資料2

past methods. In order to raise the accuracy of the moisture amount estimated on the basis of the degree of gloss, it is necessary to normalize the data based on multiple measurements. The generation of gloss depends on the shape of tongue and condition of the saliva adhering to the tongue surface, on the shape of tongue and condition of saliva change based on the conditions in the mouth before the tongue is exposed, and on how the tongue is exposed. In order to control the variation in gloss measurement due to such changes, multiple measurements should be taken. However, as Figure 8 shows, when photographing the tongue in an exposed state for a definite period, the surface dryness and degree of gloss of the tongue decrease gradually. Therefore, in order to repeat the gloss measurement accurately, it is necessary that the tongue be kept in the mouth to recover its natural moisture. This study revealed that an interval of three minutes or more is required between measurements. Until now, the length of this interval could not be estimated; now, for the first time, this estimation is possible using the computer-based method for measuring the moisture on the tongue surface established in this study. The development of this method suggests the possibility of a new quantitative method of performing tongue diagnosis.

Furthermore, this study does not distinguish the type of saliva that generates gloss. Although the saliva on the tongue surface is a mixture of mucous and serous saliva, it is difficult to visually distinguish different types of saliva. On the other hand, it became clear that the dryness of the tongue surface varied among the subjects as they continued to hold their tongues out, as shown in Figure 6. If we hypothesize that there are differences in drying between mucous saliva and serous saliva, the mixture ratio of the saliva types may be detectable from the changing trend of the degree of gloss on the tongue surface as subjects continue to hold out their tongues. This will be a subject for future examination.

5. Conclusion

This study proposes a tongue imaging system called TIAS, which can establish tongue color quantitatively and consistently. Also, TIAS can record the color and gloss of the tongue surface separately. In order to raise the accuracy of the quantitative moisture estimates, it is necessary to obtain more consistent measurements of the degree of gloss. In addition, we have confirmed that the regression formula, which estimates the moisture from the degree of gloss, has sufficient accuracy to support moisture diagnosis in the performance of tongue diagnosis in Kampo medicine. Since the tongue surface dries and the moisture changes at every measurement, it is necessary to take careful, repeated measurements. This study examined the time required for the tongue to recover its moisture between repeated measurements, and it was found that an interval of more than three minutes was necessary. The method of measuring the moisture on the tongue surface using a computer is quantitative. Moreover, as this system measures a two-dimensional distribution of tongue color, it provides new information that was not available for tongue diagnosis in the past. We can expect a new method of tongue diagnosis using this measurement technique and other applications for tongue diagnosis to be established in further investigations.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

Acknowledgment

This study was supported by a research grant from the Ministry of Health, Labour and Welfare, Japan.

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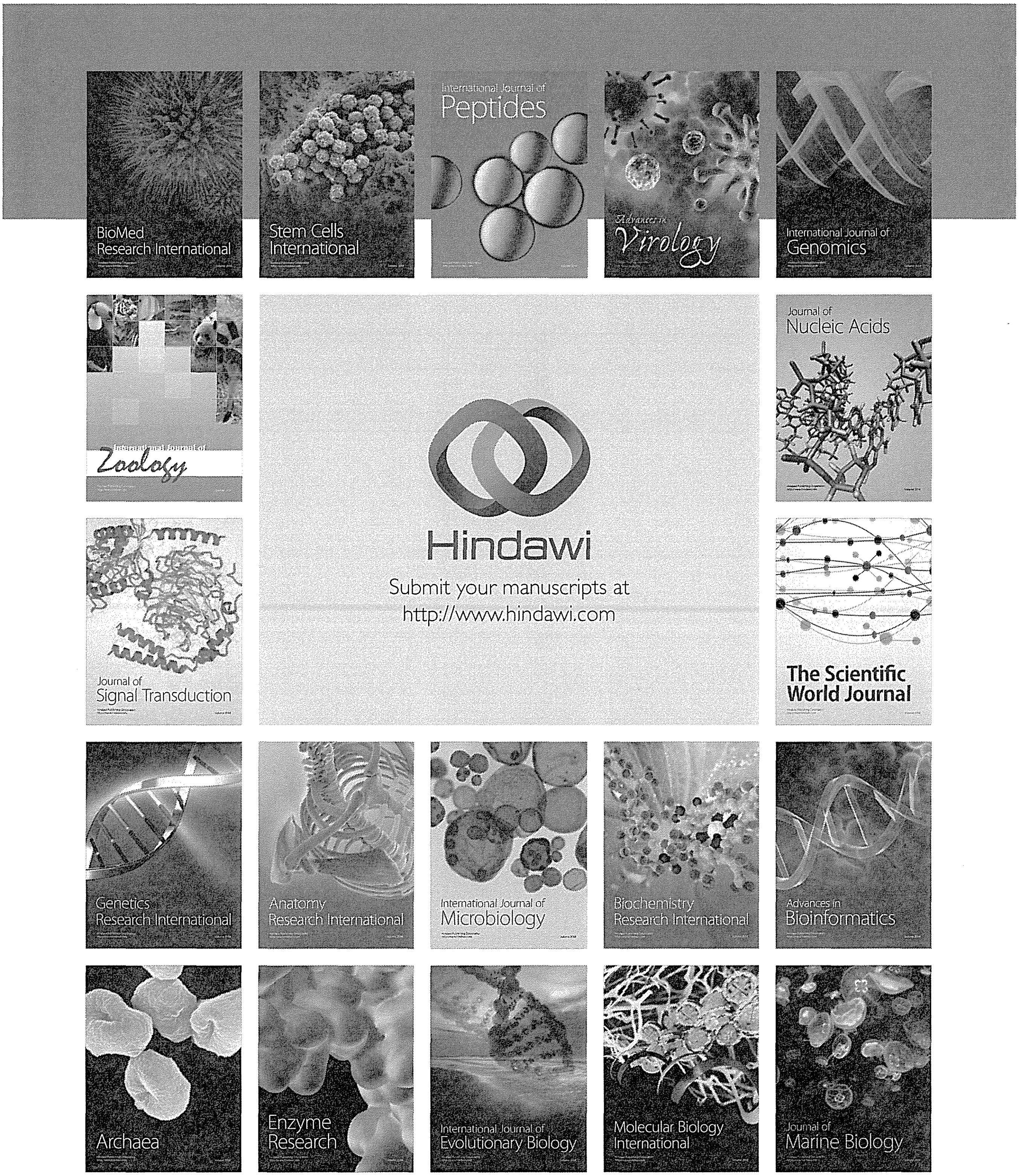
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International Medical Journal

Volume 21, Number 2 April, 2014

The Development of an Abdominal Palpitation Model for the Fukushin Simulator: Towards Improvement and Standardization of Kampo Abdominal Diagnosis

Shuji Yakubo, Yukiko Ueda, Shogo Ishino, Hideki Adachi, Yasutomo Arashima, Takao Namiki, Takashi Nakayama, Kazufumi Yamanaka, Kiyotaka Matsushita, Motoko Tamura

資料3

SHORT COMMUNICATIONS

The Development of an Abdominal Palpitation Model for the Fukushin Simulator: Towards Improvement and Standardization of Kampo Abdominal Diagnosis

Shuji Yakubo[1,2], Yukiko Ueda[1,2], Shogo Ishino[2], Hideki Adachi[2], Yasutomo Arashima[3], Takao Namiki[4], Takashi Nakayama[5], Kazufumi Yamanaka[5], Kiyotaka Matsushita[6], Motoko Tamura[7]

ABSTRACT

Introduction: Alongside the modern western style of medicine in Japan there exists the Kampo system, which has its origins in Chinese medicine but has its own indigenous system of diagnosis, based on abdominal palpation, called Fukushin. This system aims at enabling the physician to obtain an "abdominal pattern" by palpating the patient's abdomen and interpreting the physiological signs. To help in instructing medical students and practitioners in this system, and in the hope of standardizing the interpretation of the patterns, we developed the Fukushin Simulator. We have developed various abdominal models to serve as reference points.

Materials and Methods: We built costal and sternal bones using synthetic plastics and formed a thorax and pelvis. We constructed the interior using urethane foam and synthetic fibers. We included a heartbeat generating device featuring an electric motor with a cam mechanism and eccentric rotation to simulate the characteristic rhythms of the abdominal aorta.

Results: We found that the models are effective in enriching the abdominal palpation models of Kampo medicine by representing the rhythms of the abdominal aorta.

Conclusion: We believe that the abdominal palpitation models described here will be useful aids in training physicians and in moving towards standardized Kampo diagnosis.

KEY WORDS

abdominal palpation, abdominal patterns, Kampo Medicine, abdominal palpitation simulator

INTRODUCTION

According to Kampo medical theory, physiological changes manifest themselves in the abdomen, and hence the abdomen is a useful site for diagnosis of a patient's physiological state. A system of abdominal palpation called Fukushin, developed in Japan, is the method favored. In this method, the physician applies pressure to the patient's abdomen in various spots to determine the degree of resistance to the touch, both overall and at the specific spot, and the reaction of the patient to pressure[1-5].

Although some attempts have been made to interpret the abdominal patterns found in western medical terms, thus far the patterns have proven difficult to correlate with data obtained from clinical tests of modern medical imaging tests[6-11].

As an aid in teaching these patterns to medical students and physicians, and to move towards standardization of the interpretation of the patterns, we have developed a Fukushin Simulator to represent

Received on November 26, 2013 and accepted on February 5, 2014

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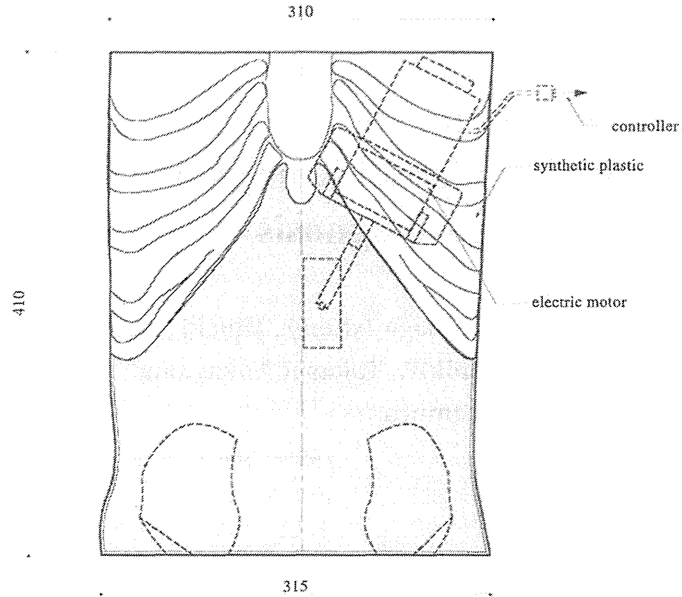

Figure 1. Plane view of the abdominal palpitation model

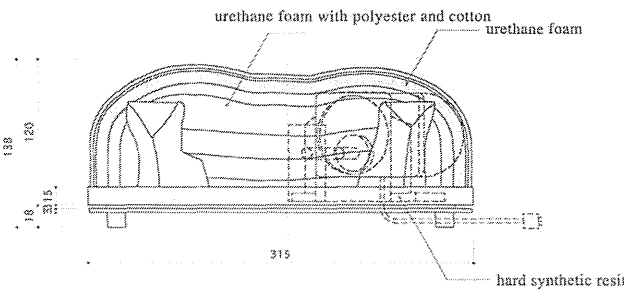

Figure 2. Cross-section of the abdominal palpitation model

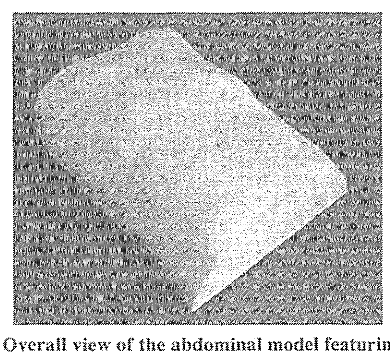

Figure 3. Overall view of the abdominal model featuring an adult male's torso from chest to lower umbilical region, coated in silicon

Figure 4. Interior structure of abdominal palpitation model

the abdominal patterns. We have previously discussed the development of a series of abdominal models as reference points or typical patterns[12].

In the present study, we report on our development of a palpitation model developed as part of the Fukushin Simulator project, to further increase the realism of the models by incorporating the sensation caused by the movement of the abdominal aorta, and aid in the standardization of diagnosis.

SUBJECTS AND METHODS

Our abdominal models represent the abdomen of an adult male

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and have a length of 410mm, width of 310 mm, and depth of 138 mm (Fig. 1,2). We used a base of hard synthetic resin, and placed various synthetic parts on the base to form costal and sternal bones and pelvis. Urethane foam with polyester and cotton were used to simulate the internal organs. To form the skin of the models we shaped a flexible silicon resin in a mold taken from a real male abdomen and used it to coat the model (Fig. 3).

We placed a tube made of soft plastic and with a longitudinal incision to simulate the abdominal aorta into the existing abdominal models. We also placed a heartbeat generating device featuring an electric motor below the left breast (Figs. 4). This heartbeat generating device consists of an eccentric cam mechanism that causes the tube to move in the vertical plane and simulate the rhythms of the abdominal aorta.

By controlling the voltage, it is possible to vary the beating rate between 50-160 beats per minute.

RESULTS

We attempted to incorporate an abdominal palpitation model into our existing Kampo models of the adult male abdomen, by adding a heartbeat generating device featuring an electric motor to simulate the rhythms in the abdominal aorta. We set the rate at 75 beats per minute.

It was possible using this model for an operator, with light contact of the palms and fingers to the epigastric region, to clearly feel palpitation in the abdomen. Note that this palpitation could be detected easily, but it does not indicate remarkable palpitation nor too weak palpitation.

DISCUSSION

It has been reported that 83.8% of physicians in Japan prescribe licensed Kampo medicines as part of their daily practice[13]. This is evidence of the extent to which practitioners are aware of certain limits to modern western medicine and have high expectations of Kampo medicine as an adjunct to conventional practice.

Unfortunately, despite widespread interest in Kampo medicine, progress in educating physicians in its practice was until recently woefully inadequate. In 1999, only 38 of Japan's 80 medical schools and university medical departments included Kampo medicine in their educational programs. The situation changed in 2001, when the Ministry of Education, Culture, Sports, Science and Technology mandated "being able to explain the outlines of Wakan [Kampo] medicine" as one of the educational goals of undergraduate education. Since 2004, all of Japan's medical schools and university medical departments have included a Kampo component in their educational programs[14].

Abdominal palpation is a key diagnostic method, and hence workshops and lectures for the training of doctors in the clinical use of Kampo invariably include this method[15]. Since a great deal depends on the skills and subjective sensations of the individual, however, training in this method is very difficult. A further difficulty lies in the fact that most of the subjects used in training are healthy and thus it is very difficult to provide experience in the patterns generally found in clinical situations.

One answer to these problems is medical simulators, which have been used in recent years with some success[16,17]. However, simulators for abdominal diagnosis did not exist until very recently; accordingly, we developed the Fukushin Simulator for use in abdominal palpation training[18].

When we have used the Fukushin Simulator in training sessions, participants have said that the simulator allows them to make better sense of the practical concepts that had felt rather abstract to them after simply listening to the explanations. 58.4% of participants have reported very good or good understanding of abdominal palpation after the training sessions, and 77.2% reported the simulator as being very useful or useful[19]. With regard to the various static models included in the current Fukushin Simulator, 78.6% of educators judged them to be very useful or useful[20]. In general, the simulator is judged to be useful by both trainers and trainees[21].

In the present study, we have described the addition to the existing Fukushin Simulator of a mechanism, featuring an electric motor, to reproduce the rhythms present in the abdominal aorta and thus make the existing models more realistic by incorporating abdominal palpitation patterns also significant in Kampo medical diagnosis. We believe that this new development will aid in our efforts to improve Kampo education and move towards standardizing diagnosis, something that we consider vital if Kampo medicine is to spread more widely internationally.

CONCLUSION

We have previously developed a simulator called the Fukushin Simulator, used in Kampo diagnosis to simulate the characteristic abdominal patterns recognized in Kampo medicine.

The enhancement described in this paper involves a heartbeat simulation device featuring an electric motor. This device features an eccentric cam mechanism that allows us to reproduce the sensations experienced in abdominal diagnosis around the abdominal aorta. We have high hopes that this enhancement will make the Fukushin Simulator even more useful in Kampo education and help to move us towards standardization of the diagnostic method of abdominal palpation.

This work was supported by Nihon University School of Medicine 50th Anniversary Fund Research Grant (2011) and a research grant of the Ministry of Health, Labor and Welfare, Japan.

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Hindawi Publishing Corporation
Evidence-Based Complementary and Alternative Medicine
Volume 2014, Article ID 783102, 9 pages
http://dx.doi.org/10.1155/2014/783102

Research Article

Study of Factors Involved in Tongue Color Diagnosis by Kampo Medical Practitioners Using the Farnsworth-Munsell 100 Hue Test and Tongue Color Images

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Received 16 December 2013; Accepted 14 February 2014; Published 6 April 2014

Academic Editor: Shao Li

In traditional Japanese medicine (Kampo medicine), tongue color is important in discerning a patient's constitution and medical conditions. However, tongue color diagnosis is susceptible to the subjective factors of the observer. To investigate factors involved in tongue color diagnosis, both color discrimination and tongue color diagnosis were researched in 68 Kampo medical practitioners. Color discrimination was studied by the Farnsworth-Munsell 100 Hue test, and tongue color diagnosis was studied by 84 tongue images. We found that overall color discrimination worsened with aging. However, the color discrimination related to tongue color regions was maintained in subjects with 10 or more years of Kampo experience. On the other hand, tongue color diagnosis significantly differed between subjects with <10 years of experience and ≥10 years of experience. Practitioners with ≥10 years of experience could maintain a consistent diagnosis of tongue color regardless of their age.

1. Introduction

In traditional Japanese medicine (Kampo medicine), observing the tongue shapes and colors is a method for diagnosing the patient's constitution and medical conditions. In addition to the information that the tongue reveals, Kampo evaluations are supplemented with data from questionnaires, pulse, and abdominal diagnosis. Tongue diagnosis is particularly useful for detecting *Mibyou*, the "disease-oriented" healthy stage in Kampo medicine. Kampo tongue information, such as tongue pain in the dental oral area, can be used to prevent potentially refractory diseases [1, 2]. Generally, tongue diagnosis focuses on tongue texture and tongue coating. The colors and shapes of each part can be investigated to diagnose medical conditions.

Mainly, tongue color is the result of light reflection and light absorption. The color of the tongue (tongue color) is especially dependent on internally diffused light. Tongue color diagnosis (TCD) can provide very useful information for medical conditions. By TCD, we can get useful information about the patient's reservoirs of heat and cold, exhaustion level, mental state, digestive system function, blood circulation dynamics, and water metabolic state. However, tongue color diagnosis is affected by two types of factors. One is environmental factors, such as light sources or room temperature, which influence impact diagnosis. The other type includes the subjective factors of the observers, especially their knowledge of Kampo and experience using it.

In recent years, to solve the problem of environmental factors (EF), many researchers have developed a tongue imaging system that operates at constant conditions [3–6]. Chiu devised the hardware and software for tongue imaging and examined the tongue surface and tongue coating, divided into areas related to concepts of traditional medicine [3]. Wang et al. introduced a method of evaluating the color of the tongue surface, dividing the tongue into different regions and excluding the tongue coating [4, 5]. Zhang et al. devised a system for tongue imaging and quantifying the tongue image information, considering both measurement values and the patient's past medical history [6]. Kanawong et al. compared the color value of tongue images with the patient's hot or cold condition [7]. In addition, they measured the RBG value of tongue images obtained in the same imaging environment and evaluated the tongue color quantitatively then used those data for early detection of diseases such as appendicitis and liver cancer [8, 9]. We first undertook research to standardize tongue diagnosis in 2008. As one of our research outcomes, we have been developing a new tongue imaging method and diagnostic support system (Tongue Image Analyzing System (TIAS)) for performing tongue diagnosis. The key characteristic of the tongue imaging method in TIAS is the exclusion of the influence of external light using an integrating sphere to achieve an evenly distributed light intensity with a halogen light source (Moritex Inc., MHAB-150W, color temperature 3200 K). Further, TIAS can remove the gloss of the tongue surface from its images. Our prior study investigated the use of spectral camera imaging [10]. We confirmed the relationships between the Kampo concept of *Oketsu* and both liver function and thyroid function in blood samples as measured by wavelength values [11–13]. Subsequently, in aiming to further promote TIAS, we changed from a spectral camera to a digital camera (Lumenera Inc., Lw115C, 1280 × 1024 pixels, Color CMOS sensor), although we are still using the basic data from the spectral camera. We changed because digital cameras are cheap and the color is superior for viewing purposes. For the quantitative measurement methods in TIAS, RGB values of digital camera images were converted into CIE1976 $L*a*b*$ color space values. Imaging by TIAS was confirmed to be stable for 3 weeks [14]. As mentioned above, our method has made it possible to perform stable quantitative measurement of tongue images by TIAS, and we have almost solved the problem of EF.

As far as we know, there are no other reports about subjective factors (SF) in TCD; the problem of SF has remained unclear. In tongue color diagnosis, age, gender, difference in color discrimination, and experience and knowledge in Kampo medicine are thought to be important influences. Thus, we set out to examine the influence of these factors. We studied the relation of age, gender, color discrimination, and duration of Kampo experience on TCD. One method to evaluate color discrimination is the Farnsworth-Munsell 100 Hue test (Hue test). The Hue test has been used for many years in industrial fields to check color discrimination. In various other fields, many studies on color discrimination have been reported using the Hue test. [15, 16]. The Hue test was evaluated for color discrimination of patients with optic neuritis in ophthalmology [17, 18]. And, the Hue test has been used by neuroscientists to study color discrimination and occipital lobe function in patients with Parkinson's disease and pituitary adenoma [19–21]. The Hue test was first devised by Farnsworth in 1943, and the present 85 colored-caps version was improved in 1957 [22]. The color caps are divided into four hues, and the 85 caps are arranged into four boxes, each containing a fixed anchor cap at both ends of each box. One box consists of 22 caps, and the other three boxes consist of 21 caps each. Color discrimination is evaluated when the subject attempts to arrange the caps into the correct hue order. The total Hue score is calculated by the number of misplacements. Thus, a lower Hue score indicates better color discrimination.

The purpose of this study was to reveal the SF involved in Kampo tongue diagnosis. We recorded data about age, gender, duration of Kampo experience, and primary occupations in Kampo medical practitioners. We evaluated color discrimination by the Hue test. Simultaneously, we examined the individual discrepancies in TCD using tongue images in which the color was adjusted by computer processing, and we studied the relationships of age, gender, color discrimination, and duration of Kampo experience with these results.

2. Subjects and Methods

2.1. Subjects. The subjects were 68 Kampo medical practitioners (48 males, 20 females). First, we questioned the subjects about their age, gender, duration of Kampo experience, and primary occupation. In order to maintain advanced color reproducibility, we had to exclude the influence of external light in the experimental environment. Thus, the experiments were conducted in a dark room (Figure 1). All subjects continuously performed the Hue test and TCD using tongue images.

2.2. Hue Test. We used artificial solar illumination (SERIC Inc., XC-19, 5500K) for the Farnsworth-Munsell 100 Hue test (SAKATA Inc., Farnsworth-Munsell 100 Hue test Munsell color) (Figure 2). The illumination was set on the ceiling of the darkroom, so that the angle of illumination could be about 90° and the angle of viewing could be about 60°. The subjects were ordered to rearrange the color caps of one color phase placed randomly in one slim-line box in correct order in two minutes. They performed this task on all four color phases; that is, they completed the Hue test. We calculated the Hue score according to the number of caps rearranged incorrectly compared with the correct orders of color phases. There were three levels of color discrimination ability: the superior-ability group (Hue score 0–16), normal-ability group (Hue score 20–100), and low-ability group (Hue score more than 100) [22]. In addition, we measured actual values of all the color caps in CIE 1976 $L*a*b*$ color space using the spectroradiometer (KONICA MINOLTA Inc., CS-1000A) in the experimental environment. The result shows that the tongue colors used in this experiment corresponded to those of color caps number 64–78 in CIE 1976 $L*a*b*$ color space (Figure 2). Therefore, we established a tongue color region (TCR) as the number 64–78 color caps region, and we also examined the relation between each influence factor and TCR.

2.3. Tongue Color Diagnosis (TCD) of Tongue Images. In creating the tongue color images, we used 1551 tongue images taken by TIAS. In order to determine the distribution of

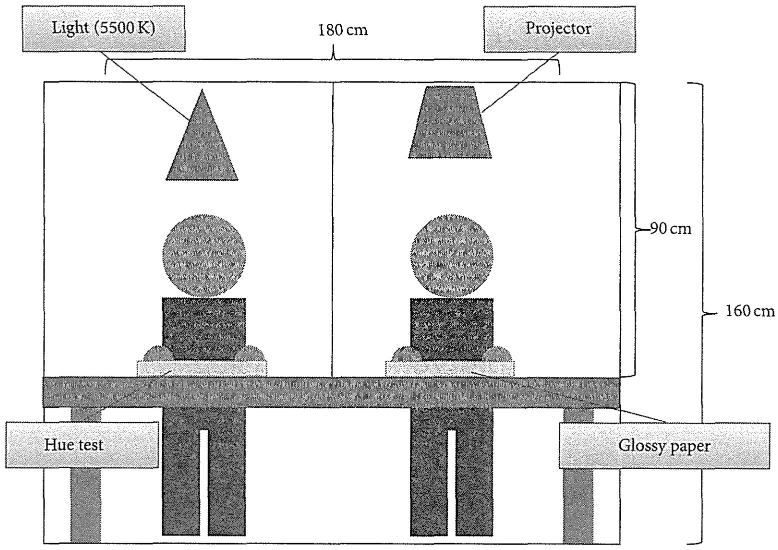

FIGURE 1: The experimental environment in this study. The experiments were conducted in a dark room with a single light source. For the Hue test, the light was positioned above so that the angle of illumination would be 90° and the angle of Hue test viewing would be approximately 60°. For the tongue color diagnosis, full-color tongue images were projected onto glossy paper by a projector.

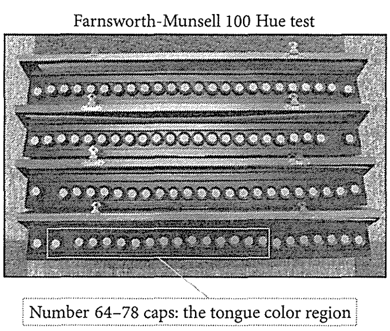

FIGURE 2: Color discrimination was evaluated by the Farnsworth-Munsell 100 Hue Test. The color discrimination is evaluated based on the subject's attempt to rearrange the caps into the correct hue order. Total Hue scores are calculated as the number of misplacements, and a lower score therefore indicates better color discrimination. The tongue color regions (TCRs) correspond to caps number 64–78.

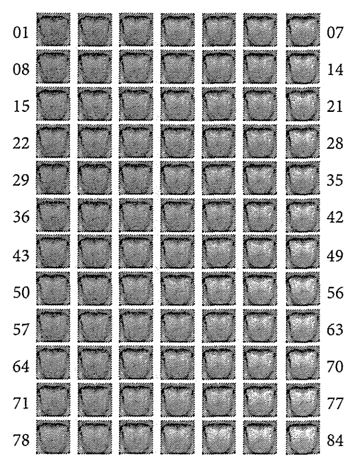

FIGURE 3: Tongue images 01–84.

the colors of the 1551 tongue images, we performed principal component analysis. By determining the color using principal component axes, it was possible to set the color gamut of the tongue without deviating far from the tongue color. The distance of the color becomes a constant interval by dividing the tongue color gamut into a 7 : 4 : 3 ratios and the 84 ($7 \times 4 \times 3$) tongue images were obtained from it (images 01–84: Figure 3). Furthermore, we measured actual values of the tongue colors on the tongue image color chart in CIE 1976 $L*a*b*$ color space in an experimental environment. The tongue color images were projected onto glossy paper by a projector (EPSON Inc., EB-1761W), and subjects were asked to diagnose the tongue color in each of the 84 tongue images. The color of the TCD was selected from among five designations: pale, pale red, red, crimson, and purple (Figure 4) [23].

2.4. The Ethics and Statistical Analysis. We obtained informed consent for this experiment from all subjects using descriptive text.

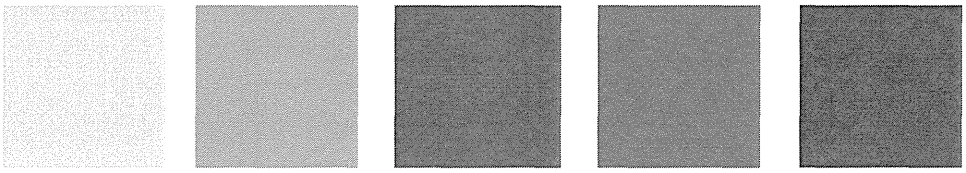

FIGURE 4: Tongue color diagnosis included five colors: pale, pale red, red, crimson, and purple.

TABLE 1: Comparison of duration of Kampo experience with subjects' age, gender, and occupation.

	Duration of Kampo experience		P value
	<10 years	≥10 years	
Age			
<43 years	26	5	0.000**
≥43 years	9	28	0.001**
Gender			
Male	19	29	0.099
Female	16	4	0.011*
Occupation			
M.D.	22	30	0.186
Not M.D.	13	3	0.017*

M.D.: medical doctor.
All P values were obtained by χ^2-test. $^*P < 0.05$, $^{**}P < 0.01$.

The data were analyzed by Student's t-test when they were assumed to be homoscedastic by the F-test. If the data could not be assumed to be homoscedastic by the F-test, they were analyzed by Welch's test. When the data were not consecutive variables, they were analyzed by the χ^2-test. In each analysis, the significance level was set at less than 5%. We used the Pearson product-moment correlation coefficient.

3. Results

3.1. Subjects. In this study, we obtained data from 68 Kampo medical practitioners. Their ages ranged from 27 to 69. The average age was 44.3 ± 9.1 among all subjects, 45.9 ± 8.9 among males and 40.5 ± 8.4 among females; the median age was 43. The subjects' duration of Kampo medical experience averaged 12.1 ± 9.5 years, ranged from 1 to 40, and had a median value of 10. The subjects consisted of 52 medical doctors, 6 acupuncturists, and 10 pharmacists who made tongue diagnosis in daily operations (Table 1). There was a positive correlation between the ages and the duration of Kampo medical experience (r = 0.753). There were fewer females than males in the age group ≥43 years and in the group with ≥10 years of Kampo medical experience.

3.2. Hue Test Color Discrimination in the Entire Region and the Number 64–78 Region. The entire region of Hue scores (EHS) ranged from 4 to 138, with an average of 39.2 ± 25.4 and median value of 30. There were 12 subjects with superior ability, 54 subjects with normal ability, and 2 subjects with low ability of color discrimination according to the Hue score. The Hue scores for the number 64–78 caps ranged from 0 to 36, with an average of 4.4 ± 6.6, and a median value of 2.

EHSs were analyzed in terms of age, gender, and duration of Kampo medical experience. The group of <43 years old (n = 31) had a significantly lower EHS average (better color discrimination) than those ≥43 years old (n = 37) (t-test, P = 0.012) (Figure 5(a)). With regard to gender, there was no significant difference between the number of men and women in the groups with scores <30 and ≥30, stratified by age (Figure 5(b)). There was no significant difference between the rate of inexperienced (<10 years) and experienced (≥10 years) Kampo practitioners in the groups with scores of <30 (n = 30) and ≥30 (n = 38) stratified by age (Figure 6(a)).

The number 64–78 region of Hue scores (64–78 HS) was considered to correspond to the TCR. In the same way as described for EHSs above, 64–78 HS were analyzed with regard to age, gender, and duration of Kampo experience. No significant difference in the 64–78 HS between the age groups <43 years (n = 31) and ≥43 years (n = 37) was found (t-test, P = 0.257). Analyzing the mean 64–78 HS for each gender in each age group, no significant difference was found between males and females. In terms of Kampo experience, we compared the ratios of experienced (≥10 years) and inexperienced (<10 years) Kampo practitioners in the group with 64–78 HS < 2 (n = 33) and that with 64–78 HS ≥ 2 (n = 35) (Figure 6(b)). A significant difference was found in the ratios in each score category between the two groups (χ^2-test, P < 0.01). In workers with <10 years of Kampo experience, age had a deleterious effect on color discrimination, with those >30 years old having a smaller ratio of good 64–78 HS scores (64–78 HS < 2). However, in the group with ≥10 years of Kampo experience, the ratio of 64–78 HS < 2 did not decrease. This tongue-color-specific region was the only one for which significant differences in color discrimination were found between workers with Kampo experience for <10 years and those with Kampo experience for ≥10 years; furthermore, in other color regions, Hue scores uniformly increased with aging.

3.3. Tongue Color Diagnosis of Tongue Images. We examined the total number of answers of each tongue color for TCD of the tongue images (images 1–84) projected onto glossy paper. The total number of answers was 5712 (84 images × 68 subjects). The cumulative numbers of answers of each tongue color were as follows: pale 1265, pale red 1536, red

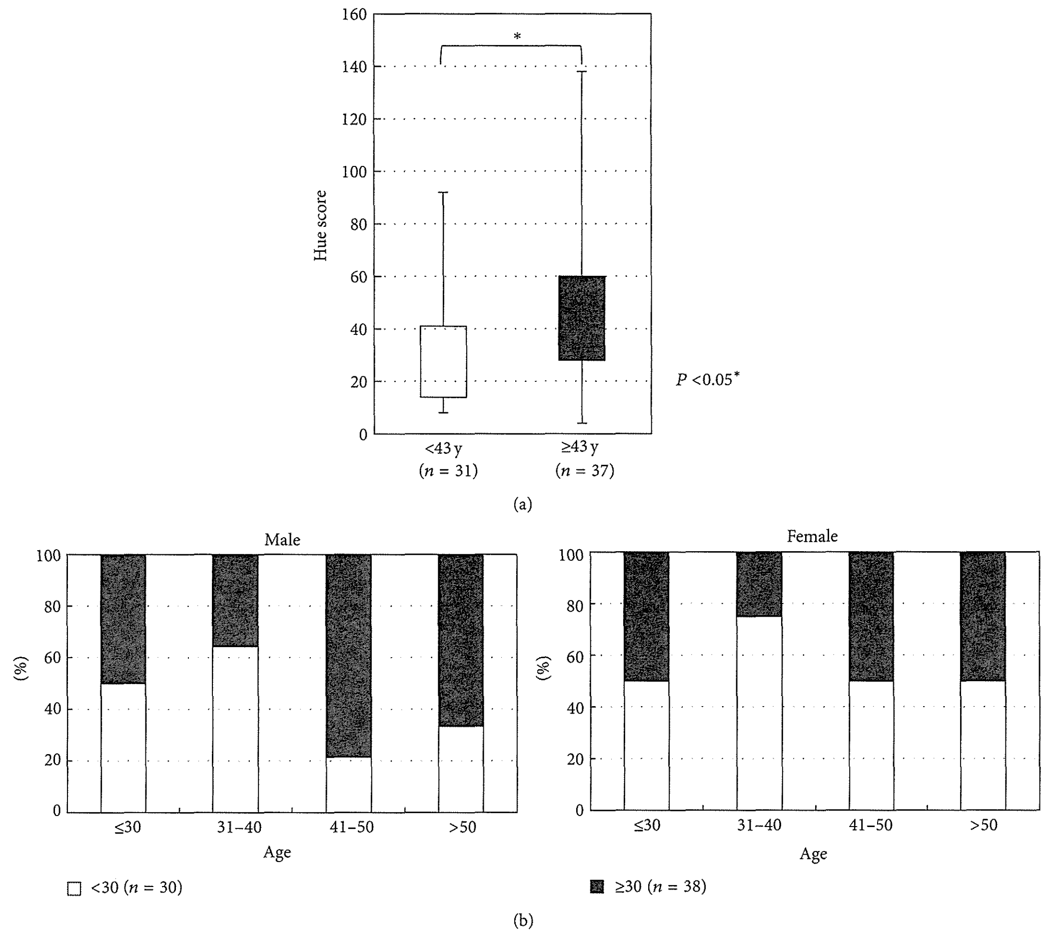

FIGURE 5: (a) The <43 years group had significantly lower average Hue scores than the ≥43 years age group (t-test, $P = 0.012$). (b) The rate of subjects with Hue scores of <30 and ≥30 was compared between genders and separated by age. There were no significant differences between males and females.

1482, crimson 1142, and purple 287. For each tongue color we compared the answer distributions with regard to age, gender, color discrimination (EHS and 64–78 HS scores), and duration of Kampo experience. There were no significant differences between age, gender, and color discrimination abilities (EHS and 64–78 HS scores) for TCD of the tongue images. However, the distribution of TCD was significantly different between workers with <10 years of Kampo experience ($n = 35$) and those with ≥10 years of experience ($n = 33$) (χ^2-test, $P < 0.01$) (Figure 7). Incidentally, there was no significant difference between other durations of Kampo experience. Further, we examined the relationship with TCD of the 64–78 HS groups and the duration of Kampo experience. TCDs were compared for the groups with 64–78 HS < 2 ($n = 18$) and 64–78 HS ≥ 2 ($n = 17$), first in the group with <10 years of Kampo experience, and then in the group with ≥10 years of Kampo experience (Figure 8). As a result, the distribution of TCD was significantly different between 64–78 HS < 2 and ≥2 in workers with <10 years of Kampo experience (χ^2-test, $P < 0.01$), but not for with ≥ 10 years of Kampo experience.

4. Discussion

We studied the relationships between color discrimination on the one hand and age, gender, and duration of Kampo experience on the other. We found that overall color discrimination was associated with age but that the color discrimination of the tongue color region (TCR) was associated with duration of Kampo experience. Further, we found that duration of Kampo experience influenced TCD.

TCD and color discrimination measurement require high color reproducibility. The reason is that color is determined

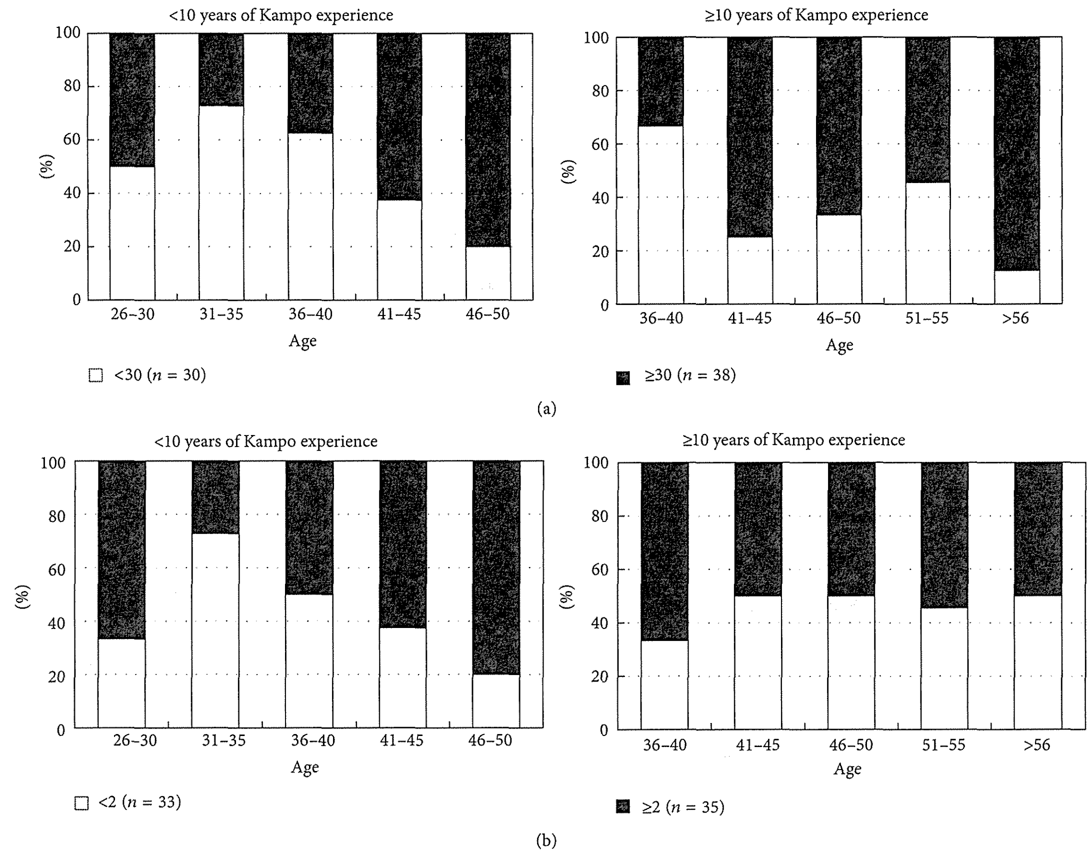

Figure 6: (a) The <10 years of Kampo experience group and ≥10 years of Kampo experience group were divided into EHS < 30 ($n = 30$) and EHS ≥ 30 ($n = 38$) in each age group. There was no significant relationship between Kampo experience and high/low EHS. (b) The <10 years of Kampo experience group and ≥10 years of Kampo experience group were divided into 64–78 HS < 2 ($n = 33$) and 64–78 HS ≥ 2 ($n = 35$) for each age group. A significant difference was observed in the 64–78 HS < 2 group between the <10 years and ≥10 years of experience groups (χ^2-test, $P < 0.01$). The ages were higher in the ≥10 years of Kampo experience group, but the ratio of 64–78 HS < 2 did not decrease.

by both the illumination light source and the characteristics of the object. Hence, the settings of the illumination light source, the light source position, and the observation viewpoint are important in order to obtain an accurate representation of the color. Zahiruddin et al. compared two conditions for the Hue test, the conventional observation method and observation under ambient room light. They recognized that Hue scores differed in the two conditions [24]. In order to control the conditions, we followed the method of D. Farnsworth, in which the angle of illumination was vertical at 90° and the angle of Hue test viewing was about 60° in an otherwise dark room [22]. On the other hand, the human visual system has two modes of appearance of the color; that is, the two visual characteristics are the light source color mode and the object color mode [25]. Usually, we observe tongue color in the object color mode. Therefore, in this experiment, we observed the tongue color in the object color mode using a projector. The measurement value in CIE 1976 $L*a*b*$ color space had been preset using the color caps of Hue test and the tongue color images. However, as the color is affected by the experimental environment, we also measured actual values (CIE 1976 $L*a*b*$) in the experimental environment. We set a TCR that matched the color caps of the Hue test and the tongue color images in the actual measurement value. Number 64–78 caps from the Hue test were considered equivalent to the color of tongue diagnosis. The method used to identify the red-green or blue-yellow area in the Hue test has been described in previous reports [17, 26]. In this study, different results were obtained when the data of this restricted area of color were evaluated instead of the entire area of the Hue test.

In general, it has been reported that discrimination of colors represented by the entire Hue test region worsens with aging [27–29]. Similar results were observed in this study. In Kinnear and Sahraie, the average Hue scores decreased gradually to about 20 years of age, but after 20 the scores

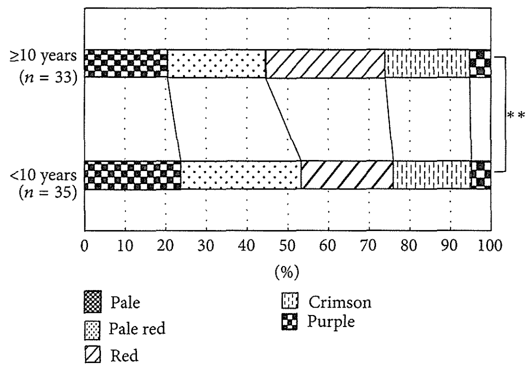

FIGURE 7: Comparison of TCD and duration of Kampo experience. The distribution of TCD showed a significant difference in the comparison of the <10 years and ≥10 years of Kampo experience groups. All P values were obtained by χ^2-test. $^*P < 0.05$, $^{**}P < 0.01$.

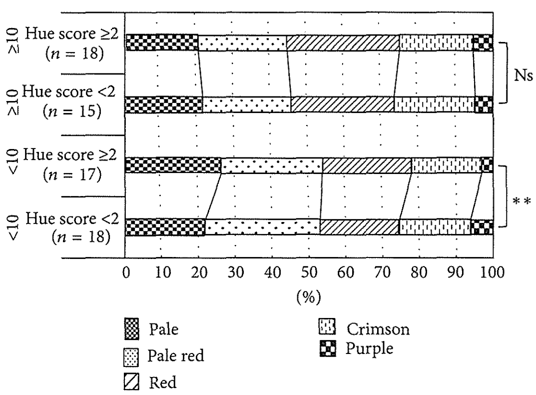

FIGURE 8: Comparison of TCD with 64–78 HS and duration of Kampo experience. The distribution of TCD was significantly different in the 64–78 HS < 2 and ≥2 groups within the <10 years of Kampo experience group. On the other hand, no significant difference was found in the ≥10 years of Kampo experience group. All P values were obtained by χ^2-test. $^*P < 0.05$, $^{**}P < 0.01$, Ns: no significance.

increased with aging (color discrimination worsened). The average Hue score was found to increase greatly at 50 years or more [27]. Roy et al. reported the same results [28, 29]. However, the average Hue scores in our study are lower than those in these previous reports. Likewise, the rate of increase of average Hue score for subject's ≥50 years in this study was lower than in these reports. We found an effect in this study whereby the color discrimination of the TCR does not suffer an age-related worsening in Kampo practitioners with ≥10 years of experience. We think this effect explains our results.

There was no significant difference in color discrimination by gender (Hue test entire region and TCR). Some reports have compared color discrimination by gender using the Hue test [26, 30]. Rigby et al. examined Hue test color discrimination by gender in pathologists [30] and found no significant difference between the scores of 23 males and 7 females in the 20–45 years age range. Moreover, Koçtekin et al. considered specific regions of Hue test in the dominant eye and the opposite side of eye of medical students [26]. The subjects were 31 males and 19 females whose mean age was 21 ± 2 years of age. Again, there was no significant difference between males and females in their study. Although the designs and purposes of these reports were different from those in this study, the results are consistent. Therefore, although the male-to-female ratio of this study was not 1 : 1, we think the effect of this bias is small.

In the TCD, no association was found between age, gender, and color discrimination (Hue test entire region and TCR). However, a significant difference in TCD was recognized between inexperienced (<10 years) and experienced (≥10 years) practitioners. Thus, an association was suggested between TCD and duration of Kampo experience. The inexperienced group tended to evaluate the pale-red area more broadly than the experienced group. Conversely, the experienced group tended to evaluate the pale and the pale-red areas more narrowly and to evaluate the red areas more broadly. Thus, there is a possibility that the ability to identify the pale-red area (normal tongue color area) is increased by gaining experience in Kampo medicine. We examined the TCD results by two factors, color discrimination of TCR and duration of Kampo experience. In the inexperienced practitioner group (<10 years), TCD results differed depending on the color discrimination of TCR. On the other hand, in the experienced group (≥10 years), TCD results were not affected by the color discrimination of TCR, but rather the TCD results became constant. Therefore, until having enough TCD, training of Kampo medicine may be needed for 10 years or more.

Actual clinical doctors diagnose tongue color independently. For this reason, we think this study is valuable because it involved the participation of many Kampo medical practitioners. Moreover, the finding that the TCD is affected by duration of Kampo experience is novel. Using this new finding, it may be possible to obtain more accurate results in the selection of tongue color diagnosis. We need to consider the duration of Kampo experience when judging tongue color findings. Further, in Kampo medicine education, age or color discrimination ability should not be considered a barrier, as experience and training can make up for these deficits. This study suggests the importance of TCD study, which we hope will progress in future. Finally, we believe this study can contribute to the standardization of tongue diagnosis in Kampo medicine.

5. Conclusions

Overall color discrimination worsened with aging, but the ability of tongue color diagnosis was not affected by aging or color discrimination ability. The ability of tongue color diagnosis and indeed ability to discern colors in the tongue color region do not degrade in those with Kampo experience. These results suggest the importance of studying tongue color diagnosis, and they are expected to contribute to the standardization of tongue diagnosis and Kampo medical education in the future.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

Acknowledgments

The authors are extremely grateful to people at the following facilities who cooperated with this study: Keio University, Kitasato University, Nihon University, Tokyo Women's Medical University, Tokai University, Jichi Medical University, Osaka University, Toyama University, Kanazawa University, Kanazawa Medical University, Kyushu University, Meiji University of Integrative Medicine, Hiroshima International University, Kameda Medical Center, Kashima Rosai Hospital, Aso Iizuka Hospital, Tsujinaka Hospital Kashiwanoha, Gunma Central General Hospital, and Fukushima Medical University Aizu Medical Center. This study was supported by a research grant from the Ministry of Health, Labour and Welfare, Japan.

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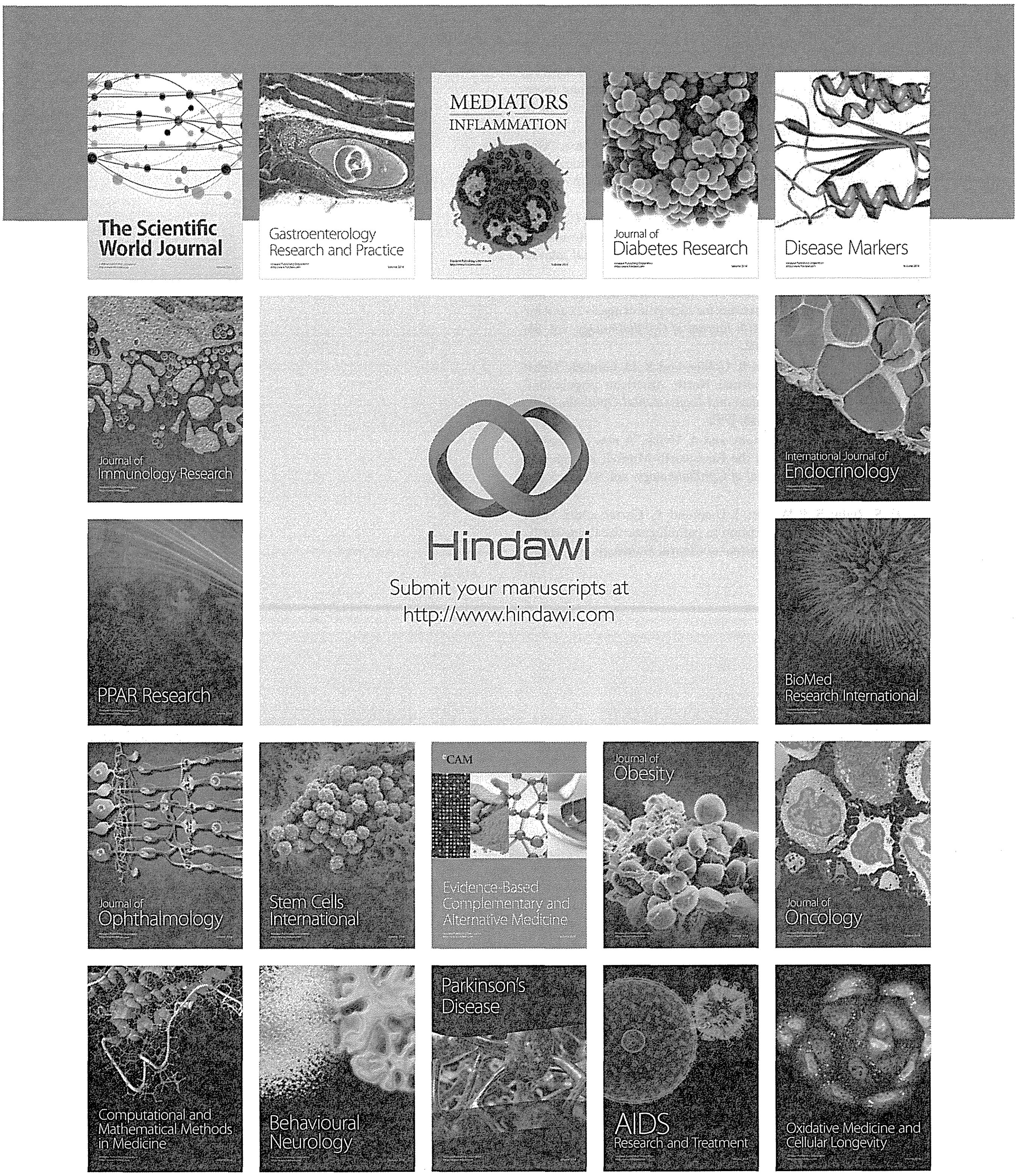

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224 日東医誌 Kampo Med Vol.65 No.3 224-230, 2014

調査報告

多施設での統一した舌診臨床診断記載の作成を目的とした日本の舌診文献調査

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Japanese Literature Survey of Tongue Findings for the Purpose of Creating a Unified Multicenter Description of Clinical Tongue Diagnoses

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受付：2013年8月29日，受理：2013年11月29日

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Abstract

In Kampo medicine, a tongue examination, whereby the shape and color of the tongue is observed, is thought to reveal the constitution and condition of the patient. In Japan, numerous books on this tongue examination have been published. However, tongue findings are expressed differently in these books, and a standard description for such findings has yet to be established. A standard description would be useful when examining the tongue, and when educating students of Kampo medicine. We therefore compared how tongue colors and shapes were expressed in the Japanese literature on tongue examinations (12 publications).

Using these results, we have arrived at a standardized description for tongue findings in accordance with Kampo specialists of tongue diagnoses at many facilities. In the process, we focused on easily recognizable findings that can be noted with short clinical examination times, and that can also be understood by beginners.
Key words: tongue examination, tongue findings, color, shape, standardization, Japanese literature comparison, short examination

要旨

漢方医学では舌の色や形状を観察する舌診が患者の体質や病状を知る重要な手掛かりになると考えている。我が国において，舌診に関する書籍が複数発行されているが，記載内容が不統一で臨床的な舌診所見の標準的な記載方法はまだ確立してない。舌診の研究および学生への漢方教育において標準的な舌診臨床所見は必要である。そこで舌診の日本の文献（計12文献）を用いて，色調や形態の記載について比較検討した。その結果を用いて舌診に習熟した多施設の漢方専門医のコンセンサスを得た上で，舌診臨床診断記載の作成に至った。作成にあたり，実際臨床において短時間で観察し得る舌所見を捉える事と初学者でも理解し易いよう，微細な所見の違いよりも確実に捉えやすい舌診所見に重点を置いた所見記載とした。
キーワード：舌診，舌診所見，臨床診断記載，標準化，多施設

緒言

漢方医学では舌の色や形状を観察する舌診が患者の体質や病状を知る重要な手掛かりになると考えている。しかし，舌診は医師の知識・経験に依存する主観的要因と光源・室温等の外部環境要因に影響を受けやすいという問題点があり，そのため技術の習得に時間を要する難点がある。2008～2010年に文部科学省委託事業・都市エリア産学連携促進事業において，一定の条件下で舌を撮影でき，舌の色調から漢方医学的診断をコンピューターで行う舌撮影解析システム（Tongue Image Analyzing System : TIAS）を開発した。TIASでは積分球と拡散光照明を用いることで光の強度を一定とし，安定した撮影条件を構築することで外部環境要因が影響するという問題を解決した。このTIASを用いて，2012～2013年に厚生労働科学研究費補助金により研究参加した施設で舌を撮影し，舌診所見（色調，形態）の検討を行っている。一方，上記研究班での会議で標準的な

舌診臨床所見の記載方法がなく，撮影された舌写真の臨床評価が問題となった。そこで，現時点での日本における舌診に関する文献で臨床的舌診所見項目を調査するとともに，専門家の意見を統合した舌診臨床診断記載の作成を試みることとした。

方法

1．舌診の記載に関して系統的に書かれた日本で出版された10書籍文献，および2文献（非公開1文献を含む）の合計12文献の舌診所見項目を抽出し，記載の相違を調査した[1)~12)]。なお，舌診所見は(1)舌質の色調(2)舌質の形状(3)舌苔の色調(4)舌苔の形状(5)舌の乾湿度合の計5区分として抽出した。また，舌写真のある文献については，同じ所見での写真を比較した。さらに，一部の中医学等の文献も参考にした[13)~16)]。

2．上記の文献調査結果を踏まえ，舌診に習熟した漢方専門医の意見を加え，舌診臨床診断記載案を作成した。さらにその案を研究班内で回覧し，意見を加えて最終記載を完成させた。作成した舌診臨床診断記載は以下の点を考慮して決定した。臨床に用いるのに簡便で，初学者にも理解し易いよう舌診所見をまとめた。つまり，なるべく多くの文献で共通する舌診所見を採用するとともに，一般的に臨床での舌診は数秒と短時間で行われるため区別の難しい色調は除外し，一項目内ではなるべく少ない分類にすることとした。

結果

1．舌診所見の(1)舌質の色調(2)舌質の形状(3)舌苔の色調(4)舌苔の形状(5)舌の乾湿度合の順に調査結果を以下に示す。

(1)　舌質の色調についての比較を**表1**に示す。舌質の色調は計9種の表現でされており，統一はされていなかった。淡紅，淡白紅，紅，暗赤紅，紫，絳（深紅）が過半数の文献で見られた。

(2)　舌質の形状についての比較を**表2**に示す。舌質の形状は計13種の表現でされており，統一性はなかった。舌萎縮（痩薄），舌腫大（胖大），歯痕，亀裂（裂紋）が過半数の文献で見られた。また，特殊なものとして紅点（点刺），瘀点・瘀斑，舌尖紅，舌裏静脈怒張も過半数の文献で見られた。

(3)　舌苔の色調についての比較を**表3**に示す。舌苔の色調は計8種の表現でされており，統一はされていなかった。白苔，黄苔，黒苔の3表現は全文献に見られた。その他に褐色苔（灰苔）が9文献で見られた。

(4)　舌苔の形状についての比較を**表4**に示す。舌苔の形状は計16種の表現でされており，統一性はなかった。薄苔，厚苔，膩苔，地図状舌，鏡面舌が過半数の文献で見られた。

(5)　舌の乾湿度合については舌苔のみに限った表現がなされ，**表4**の燥苔，潤苔，滑苔の3表現がそれに相当した。北里大学東洋医学総合研究所の「診察記載申し合わせ」では舌全体としての乾・湿と表現されていた[11)]。

2．上記の結果1．より舌診所見を総括し，**表5**の舌診臨床診断記載を作成した。舌診臨床診断記載を**表5**と略す。舌質の色調は淡白紅，淡紅，紅，暗赤紅，紫の5色調，舌苔の色調は白苔，白黄苔，黄苔，褐色苔，黒苔の5色調に定めた。舌質の形状は舌萎縮，舌腫大，歯痕，亀裂，舌尖紅，瘀点・瘀斑，紅点，舌裏静脈怒張の計8項目の有無判定と定めた。舌苔の形状は舌苔の有・無の判定，舌苔の厚さを薄苔（正常），中，厚苔の3段階評価とし，舌苔の分布程度は地図状苔の有無判定と定めた。舌の乾湿は乾燥または湿潤の有無判定と定めた。

考察

現在まで日本では脈診や腹診記載と比較すると舌診の統一した記載がなく，この点では劣っていた。今回，我々が作成した**表5**はその最初の試金石になると考える。

表5の作成過程で各種舌診文献を参考にした。文献に記載されていた舌診所見の表現の相違が多々あり，また表現が多種にわたるため，すべてを網羅的に統一することは極めて困難であった。その一例として舌質色調の紫の表現でも同義の暗舌，やや淡色が多いのを淡紫と淡暗，やや青色が多いのを青紫，やや紅色が多いのを赤紫と暗紅があり，紫の類似色調表現で6種類にもなる[5)]。その各色調表現の診断基準や程度判定は文献では記載がなく，経験的，主観的な診断になることや，初学者には理解が困難である問題点がある。**表5**の作成にあたり，このような問題点を踏まえ，臨床で簡便に使用でき，初学者