

Thermographic Evaluation of the Efficacy of Kampo Medicines

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ABSTRACT

Kampo medicine has a specific concept known as “Sho”, and herbal formulations are prescribed according to the “Sho”. “Sho” is defined as “the decision of prescription judging from the patient’s symptoms, systemic conditions and physical constitution generally”. In the present study, the authors used thermography to evaluate the effects of herbal formulations based on “Sho” scientifically. In the cases that were suitable for Keishibukuryogan, the so-called Keishibukuryogan Sho, a significant skin temperature rise was observed in the upper half of the body after the intake of Keishibukuryogan. In a case that was suitable for Hochuekkito, the so-called Hochuekkito Sho, a marked elevation of skin temperature spread through the upper trunk. Thus, when individuals took herbal formulations according to the Sho, a marked skin surface temperature rise was observed. On the other hand, in a case that was not appropriate for the herbal formulation, a skin temperature rise was not observed after intake of this formulation. In an experiment that examined the role of the Keishi (Cinnamon Bark) contained in Keishibukuryogan, Keishibukuryogan acted on the abdomen including the upper part of the body, while the Keishi contained in Keishibukuryogan worked particularly on the upper part of the body. It suggested that thermography is useful for an objective evaluation of Sho in Kampo medicines, and for identification of the action site of the herbal formulation.

Key words: *Kampo medicine, Thermography, Keishibukuryogan (桂枝茯苓丸), Skin surface temperature*

Scientific evaluations of Kampo medicine, a traditional pharmacotherapy originating from ancient China, have been reported, including a numerical analysis of abdominal information with a digital abdominal diaphragm¹⁰⁾, a double-blind clinical comparison of herbal formulations such as Shosaikoto (小柴胡湯)⁶⁾, and an evaluation of herbal formulations with an infrared electronic pupillometer²⁵⁾.

In recent years, the usefulness of thermography has been demonstrated clinically for: the diagnosis of breast cancer²⁰⁾, the diagnosis and treatment of oversensitivity to cold¹⁴⁻¹⁶⁾, the evaluation of responses to acupuncture therapy²⁾ and the antifebrile effect of herbal formulations in atopic dermatitis^{11,18)}. In addition, the efficacy of Goshajinkigan (牛車腎氣丸) and Keishikajutsu-butō (桂枝加朮附湯) against diabetic peripheral neuropathy¹⁹⁾ and Goshajinkigan against cold sensations of the legs associated with osteoporosis⁸⁾ have been evaluated by thermography. These reports indicated observations at partial sites such as the extremities and face. To the best of our knowledge, there have been no studies regarding the efficacy of

Kampo medicines by thermography, which pay closer attention to Sho²²⁾ over the whole body in particular.

The effects of herbal formulations based on “Sho” and the action sites of herbal formulations will be elucidated by observing the skin temperature of parts of the body using thermography and scientifically analyzing the relationship between the rise in skin temperature and the effects of the therapy with Kampo medicine.

In the present study, we evaluated the effects of herbal formulations based on “Sho” and examined the target sites of their action using thermography. In addition, we evaluated the effects of herbal formulations by changing the components of the formulations, and examined the significant role of each crude drug.

SUBJECTS AND METHODS

Subjects

The volunteers consisted of 9 members (5 females and 4 males) aged 29-57, with an average age of 42 years. The study was conducted at the

Iguchi Clinic, Fukuyama City. Informed consent was obtained from each subject prior to the study.

Methods

1. Medical examinations

To determine the appropriate Sho, visual examination, tongue examination, interview and abdominal palpation were performed for each of the 9 volunteers^{5,23}. Abdominal palpation was examined in the presence of a physician.

2. Prescriptions

Each subject took a herbal formulation according to a judgment based on the Sho. In addition, Keishibukuryogan (桂枝茯苓丸) as a comparative formulation and tepid water (plain water, 37°C, 150 ml) as a control were administered.

Keishibukuryogan is one of the commonly prescribed formulations for curing blood stagnation and is most frequently used for the evaluation of Kampo medicine. All subjects took herbal formulations and tepid water from nine to twelve in the morning.

In this study, a volunteer who was suitable for Keishibukuryogan, the so-called Keishibukuryogan Sho, took Keishibukuryogan, and tepid water. A volunteer who was suitable for Hochuekkito (補中益氣湯), the so-called Hochuekkito Sho, took Hochuekkito, Keishibukuryogan, Tokishakyakusan (当歸芍藥散) and tepid water, while a volunteer who was suitable for Kyukikyogaito (芎歸膠艾湯), the so-called Kyukikyogaito Sho, took Kyukikyogaito and Keishibukuryogan. The herbal formulations used in this study were products of Tsumura & Co. Tokyo, Japan (extracted herbal formulations). Each formulation was administered at a dose level of 2.5 g (3 g in some cases).

3. Preparation of Keishi-free Keishibukuryogan and Keishibukuryogan.

Keishi-free Keishibukuryogan (powdered drug) was prepared as follows. Crushed Tonin (桃仁) was roasted until it became brown. It was then mixed with pieces of Bukuryo (茯苓), Botanpi (牡丹皮) and Shakuyaku (芍藥), and crushed mechanically to yield Keishi-free Keishibukuryogan. This formulation was mixed with crushed Keishi (桂枝) to yield Keishibukuryogan. To examine the effect of the Keishi contained in Keishibukuryogan, Keishi-free Keishibukuryogan, Keishibukuryogan and Keishi alone were administered.

4. Conditions for thermography

Thermography was performed at a constant room temperature (23–24°C) and humidity (40–45%). During the test, the indoor air flow was kept to a minimum. The thermotracer used was a TH5108ME (NEC-Sanei). The range of temperatures measured was 29.4–35.0°C.

5. Body sites analyzed

According to Kampo medicine, the upper half of the human body is divided into three parts in a vertical direction (upper, middle and lower

areas)¹⁷. The upper area ranges from the neck to the diaphragm. The middle area spans from the diaphragm to the umbilicus. The lower area (lower abdomen) refers to the part below the umbilicus. Changes in the skin surface temperature were analyzed for these three parts, as well as for the face, neck and extremities (hand, brachium, forearm, thigh and leg). At each of these sites, both the ventral and dorsal sides were examined.

6. Statistical analysis

Results are expressed as the mean \pm S.D. A comparison of the two groups was analyzed using Student's *t* test for pairs.

RESULTS

The results of Keishibukuryogan Sho that is suitable for Keishibukuryogan were presented as follows.

Eight volunteers were divided into four volunteers who were suitable for Keishibukuryogan (Keishibukuryogan Sho) and four volunteers who were not suitable for Keishibukuryogan (non-Keishibukuryogan Sho).

Fig. 1 shows a comparison of skin temperatures in the upper half of the body after treatment with either Keishibukuryogan (Fig. 1 (b), (c)) or tepid water (Fig. 1 (e), (f)) in a case of Keishibukuryogan Sho. A rapid skin temperature rise was observed even after 30 min (Fig. 1(b)), and a remarkable temperature rise (about 1.5–2.0°C) was observed in the upper half of the body such as the face, upper area and brachium 60 min (Fig. 1 (c)) after the intake of Keishibukuryogan, compared to before administration (Fig. 1 (a)). On the other hand, although a skin temperature rise (about 1°C) was observed after the intake of tepid water 60 min (Fig. 1 (f)), the degree of skin temperature rise (Fig. 1 (e), (f)) was lower than that for Keishibukuryogan (Fig. 1 (b), (c)) at all times and sites.

Fig. 2 shows the time course of skin temperatures at various sites following treatment with Keishibukuryogan and tepid water in the 4 volunteers with Keishibukuryogan Sho. As indicated in Fig. 2, significant temperature rises were observed after treatment with Keishibukuryogan in the upper half of the body such as (a) the face, (b) neck, (c) upper area, (d) middle area, (e) lower area, (g) brachium and (h) forearm. The skin temperature in the upper half of the body (Fig. 2 (a)-(e), (g)) was higher than that in the hands and feet (Fig. 2 (f), (h)-(j)) 60 min after treatment. On the other hand, the time course of skin temperatures at various sites after intake of Keishibukuryogan and tepid water in the 4 volunteers with non-Keishibukuryogan Sho, is shown in Fig. 3. There was no significant rise in temperature after treatment with Keishibukuryogan at any site of the body. The difference in skin temperature in the

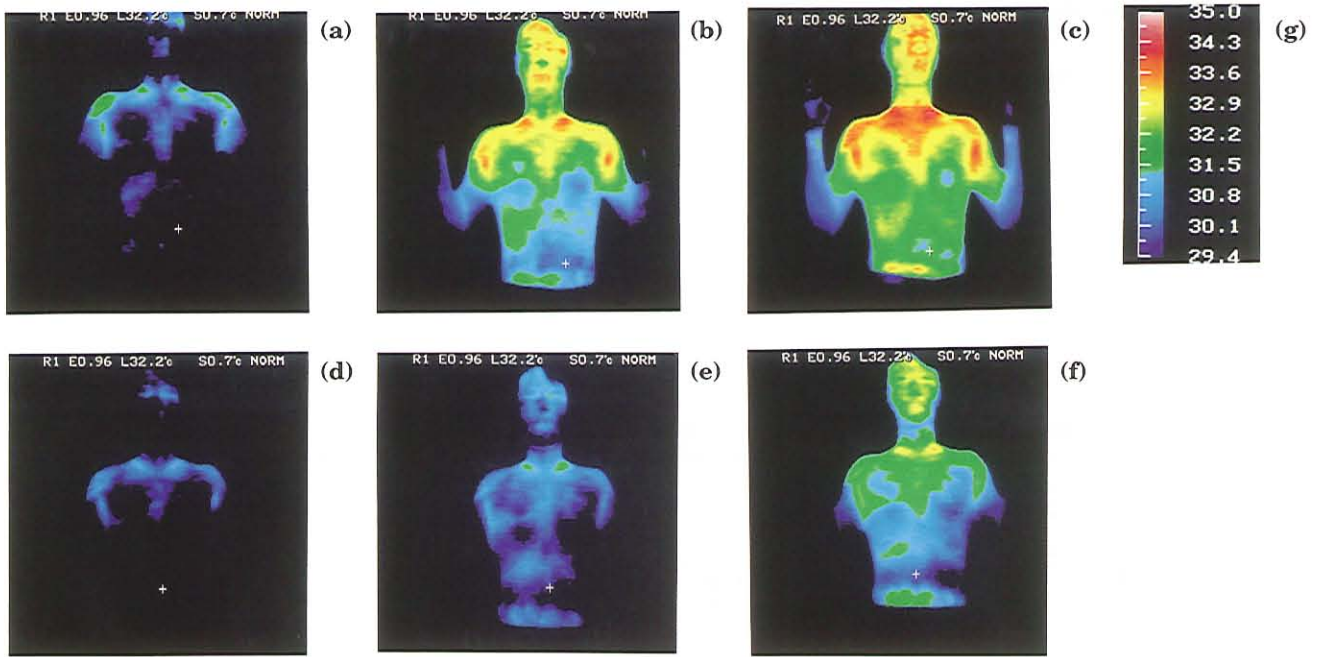


Fig. 1. Comparison of skin temperature after treatment with Keishibukuryogan (桂枝茯苓丸) or tepid water in the case of Keishibukuryogan Sho. Change in skin temperature in the upper trunk (a) before, (b) 30 min after the intake of Keishibukuryogan, (c) 60 min after and (d) before, (e) 30 min after the intake of tepid water, (f) 60 min after. The range of temperature measured (29.4–35.0°C) is indicated in (g).

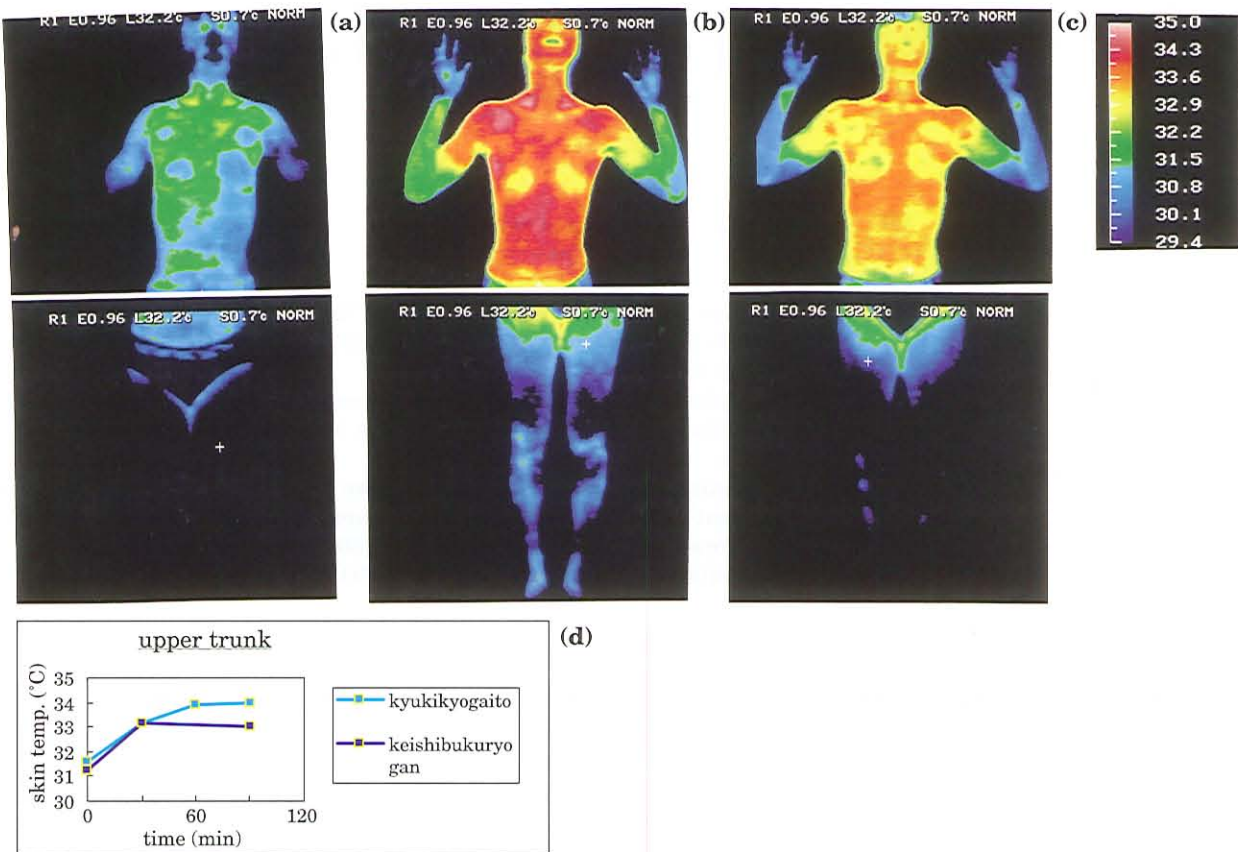


Fig. 4. Comparison of efficacy between Kyukikyogaito (芎歸膠艾湯) and Keishibukuryogan (桂枝茯苓丸) in the case of Kyukikyogaito Sho. Change in skin temperature in upper trunk and lower trunk (a) before and (b) 90 min after the intake of Kyukikyogaito or (c) Keishibukuryogan. The results in the upper trunk (a), (b) and (c) are shown graphically in (d).

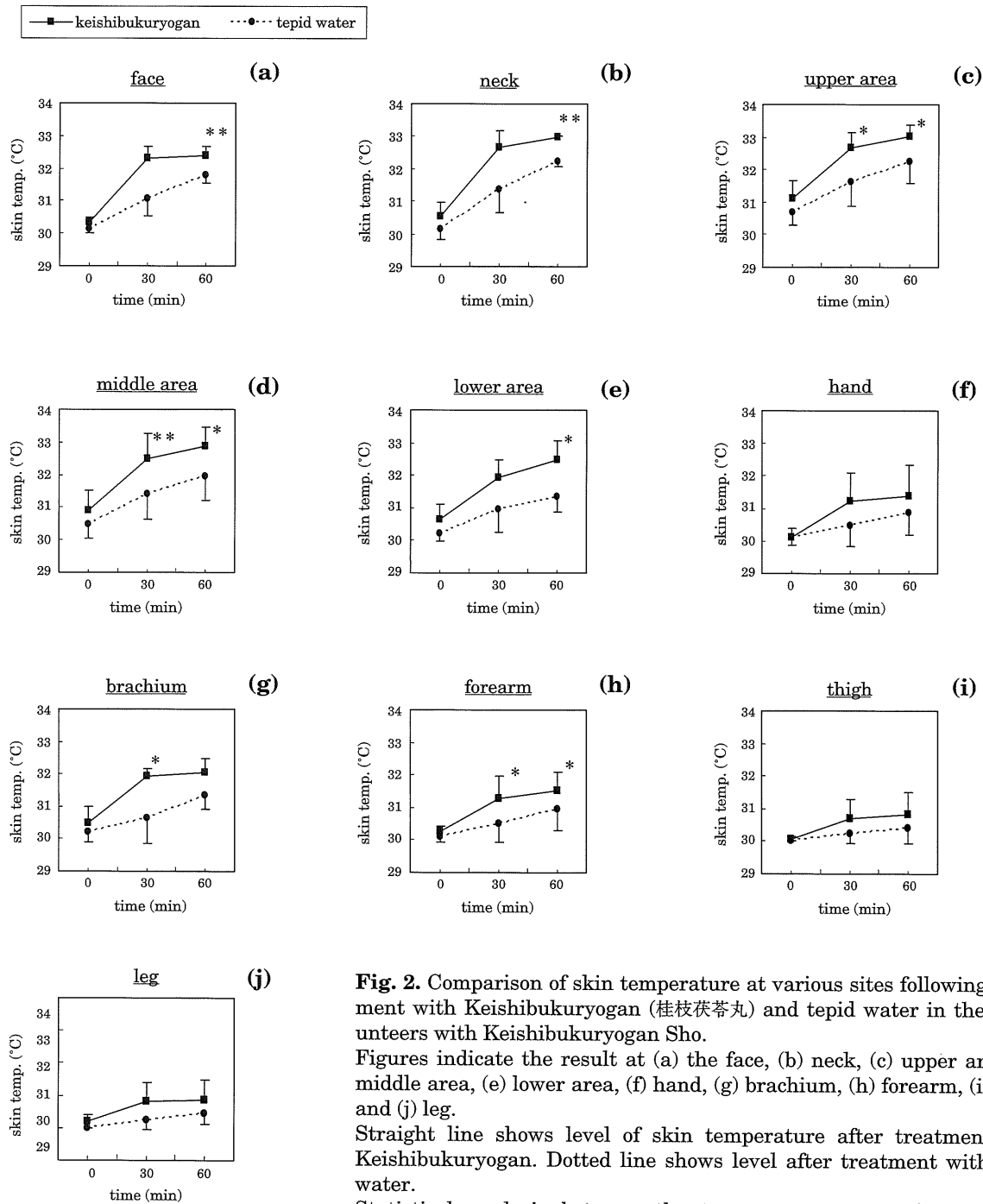


Fig. 2. Comparison of skin temperature at various sites following treatment with Keishibukuryogan (桂枝茯苓丸) and tepid water in the 4 volunteers with Keishibukuryogan Sho.

Figures indicate the result at (a) the face, (b) neck, (c) upper area, (d) middle area, (e) lower area, (f) hand, (g) brachium, (h) forearm, (i) thigh and (j) leg.

Straight line shows level of skin temperature after treatment with Keishibukuryogan. Dotted line shows level after treatment with tepid water.

Statistical analysis between the two groups was performed using Student's *t* test for pairs. The results are expressed as the mean \pm S.D.

Pre-treatment (n=4), 0~30 min (n=4), 30~60 min (n=4)

Statistical significance: *p<0.05, **p<0.01

upper half of the body, such as the face, neck and upper, middle and lower areas, brachium and forearm between Keishibukuryogan and tepid water in the 4 volunteers with Keishibukuryogan Sho was greater than in the 4 volunteers with non-Keishibukuryogan Sho (Fig. 2, 3). For example, in Keishibukuryogan Sho, the difference in skin temperature in the upper area was 1.05°C at 30 min after treatment, and 0.79°C at 60 min. On the other hand, the difference was 0.38°C at 30 min

after treatment, and 0.02°C at 60 min in non-Keishibukuryogan Sho (Fig. 2 (c), 3 (c)).

In the experiment shown in Fig. 4, a volunteer was diagnosed as a case of Kyukikyogaito Sho, based on the results of medical examinations and the symptoms of headache and menorrhagia, and was administered with Keishibukuryogan as a comparative prescription. Fig. 4 shows the thermograms of the upper and lower halves of the body on the ventral side after intake of

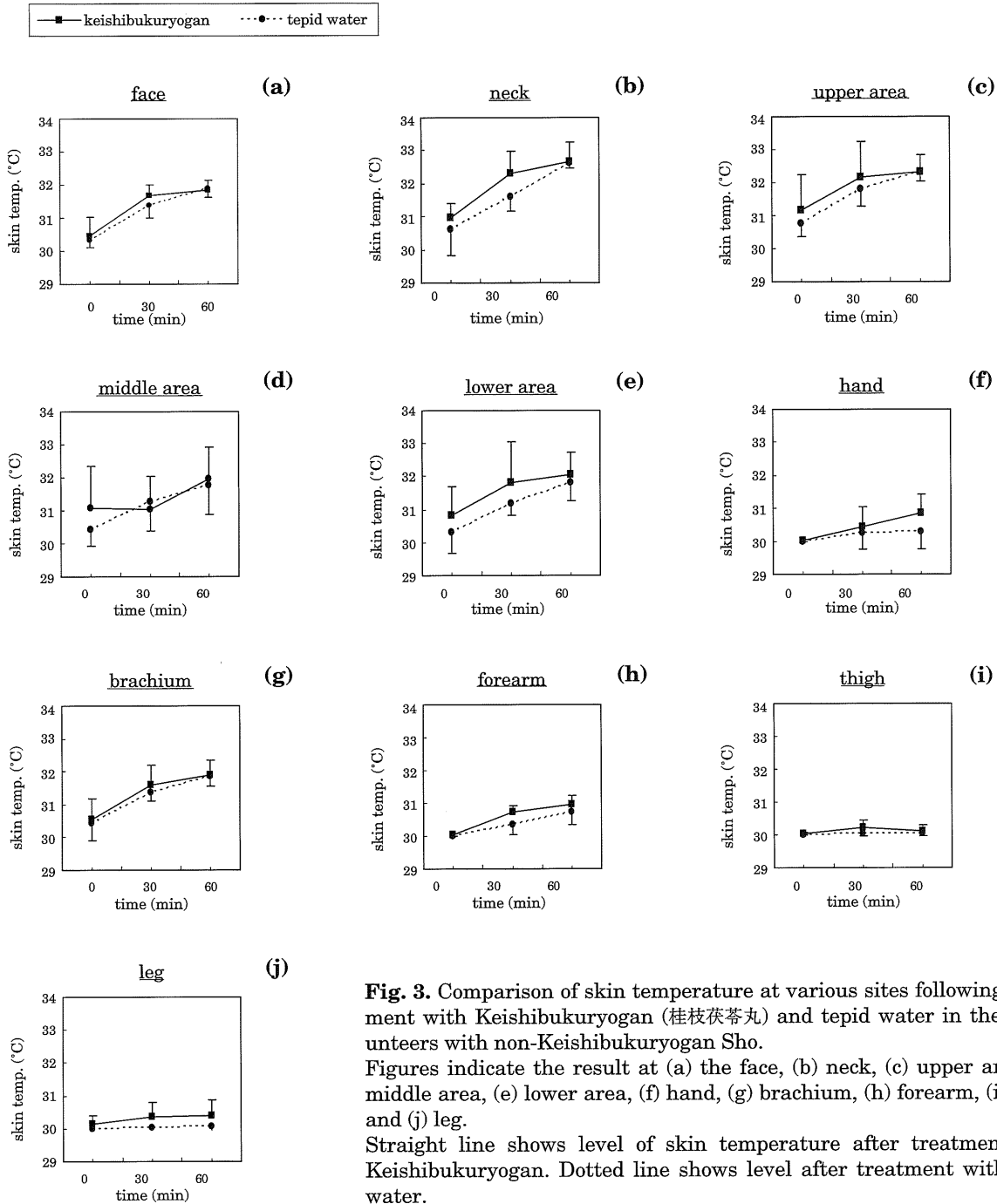


Fig. 3. Comparison of skin temperature at various sites following treatment with Keishibukuryogan (桂枝茯苓丸) and tepid water in the 4 volunteers with non-Keishibukuryogan Sho.

Figures indicate the result at (a) the face, (b) neck, (c) upper area, (d) middle area, (e) lower area, (f) hand, (g) brachium, (h) forearm, (i) thigh and (j) leg.

Straight line shows level of skin temperature after treatment with Keishibukuryogan. Dotted line shows level after treatment with tepid water.

Statistical analysis between the two groups was performed using Student's *t* test for pairs. The results are expressed as the mean \pm S.D.

Pre-treatment (n=4), 0~30 min (n=4), 30~60 min (n=4)

Kyukikyogaito (Fig. 4 (b)), Keishibukuryogan (Fig. 4 (c)) and before administration (Fig. 4 (a)). A marked skin temperature rise (about 2.5–3.0°C) was observed in the face and upper, middle and lower areas 90 min after intake of Kyukikyogaito, compared to Keishibukuryogan (Fig. 4 (b), (c)). There was a skin temperature rise in the hands and feet as well. Headache as a subjective symptom was also alleviated. Although a skin temperature rise was seen in the upper, middle and lower

areas following treatment with Keishibukuryogan, the degree of the skin temperature rise was lower than that with Kyukikyogaito (Fig. 4 (b), (c)).

In the experiment shown in Fig. 5, Hochuekkito (Fig. 5 (d)), Keishibukuryogan (Fig. 5 (b)) or Tokishakuyakusan (Fig. 5 (c)) were assumed to be appropriate formulations. However, because the symptoms of physical and gastrointestinal weakness were specific, the person was diagnosed as a case of Hochuekkito Sho. Fig. 5 shows the thermograms of

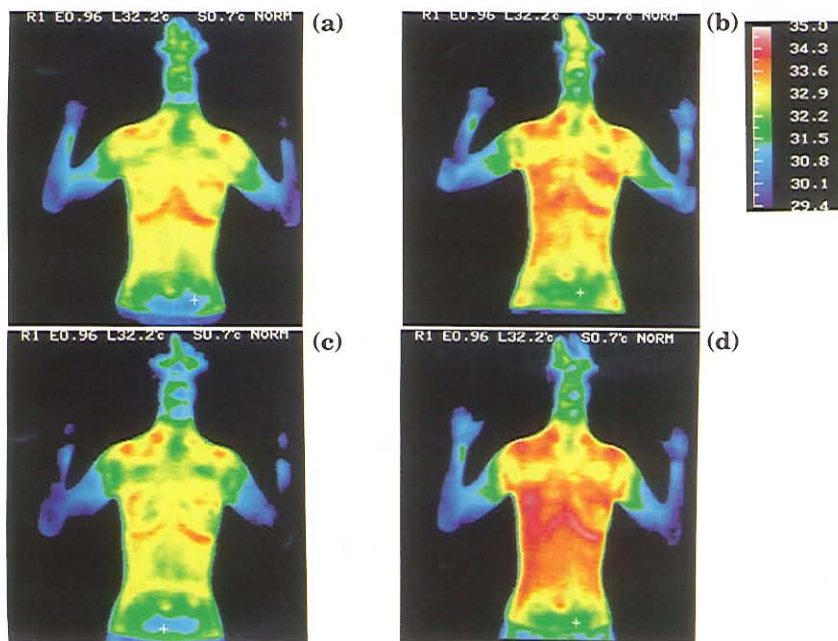


Fig. 5. Comparison of efficacy among Keishibukuryogan (桂枝茯苓丸), Tokishakuyakusan (当帰芍薬散) and Hochuekkito (補中益気湯) in the case of Hochuekkito Sho.

Thermograms of the upper trunk are shown after the intake of each formulation, (b) Keishibukuryogan, (c) Tokishakuyakusan, (d) Hochuekkito and (a) tepid water as a control after 90 min.

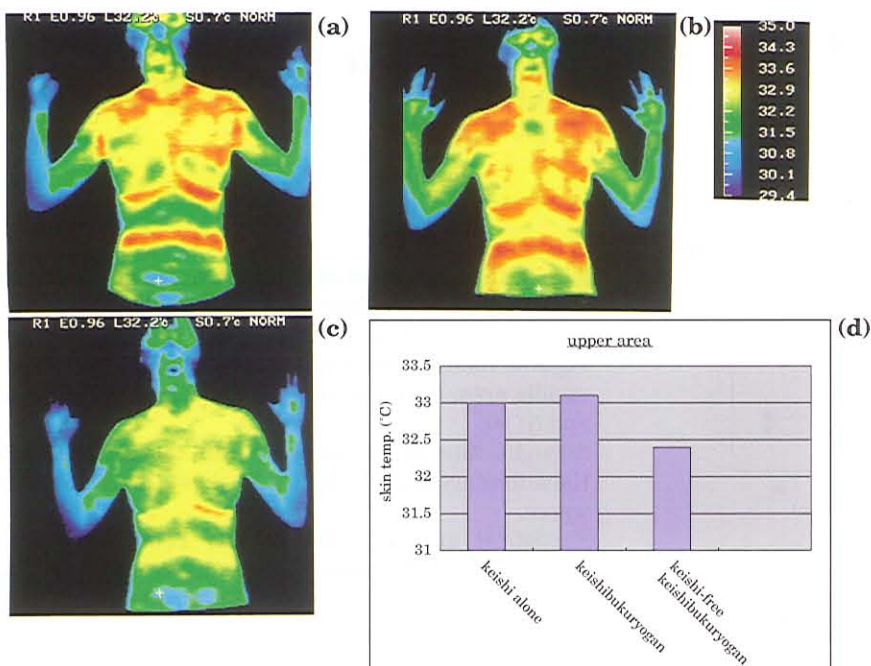


Fig. 6. Comparison of skin temperature after treatment with Keishi alone, Keishibukuryogan (桂枝茯苓丸), Keishi-free Keishibukuryogan.

Thermograms of the upper trunk are shown 30 min after the intake of each component of Keishibukuryogan, (a) Keishi alone, (b) Keishibukuryogan and (c) Keishi-free Keishibukuryogan. Skin temperature in the upper area after the intake of each formulation (a), (b) and (c) is shown graphically in (d).

the upper half of the body after intake of Hochuekkito, Keishibukuryogan, Tokishakuyakusan and tepid water (Fig. 5 (a)). Following treatment with Hochuekkito, a marked elevation of skin temperature (2.5–3.0°C) was seen that spread to the

neck, upper and middle areas, as shown in Fig. 5 (d). The tendency of physical weakness as a subjective symptom was also alleviated. Although a skin temperature rise was seen at all sites following treatment with Keishibukuryogan (Fig. 5 (b)), the degree

of temperature rise was lower than that with Hochuekkito (Fig. 5 (d)). The skin temperature following treatment with Tokishakuyakusan (Fig. 5 (c)) did not differ from that with tepid water (Fig. 5 (a)). Thus, Hochuekkito was confirmed as an appropriate prescription among the herbal formulations used, as we expected.

In Kampo medicine, Keishi cures symptoms associated with palpitation, headache, fever, mild chill, over-sweating and pain^{3,21}. Keishi is also used to stimulate sweating and is known to warm the body^{3,7,24}. To examine the effect of Keishi on the rise of skin temperature, we prepared Keishi-free Keishibukuryogan and checked the effect of Keishi.

Thermograms of the upper half of the body are shown after intake of Keishi alone (Fig. 6 (a)), Keishibukuryogan (Fig. 6 (b)) or Keishi-free Keishibukuryogan (Fig. 6 (c)) in a subject in whom an extracted herbal formulation, Keishibukuryogan, had been effective. From the thermographical findings, there was no skin temperature rise after treatment with Keishi-free Keishibukuryogan (Fig. 6 (c)). However, following treatment with Keishi alone or with Keishibukuryogan, the rise in the skin temperature of the face, neck and upper area was marked (Fig. 6 (a), (b)). As for the subjective symptoms, following treatment with Keishi alone, the face and upper area showed a rise in temperature while the hands and feet showed no temperature rise even after 2 hours. On the other hand, a skin temperature rise after treatment with Keishibukuryogan was observed in the ventral side of the middle and lower areas, in addition to the upper part of the body. From these thermographical results, it is clear that the role of the Keishi contained in Keishibukuryogan is to warm the upper part of the upper half of the body.

DISCUSSION

In some cases that are suitable for Keishibukuryogan, a skin temperature rise in the extremities occurred after the intake of Keishibukuryogan, accompanied by the alleviation of oversensitivity of the hands and feet to cold as a subjective symptom (data not shown). This oversensitivity seems to be due to a peripheral circulation disturbance. Keishibukuryogan has been reported to be effective for treating oversensitivity of the hands and feet to cold due to a peripheral circulation disturbance⁴. These results support the relationship between a rise in skin temperature and the efficacy of herbal formulations.

Treatment with Hochuekkito resulted in a marked temperature rise throughout the upper half of the body (upper and middle areas), as shown in Fig. 5. Hochuekkito is composed of Ninjin (人參), Sojutsu (蒼朮), Kanzo (甘草), Shokyo (生姜), Taiso (大棗), Chinpi (陳皮), Toki (當歸), Ogi

(黃耆), Saiko (柴胡) and Shoma (升麻). Of these components, Ninjin, Sojutsu, Kanzo and Chinpi improve the gastrointestinal function¹². Shoma, together with Saiko, improves descent in the internal organs (e.g., gastroptosis)¹². These components are thought to potentiate the gastrointestinal system. The thermographic findings showed a skin temperature rise over the upper and middle areas of the body. These results suggested that blood flow in the upper part of abdomen is selectively elevated by the formulation. A case in which Hochuekkito was suitable for Sho revealed a more marked skin temperature rise than the other three herbal formulations used in thermography, and the efficacy of this herbal formulation was demonstrated.

The thermographic findings and subjective symptoms following treatment with Keishi alone indicated that Keishi can elevate the skin temperature of the upper part of the body, as indicated in Fig. 6. In abdominal areas, such as the middle area (ventral side) and the lower area (ventral side), treatment with Keishi alone caused no rise in temperature. The skin temperature of these areas was elevated by treatment with Keishibukuryogan (containing Botanpi, Tonin, Shakuyaku, Bukuryo and Keishi).

As a component of Keishibukuryogan, Keishi is reported to promote the circulation of blood in the body, reduce blood coagulation in cooperation with Tonin, Botanpi and Shakuyaku, and regulate the autonomic nerve system²⁴. Bukuryo reduces water retention and cures pulsation at the pit of the stomach and navel in cooperation with Keishi²⁴. Botanpi, Tonin and Shakuyaku alleviate the stagnation of blood²⁴. Shakuyaku additionally exerts astringent, analgesic and anti-spasmodic actions^{13,24}. Thus, in the abdominal areas, it seems likely that Keishi worked with Botanpi, Tonin, Shakuyaku and Bukuryo to alleviate blood stagnation, and led to the elevation of the hypogastric skin temperature. These results seem to be applicable to other prescriptions, in which the components of the herbal formulations are changed, thus enabling the elucidation of the action site of each crude medicine.

In the present study, we attempted to evaluate the efficacy of herbal formulations based on Sho, using thermography. Regarding the usefulness and application of thermography, we made the following findings. (1) The change of body skin surface temperature after intake of an appropriate formulation for Sho, or of an inappropriate formulation for Sho, can be confirmed and validated by thermography. (2) A polarity analysis of rises in skin temperature can indicate the characteristics and action sites of each herbal formulation or their components. (3) Sho has been confirmed through empirical testing by a highly sensitive clinician. We showed that the suitability of herbal formula-

tions for Sho could be confirmed using thermography.

Thermography has the advantages of simplicity, a very short measurement time, and the ability to measure the temperature of the body skin surface directly and with high accuracy. However, it should be noted that the measurement of skin temperature using thermography is likely to be affected by factors such as seasonal changes in temperature, (ambient) air temperature, diet and exercise^{1,9)}.

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