief for their LUTS. Next, the temperatures of their middle fingers and toes were measured before and after 5–10 min of the exercises. Two weeks later, the IPSS, OABSS, and QOL scores were reassessed.

Results: Before exercise, the middle fingers were significantly warmer than the middle toes. Exercise had no significant effect on the middle finger temperature of either group; however, it did increase the middle toe temperature for both groups. The increase was greatest for the CS group. The CS group had higher LUTS storage symptoms than the CNS group, and these improved after 2 weeks of lifestyle changes and exercise.

Conclusion: Improvements in lifestyle and daily exercise may be effective for LUTS in CS people.

Key words cold stress, lower urinary tract symptoms, overactive bladder

1. INTRODUCTION

Changes in environmental temperatures induce numerous physiological responses. For example, cold stress increases heart rate and blood pressure, and in many people, it elicits sensations of urinary urgency and increases urinary frequency.1–3 Seasonal or continuous cold environmental stress can aggravate existing lower urinary tract dysfunctions, such as urinary urgency, frequent urination, or cystitis.4–6 For some patients, cooling of the hands and feet elicits cold stress lower urinary tract symptoms (LUTS), while for others the same stimulus has no effect on LUTS. This suggests that there is high variability in responses to cold stress. Cold sensitivity is not an idea of Western medicine, but oriental. The complaint of cold sensitivity of patients is very important in oriental medicine. However, the complaint of cold sensitivity is a very vague idea in Western medicine.

In the present study, we monitored the temperature of fingers and toes in subjects who did and did not complain of LUTS in response to cold stress. We then instructed the subjects with regard to lifestyle modifications and exercises to improve LUTS and peripheral blood flow. After 2 weeks, we reassessed LUTS in the subjects to determine the effects of the lifestyle training and exercise regimen.

2. METHODS

The protocol of this study was approved by the ethics committee of Shinshu University School of Medicine (Permission No.185, 2011). The study population consisted of 50 subjects (7 males, 43 females, average age ± standard deviation: 66.3 ± 9.3 years) who attended a public health management seminar organized by the city of Matsumoto in October 2011. The people were divided into two groups based on their complaints of sensitivity to cold stress. The cold non-sensitive (CNS) group consisted of participants (3 males, 20 females, 66.9 ± 10.8 years old) who did not complain of LUTS sensitivity to cold stress. The cold sensitive (CS) group consisted of participants (3 males, 20 females, 66.9 ± 10.8 years old) who did not complain of LUTS sensitivity to cold stress. The cold sensitive (CS) group consisted of participants (4 males, 23 females, 65.8 ± 8.01 years old) who complained of LUTS sensitivity to cold stress. Such complaints usually consisted of cold feelings in the hands and feet and urinary urgency and frequency related to cold stress.

*Correspondence: Osamu Ishizuka, MD, PhD, Department of Urology, Shinshu University School of Medicine, 3-1-1 Asahi, Matsumoto 390-8621, Japan. Tel: +81-263-37-2661; Fax: +81-263-37-3082. Email: ishizuk@shinshu-u.ac.jp
Received 17 January 2012; revised 27 February 2012; accepted 7 March 2012.

DOI: 10.1111/j.1757-5672.2012.00151.x

© 2012 Wiley Publishing Asia Pty Ltd
For subjects in both groups, we recorded body mass index (BMI), systolic blood pressure and diastolic blood pressure. The subjects then answered questionnaires to determine their international prostate symptom score (IPSS), overactive bladder symptom score (OABSS), and quality of life (QOL) score. Afterwards, they attended a lecture about lifestyle improvements (limiting water, coffee and alcohol consumption; bladder training; limiting hot food consumption; avoiding constipation and long periods of sitting etc.) suggested by clinical guidelines for overactive bladder (OAB),^7^ LUTS,^8^ and benign prostatic hyperplasia.~^9~ They were also provided with an exercise training plan to improve peripheral blood flow (Fig. 1)^10^–^14^.

Next, the temperature of the tips of the middle fingers of both hands and the middle toes of both feet were measured by a thermosensor (Thermo Shot F30; NEC/Avio, Tokyo, Japan) before and after 5–10 min of exercise in a room in which the ambient temperature was maintained at about 22 °C. The duration of the exercise was adjusted to fit the ability of each participant. The temperatures of both groups were measured at the same time in the same room.

The subjects were asked to maintain the improved lifestyle and continue the 10–15 min exercises for 2 weeks before going to sleep each night. After a 2-week period, they were reassessed to determine any changes in IPSS, OABSS, and/or QOL score in the last 2–3 days.

All values were calculated as mean ± standard deviation. Comparisons were made by paired t-tests between the before and after 2-week exercise period. Comparisons between groups were made by unpaired t-tests. In all analyses, $P < 0.05$ was taken to indicate statistical significance.

### 3. RESULTS

BMI, systolic blood pressure, and diastolic blood pressure were 23.6 ± 2.6, 120.0 ± 13.7 and 74.5 ± 15.4 mmHg, respectively in the CNS group. In the CS group, the values were 22.6 ± 2.6, 123.4 ± 14.6, and 73.4 ± 7.3 mmHg. There were no significant differences ($P > 0.05$) in BMI or blood pressure between the groups.

#### 3.1. Temperature changes of hands and feet before and after exercise

Either before or after exercise, there were no differences in the temperatures between the left and right hands, as measured in the middle fingers, or the left and right feet, as measured in the middle toes (Tables 1,2). Prior to exercise, there were no significant differences in the temperatures of the middle fingers between the CNS and CS groups (Figs 2,3; Tables 1,2). However, the middle toes of the CNS group (left, 30.7 ± 4.2 °C; right, 30.8 ± 4.3 °C) were significantly warmer than those in the CS group (left, 28.7 ± 3.7 °C, $P = 0.030$; right, 28.8 ± 3.9 °C, $P = 0.031$; Tables 1,2). After exercise, the temperature of the middle fingers of subjects in the CS group and middle fingers of the left hands of subjects in the CNS group did not change significantly; however, the temperature of the middle finger of the right hands of subjects in the CNS group increased significantly (Fig. 3; Tables 1,2).

#### TABLE 1. Effect of exercise on left middle finger and toe temperatures (°C) before and after exercise

<table>
<thead>
<tr>
<th>Exercise</th>
<th>CNS</th>
<th>CS</th>
<th>P*</th>
<th>CNS</th>
<th>CS</th>
<th>P*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before</td>
<td>34.7 ± 2.6</td>
<td>34.5 ± 2.5</td>
<td>0.291</td>
<td>30.7 ± 4.2</td>
<td>28.7 ± 3.7</td>
<td>0.030</td>
</tr>
<tr>
<td>After</td>
<td>35.1 ± 1.5</td>
<td>35.5 ± 2.6</td>
<td>0.388</td>
<td>32.2 ± 3.3</td>
<td>32.3 ± 3.4</td>
<td>0.429</td>
</tr>
<tr>
<td>P†</td>
<td>0.229</td>
<td>0.083</td>
<td>—</td>
<td>0.046</td>
<td>&lt;0.001</td>
<td>—</td>
</tr>
</tbody>
</table>

*P-value between cold non-sensitive (CNS) and cold sensitive (CS) groups; †P-value between before and after exercise.

#### TABLE 2. Effect of exercise on right middle finger and toe temperatures (°C) before and after exercise

<table>
<thead>
<tr>
<th>Exercise</th>
<th>CNS</th>
<th>CS</th>
<th>P*</th>
<th>CNS</th>
<th>CS</th>
<th>P*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before</td>
<td>35.2 ± 2.4</td>
<td>34.7 ± 2.7</td>
<td>0.133</td>
<td>30.8 ± 4.3</td>
<td>28.8 ± 3.9</td>
<td>0.031</td>
</tr>
<tr>
<td>After</td>
<td>35.4 ± 1.5</td>
<td>35.8 ± 2.5</td>
<td>0.363</td>
<td>32.6 ± 3.4</td>
<td>32.4 ± 3.5</td>
<td>0.300</td>
</tr>
<tr>
<td>P†</td>
<td>0.358</td>
<td>0.044</td>
<td>—</td>
<td>0.005</td>
<td>&lt;0.001</td>
<td>—</td>
</tr>
</tbody>
</table>

*P-value between cold non-sensitive (CNS) and cold sensitive (CS) groups; †P-value between before and after exercise.
CNS group increased significantly (left, $P = 0.046$; right, $P = 0.005$), but the increase in the CS group was significantly greater than in the CNS group (left, $P = 0.016$; right, $P = 0.015$; Fig. 3).

3.2. IPSS and QOL score before and after lifestyle changes and daily exercise for 2 weeks

We evaluated IPSS voiding symptom scores, storage symptom scores, and total scores before and after the 2 weeks of lifestyle changes and exercise (Fig. 4). There was no change in voiding symptom score in either the CNS or CS groups. However, in the CS group, there was significant improvement in the storage symptom score and total IPSS. There was also a significant improvement in the QOL score of both groups, but the improvement in the CS group tended to be larger.

3.3. OABSS before and after lifestyle changes and daily exercise for 2 weeks

After 2 weeks of lifestyle changes and exercise, the OABSS of the CNS group slightly increased while that of the CS group decreased. However, neither change was statistically significant (Fig. 5). After 2 weeks of exercise, the number of OAB participants in the CNS group increased from four to six. In contrast, in the CS group, the number decreased from six to five.

4. DISCUSSION

This study was conducted at the beginning of the autumn cold season in Japan. We felt that this timing might be appropriate and important for the education and training of people with OAB who are sensitive to colder temperatures. We divided the people into two groups according to their own complaints about urinary weakness to cold stress. We were not able to find any epidemiological data about the incidence of cold stress and LUTS; nevertheless, more than half of the participants, including both genders, had complaints regarding the effect of cold on urinary symptoms.

The temperature of the middle toes, and the feet in general, was lower in the CS group than in the CNS group. While the reason for the lower temperature of the toes is not clear, it is unrelated to age, BMI, or blood pressure as these were similar in both groups. Possibly the temperature difference of the lower extremities is related to differences in metabolism, blood vessels, or skin thermosensor receptors, such as the transient receptor potential channels.\textsuperscript{15,16} Further study is needed to clarify this difference.

Recently, clinical guidelines for OAB, male LUTS, and benign prostatic hyperplasia were published by the Japanese Urological Association.\textsuperscript{7–9} These guidelines recommended lifestyle modifications as one of the conservative therapies. A principal benefit of this approach is
that it is non-invasive and has a low financial burden. In these guidelines, recommended lifestyle changes include the provision of education and reassurance, restriction of excessive fluid intake, bladder training, and prompt voiding. In this study, we provided educational information as recommended by these guidelines, and after 2 weeks, there was significant improvement of LUTS. Thus, our evidence suggests that this non-invasive approach involving education and exercise might be effective.

With age, gender, and training status, blood flow to exercising limbs varies. For heart failure patients and patients with peripheral artery disease, exercise training is recommended to improve blood flow. In the present study, the exercises were modified mainly to focus on improvement of peripheral blood flow and to improve basic metabolism. While the exercise increased the temperature of the middle toe of both groups, the increase was greater for the CS group. Presumably the increased temperature represents a relatively greater improvement in peripheral circulation and basic metabolism for the CS group than for the CNS group. Even though the difficulty and continuity of the exercises may have varied according to age and body condition, they were still effective, along with the lifestyle changes, in improving LUTS, especially for participants in the CS group.

IPSS storage urinary symptoms were present in both groups of participants. Not surprisingly, the CS group showed greater improvement in the IPSS storage symptoms after 2 weeks of exercise than did the CNS group. The QOL score for the CS group also tended to improve more than the CNS group, as did the OABSS, though the improvement was not statistically significant. Curiously, there were four OAB participants in the CNS group (17.0%) at the beginning of the study, but after the 2-week exercise period, the number was increased to six. The importance of this unexpected change is unclear. In contrast, in the CS group there were six OAB participants at the beginning of the study (22.2%), and after the 2-week exercise period, there were only five. At least for this group, the lifestyle education and 2 weeks of daily exercise may have reduced the incidence of OAB.

In the present study, we showed that low temperature of the feet in the CS group, especially as measured in the middle toe, was associated with a high incidence of LUTS storage symptoms. Changes in lifestyles and exercise routines improved these symptoms. Further study will be needed to further clarify the mechanisms by which these changes occur.
Fig. 4 International Prostate Symptom Score (IPSS) voiding symptoms score, storage symptoms score, and total score and Quality of Life (QOL) in cold non-sensitive (CNS) and cold sensitive (CS) subjects before (0W) and after (2W) the 2-week lifestyle and daily exercise period. *P < 0.05, **P < 0.01.

Disclosure

The authors of this paper have no financial or commercial interests to disclose.

REFERENCES