

Hot Spring Hydro Therapy Regulates Hypothalamus System Together with Recovery of Hearing Loss

Daisuke Sakamoto^{1*}, Kazuhiro Okamoto², Yuma Katoh^{3,4}, Keiko Kawasaki³ and Nobuo Yamaguchi³

¹Department of Cardiovascular Surgery, Kanazawa Medical University, Uchinada, Ishikawa, Japan

²Department of Rehabilitation, Kanazawa Medical University, Uchinada, Ishikawa, Japan

³Ishikawa Natural Medicinal Products Research Center, Kanazawa, Ishikawa, Japan

⁴Department of Respiratory Medicine, Tohkai Central Hospital, Gifu, Japan

***Corresponding Author:** Daisuke Sakamoto, Department of Cardiovascular Surgery, Kanazawa Medical University, Uchinada, Ishikawa, Japan.

Received: February 18, 2019; **Published:** March 26, 2019

Abstract

Background: Prolonged IRS promised to induce immunological dysfunction with qualitative and quantitative. These condition resulted in age-related disabilities, yet, only a small part of affected individuals seek medical attention. Several studied have described complementary and alternative medicine (CAM) as effective strategies for improving leukocyte subset through safety root such as hypothalamus system, hot-spring hydrotherapy and some other menu in CAM. The purpose of this study was to provoke the effect of hot-spring hydrotherapy (HSH), especially for the recovery from hearing loss together with hypothalamus system, leukocyte subset proportion.

Methods: In this approach of alternative study, participants with prolonged IRS at least lasting 4 weeks were randomly allocated into the trial: The attendant were monitored their audio grapy before and one day after the hydrotherapy. The hydrotherapies were prepared two mode, one was full body hydrotherapy and the other was foot-leg dipping style, so to say partial one.

Results: Twenty four our later of examination showed that the recovery of hearing loss especially in aged group. The recovery area was high frequency hlz. 2000, 4000 and 8000 db. Middle aged grope also leveled up their activities.

Conclusion: The present results suggested that HSH formulation reduces immunological dysfunction together with hearing loss in old ager. The whole body hydrotherapy as well as partial hydrotherapy also effective but less than that of whole body one.

Keywords: Hot Spring Hydrotherapy; Hypothalamus Regulation; Leukocyte Subset Regulation; Recovery of Hearing Loss; Whole Body Hydrotherapy; Foot Leg Hydrotherapy

Abbreviations

AC: Air Conduction; CAM: Complementary and Alternative Medicine, beside the western medicine, there are many traditional medicine and/or health promoting menu all over the world; CD: Cluster of Differentiation. Each lymphocyte has their own name that expressed CD number, for example CD2, CD4, CD8 etc; FCM: Flow Cytometry; HSH: Hot Spring Hydrotherapy; IRS: Immune Retorted Status; LAC: Left Air Conduction; QOL: Quality of Life; RAC: Right Air Conduction

Introduction

Hot spring hydrotherapy has been reported for treating a wide variety of diseases, such as life-related disease and hypersensitivity and infertility [1-5]. Although the exact mechanism of HSH is going to clear, the thermal effect is considered as a key point for the effectiveness and temperature has an essential role for this therapy [6-10].

Our research has been conducted to investigate the thermal effect of on hypothalamus, endocrine and immune system [11-16]. Many reports had investigated the temperature and blood perfusion volume changes on healthy human subjects, and revealed a rapid and sharp increase both in blood perfusion volume and skin capillaries. The reports analyzed that the increase in blood flow occurred due to an axon reflex that had a reflex arc below the spinal cord, and the transient decrease in blood flow was induced by excitation of postganglionic muscle sympathetic element.

Furthermore, several research showed that the effectiveness of HSH was related to the modulation of autonomic nervous system, especially the sympathetic nervous system. The research of ours shows that HSH was more effective than other CAM menu in treatment of chronic fatigue syndrome in the long-term and the mechanism of this effect may involve both the vague nerve activation and the modulation of sympathetic nervous system as well [17-20].

Recently, hot spring hydrotherapy has sparked more and more interest and many objective studies have been established. What is the mechanism of hot spring hydrotherapy that affects humans? It is known that the function of the immune system is closely related to the nervous and endocrine rout controlled by hypothalamus system, and varies with physical conditions [21-25]. It seems reasonable that hot spring hydrotherapy should also influence the othrarhygol system, but so far no objective studies have been made. Finding the answer to this query became the focus of our investigation [26-29].

In order to investigate the influence of hot spring hydrotherapy on the hearing ability, we examined 23 volunteer during 30 days, 2017. In Japan, centuries of tradition have shown that alternative therapies like hot spring hydrotherapy, together with the recovery of hearing loss in aged people and enhance the ability for the young one.

Purpose of the Study

The purpose of this study was to confirm the hypothalamus system within 24 hours by focusing the recovery of hearing loss.

Subjects and Methods

Subjects

We selected 23 healthy volunteers for assessing emotional hormones (aged 24~77 years, both sex) and 5 healthy volunteers (aged 40~77 years, both sex) and informed consented according to The Ethics Committee of Kanazawa Medical University Hospital.

In addition, the HSH modes were further divided into two sorts according to the dipping style, whole body hydrotherapy and foot-leg one. Each menu kept about 30 minutes and then move to the Otolaryngol Department of Him-City Branch of Kanazawa Medical University Hospital. Hearing abilities were assessed by a diagnostic audiometer (AA-75; RION, Tokyo, Japan).

Two types of hot spring hydro therapy

We sampled peripheral blood from the volunteers before and after hot hydro therapy, at the same time on each day, in consideration of circadian rhythm [30-32] of leukocyte. These subjects participated in this study after giving their informed consent. We conducted the experiment at Kamishiro Onsen Spa (Himi City, Toyama Pref., Japan) in one night of the day. The spring quality was a weak sodium chloride, ferric chloride with sodium carbohydrate of the water and the temperature was controlled by $41 \pm 1^\circ\text{C}$.

Assessment of emotional hormone

The analysis of β_2 -AR expressing cells and CD positive cells by FCM was measured by gating in the lymphocytes region on the scattered gram. Nonspecific reaction of the PE fluorescence was found in the isotype control. Therefore, the real values of the AR expressing cell counts were calculated by subtracting the control values.

The adrenaline and noradrenaline are secreted by various stress (stimulation); the former from the adrenal medulla and the latter from both the adrenal medulla and the end of sympathetic nerve. They express these functions through the adrenergic receptors (ARs) and regulate the target organ. The adrenergic receptor has two types of α and β , and there are multiple subtypes (α_1 , α_2 , β_1 , β_2 , β_3) [4]. These subtypes present the vascular (α_1), the presynaptic terminal (α_2), the heart (β_1), the bronchial muscle of the lung (β_2), fat cells (β_3), respectively. The α -receptor stimulation causes Broncho dilatation and vasodilatation, the β_1 -receptor stimulation causes an increase in heart rate and lipolysis, and the β_2 -receptor stimulation causes bronchoconstriction, vasodilatation, and muscle glycogen resolution. The adrenaline provides heart activation by effect on α - and β -receptors, and the noradrenaline provides blood pressure rises by strongly effect on α -receptors. In addition to the above, it has been reported that the ARs are present on leucocyte membranes [20,21] and that the level of expression of β -ARs in lymphocytes was examined by radio ligand (^{125}I -iodopindolol) binding, but the details of subtype of β -receptors have not been disclosed. The subtypes of the AR are able to be analyzed by flow cytometry (FCM) method. In this study, we described how hot spring hydrotherapy influences leukocyte, lymphocyte subpopulations expressing β_2 -AR and the levels of catecholamine in human peripheral blood.

Statistical analysis

The statistical comparisons between two groups (before and after hot-spring hydrotherapy) for the test of significant difference were performed using paired t-test and wilcoxon signed-ranks test. Further, the test of the correlation were performed a spearman's correlation coefficient by rank test. Results are indicated as means \pm standard error of mean (SE). A P value < 0.05 was recognized to be statistically meaningful.

Ethical considerations

This trial was designed to the principals of the Declarations of Helsinki (1975, 1983). The research protocol and volunteer sheet were written informed and consented according to the form of Ethical concept by the Kanazawa Medical University Hospital.

Results

Recovery of hearing loss by whole body HSH, foot-leg HSH

HSH was setup at the local hot spring facility where none of visitor was found without us. These subjects participated in this study after giving their informed consent.

During 4 weeks, we tried to test by whole body hydrotherapy and foot hydrotherapy in order to adjust the condition for seasonal factor etc.

Before starting the HSH, hearing ability were checked by the audio graph. A high frequency band, 2000, 4000, 8000 Hz were found to loose especially in 70 ager. After the whole body HSH, 10 - 20 db were got up their performances. Under the 70 ager, 5 - 10 db were also leveled up their performances by the HSH at 41°C for 30 minutes.

Hearing threshold changes after HSH, hearing changes in seven frequencies (125 to 8000 Hz) in air conduction threshold were studied at 4 weeks after hot spring hydrotherapy. The hearing improvement in ears that received HSH as greater in the high frequencies than in the middle and low frequencies. The rate of improvement in the high frequencies was correlated with the number of the frequencies.

Increased threshold was observed especially at 8000 Hz in ears that received whole body hydrotherapy.

This increment, however, could not find other type of hydrotherapy. Threshold at 8000 Hz was probably due to impedance changes in the ear. Threshold changes with hydrotherapy limited in 2000, 4000 and 8000 Hz. So, we conclude that threshold improvement at the high frequencies was no transient increment at low and middle Hz was observed.

Comparison to foot and leg HSH

HSH was setup at the local hot spring facility where none of visitor was found without us.

During 4 weeks, we tried to test by whole body hydrotherapy and foot hydrotherapy in order to adjust the condition for seasonal factor etc. These subjects participated in this study after giving their informed consent. The recovery of hearing loss were fade out by foot HSH compared by whole body HSH, even by the same temperature and the mode of bath room (Figure 1-5).

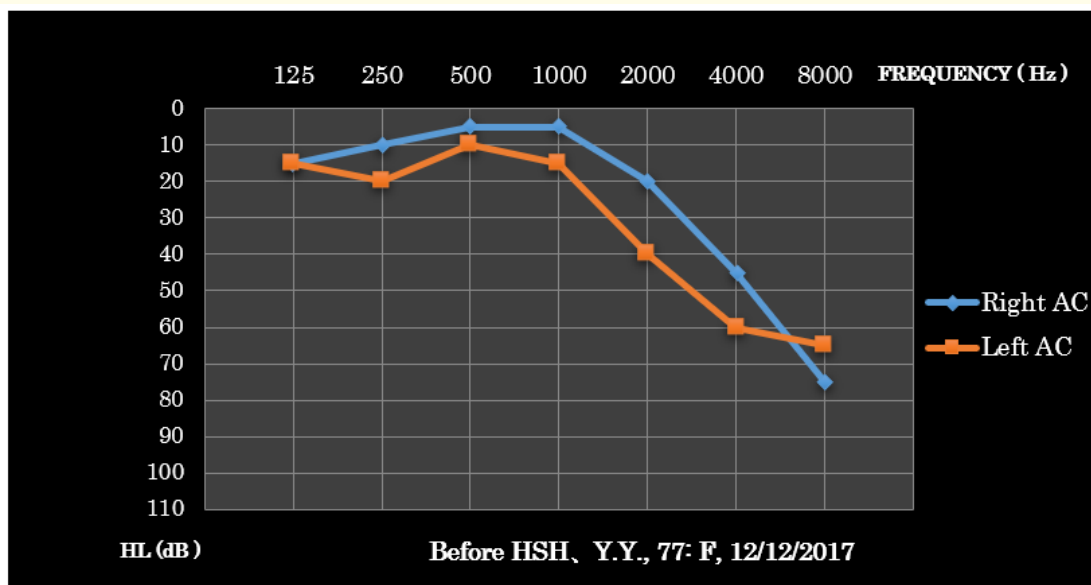


Figure 1a

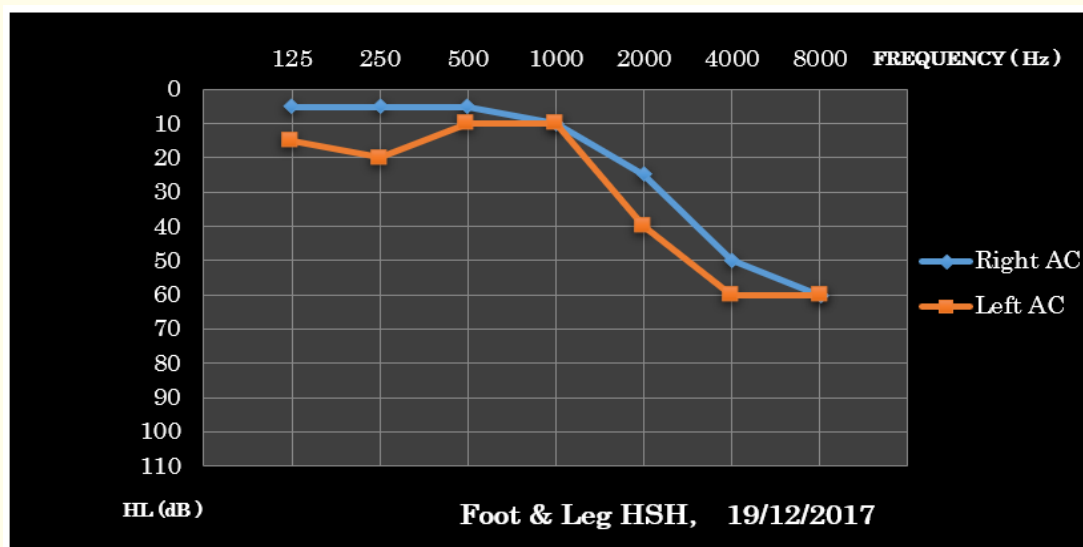


Figure 1b

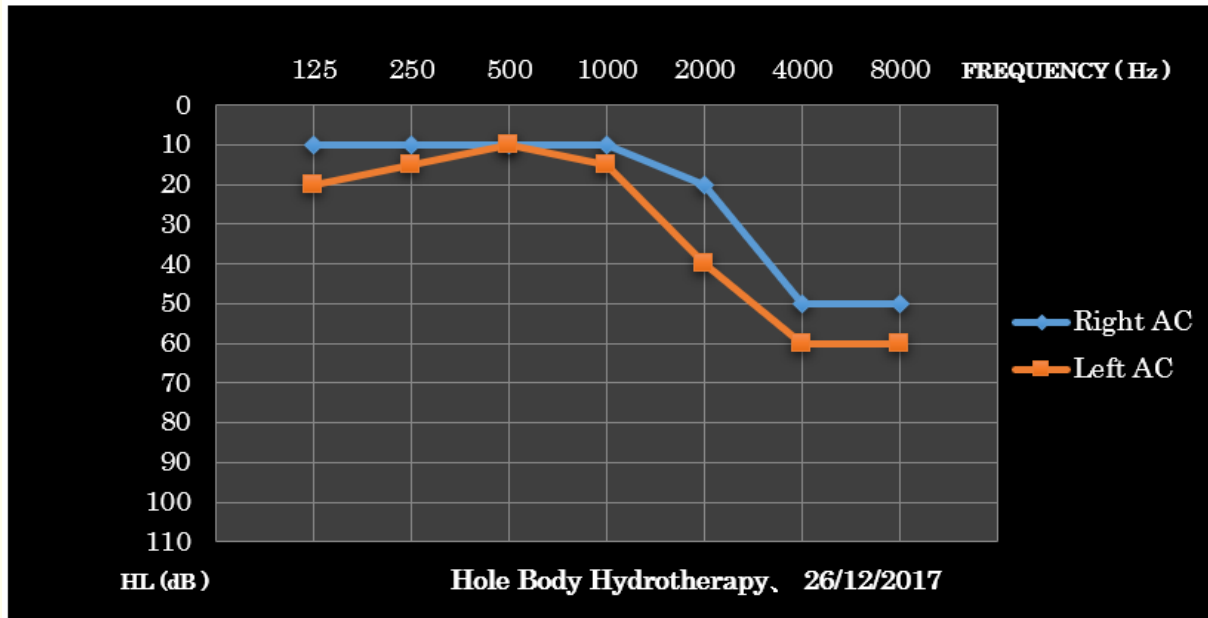


Figure 1c

Figure 1: Recovery of hearing loss in high frequency.

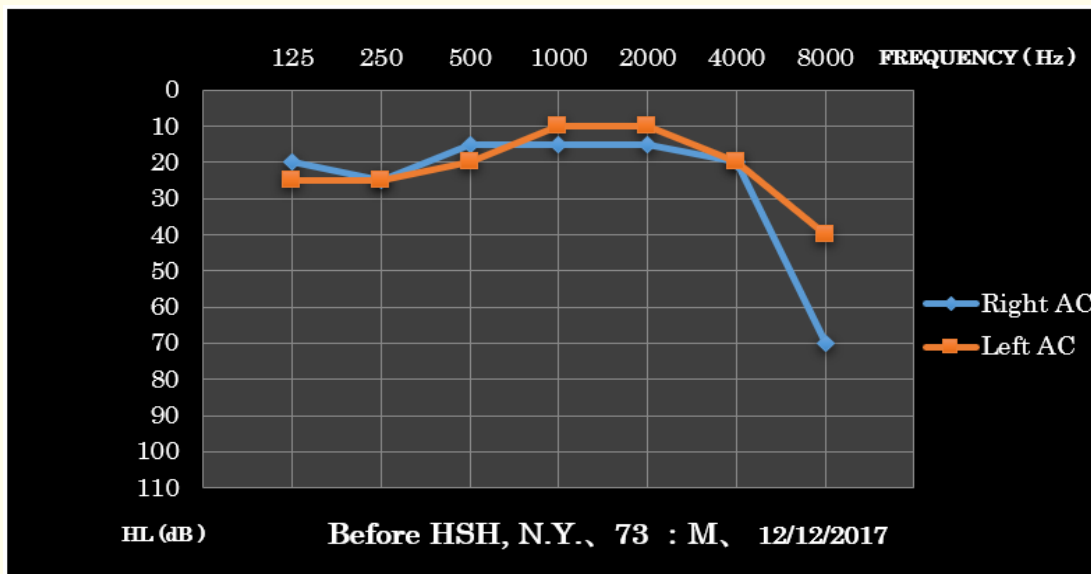


Figure 2a

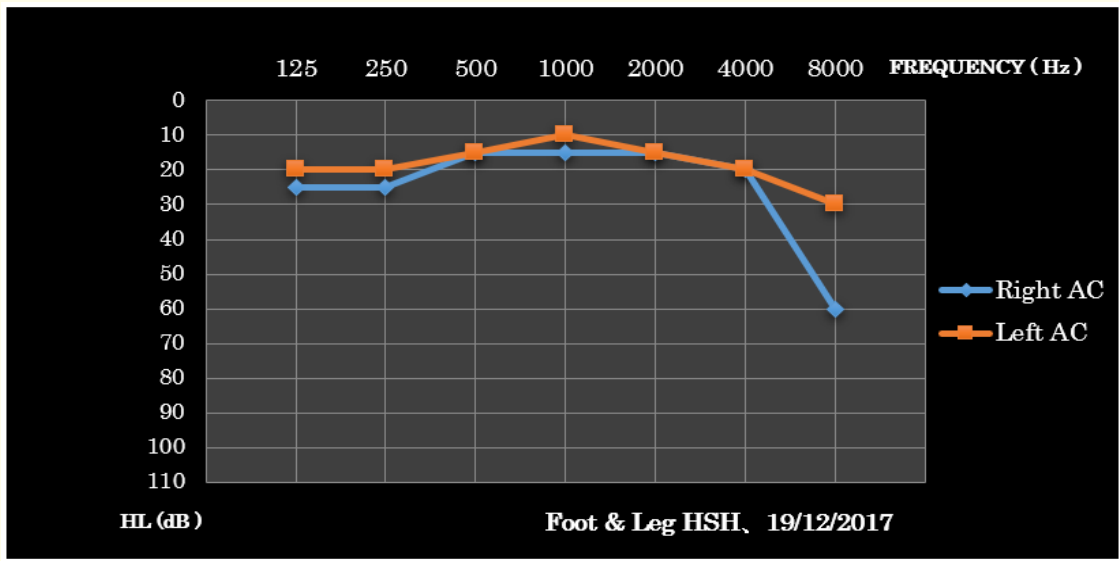


Figure 2b

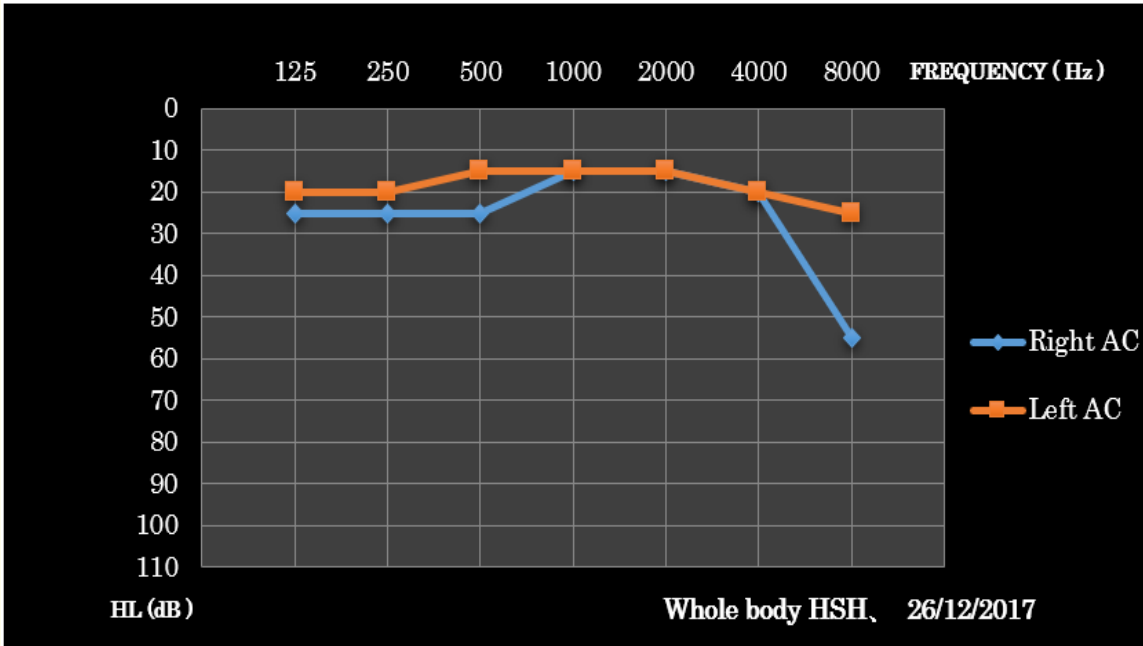


Figure 2c

Figure 2: Recovery of hearing loss in high frequency.

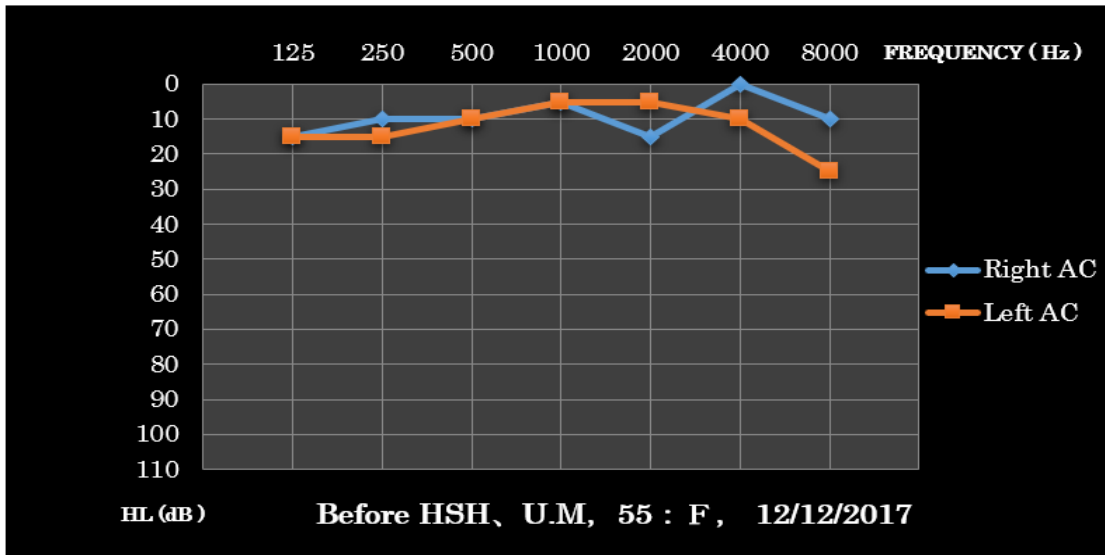


Figure 3a

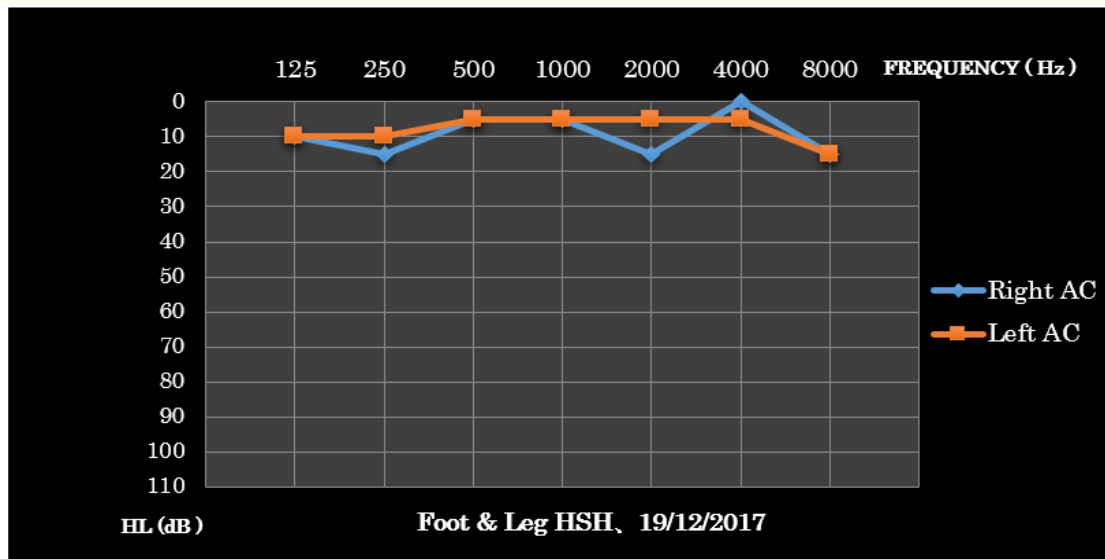


Figure 3b

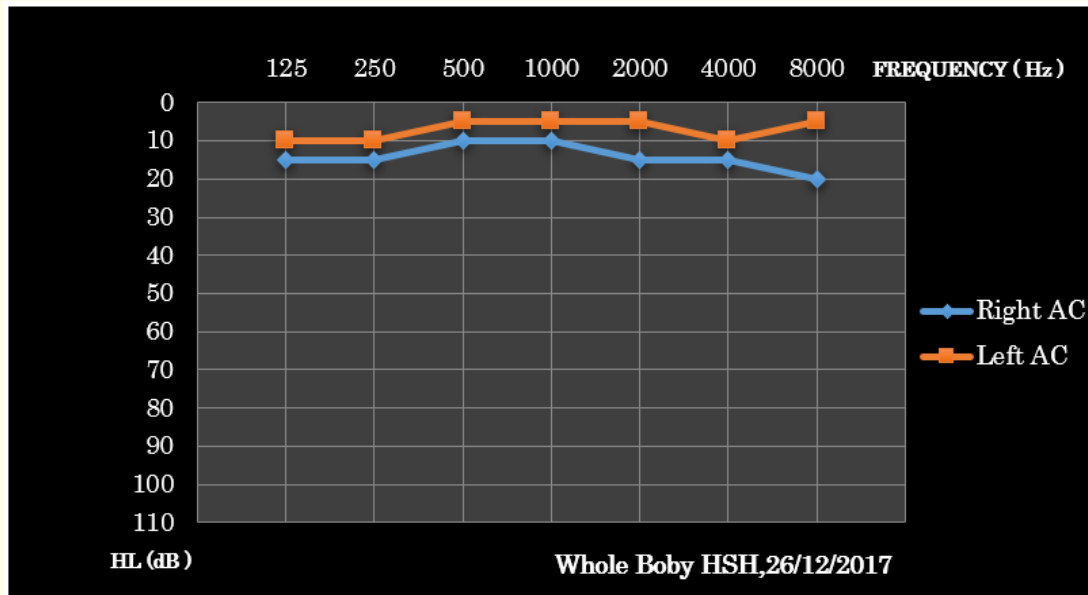


Figure 3c

Figure 3: Recovery of hearing loss in middle and high frequency.

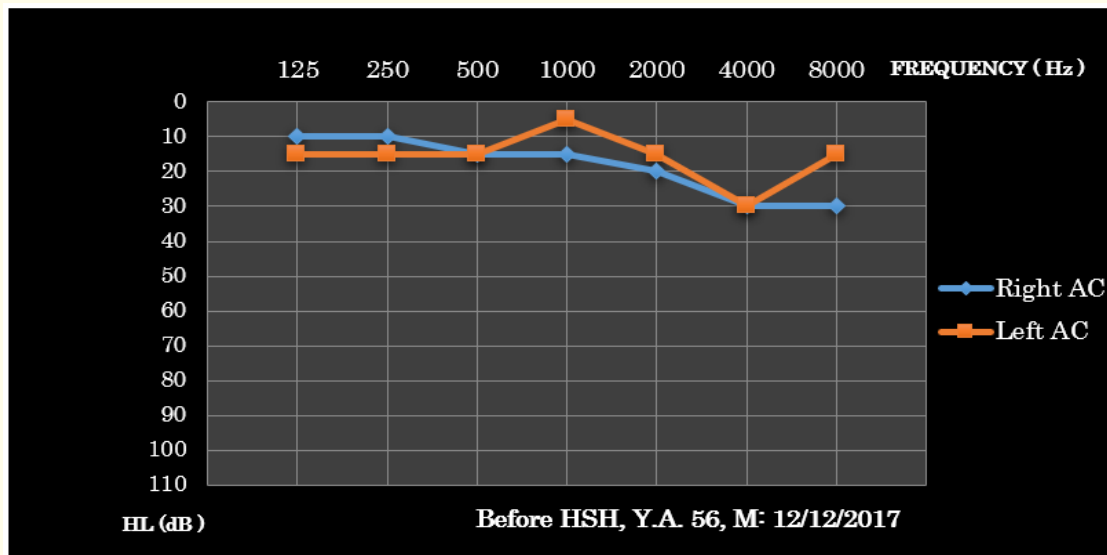


Figure 4a

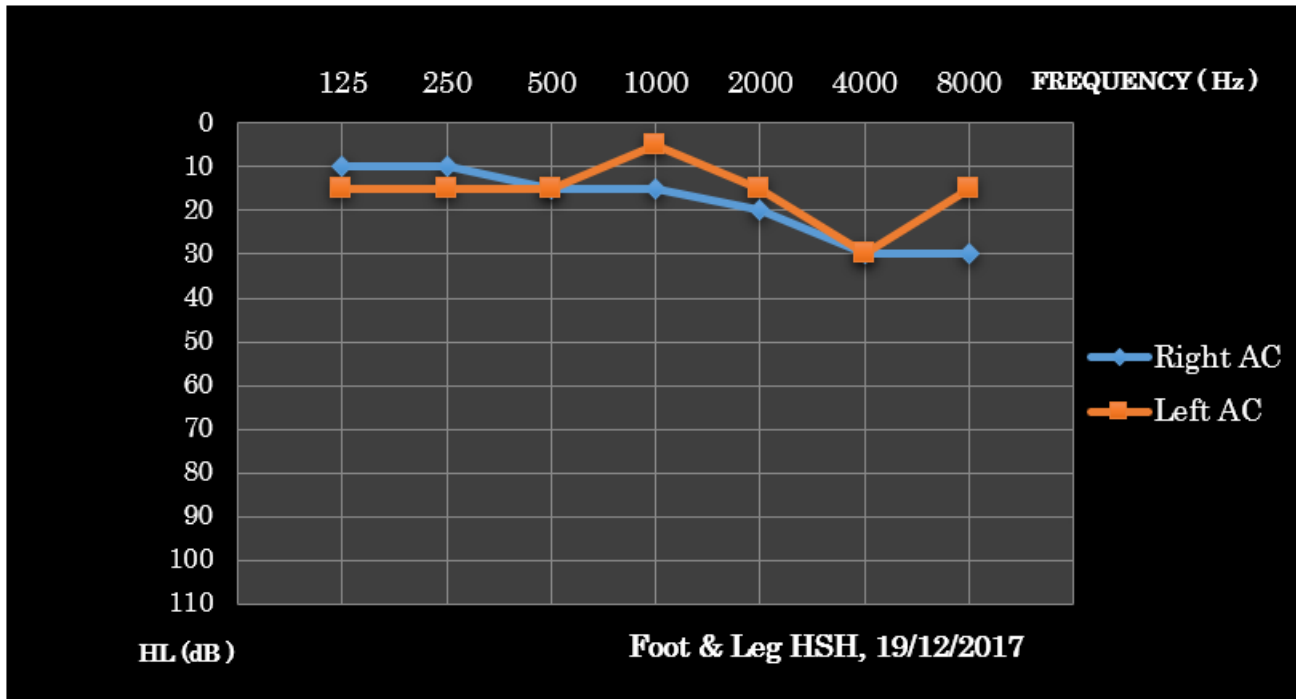


Figure 4b

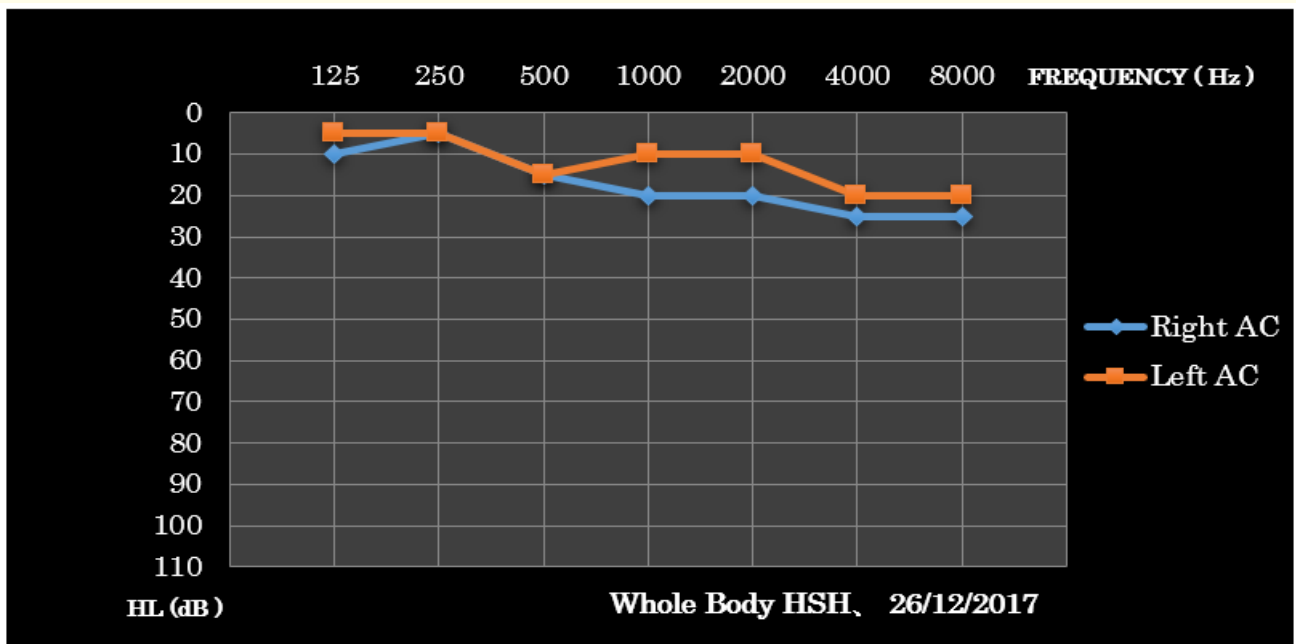


Figure 4c

Figure 4: Recovery of hearing loss in Lo and middle frequency.

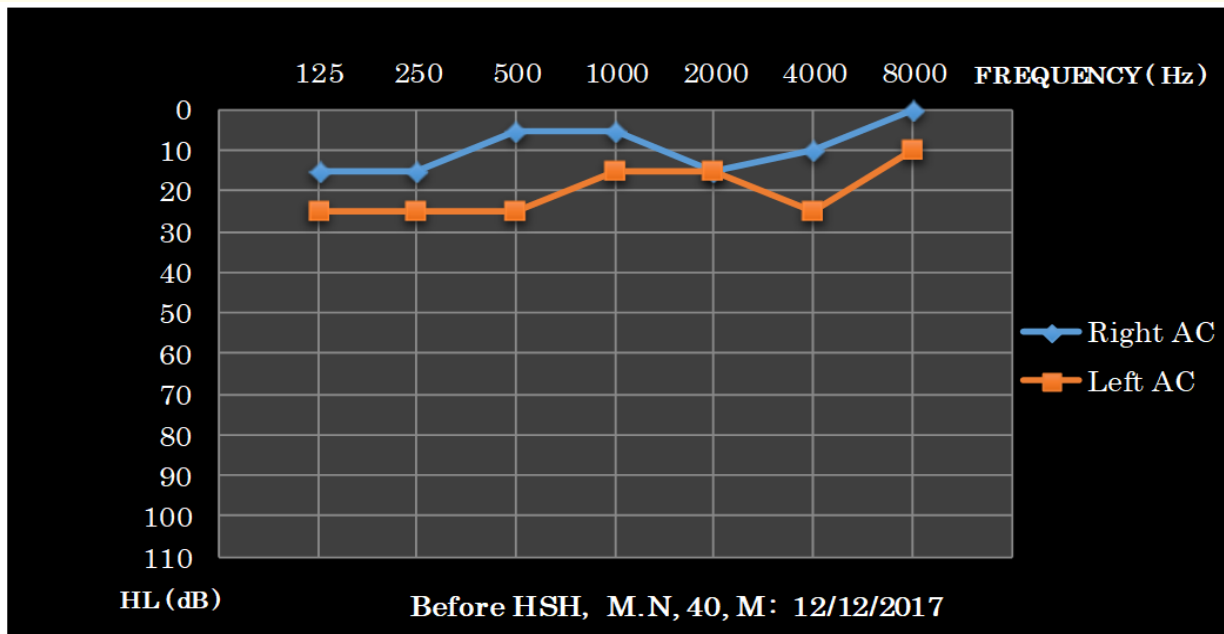


Figure 5a

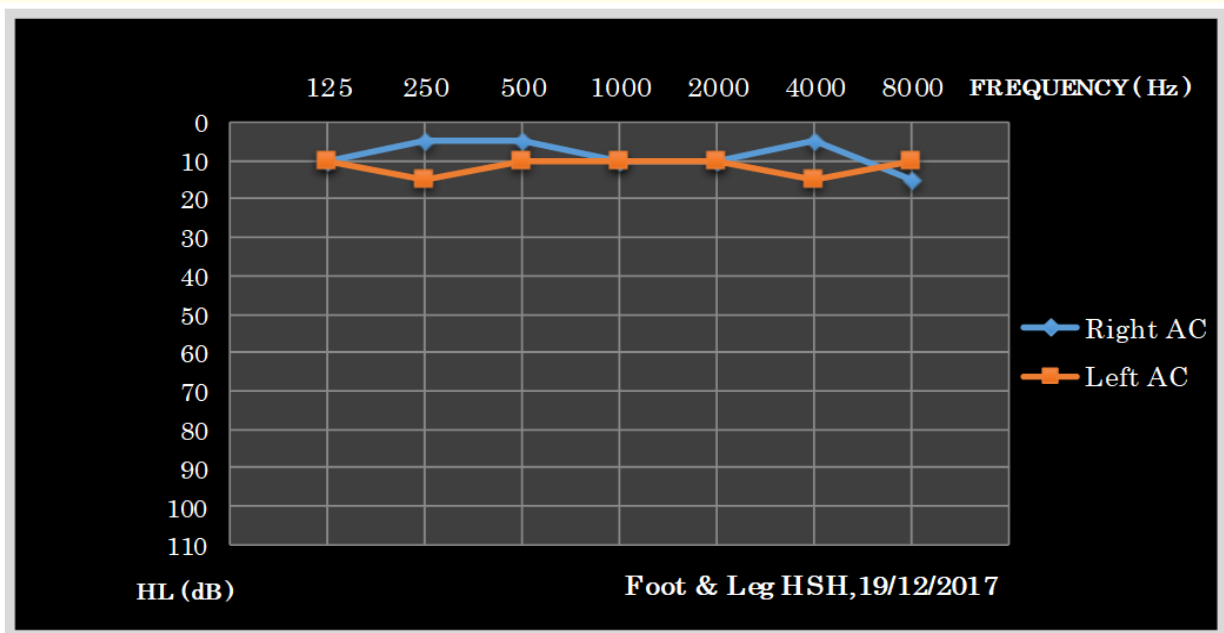


Figure 5b

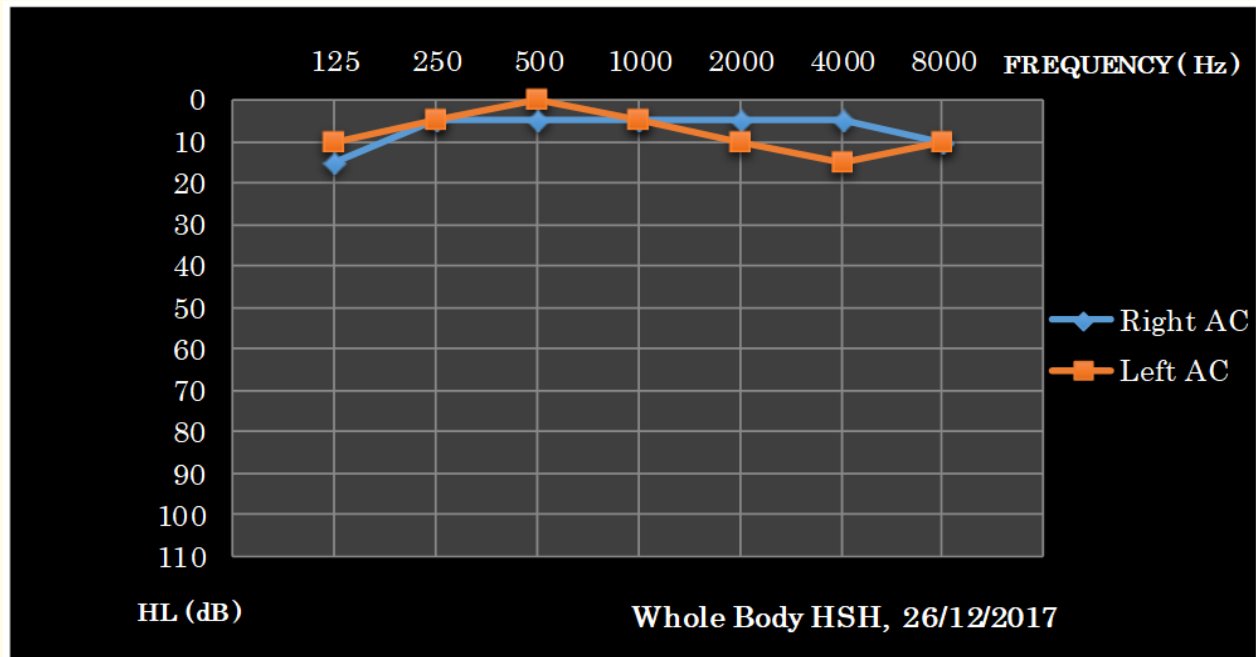


Figure 5c

Figure 5: Recovery of hearing loss in Low and middle frequency.

Emotional hormones also regulated with condition/constitution dependent manner

We had been observed the reputational effect of hydrotherapy could be evidenced within a short period. But the possibility still remain that the leukocyte change was happen to emerge for the dairy life as accidental factor, such as stress and so on. In order to avoid such possibility, then we tried to show the change of the peripheral leukocyte number was the result of another network system of the inner system such as peripheral leukocyte, endocrine and brain system. We sampled peripheral blood from the 19 volunteers before and after hot spring hydro therapy, at the same time on the next day, with the respect of circadian rhythm [30-32] of leukocyte. These subjects participated in this study after giving their informed consent. We conducted the experiment at Kamishiro Onsen Spa (Himi City, Toyama Pref., Japan) in one night of the day. The spring quality is a weak sodium chloride with sodium carbohydrate of the water temperature $41 \pm 1^\circ\text{C}$. During the night and in the morning of the next day, they had a bath in the hot spring two or three times, for 20 - 30 minutes each time. Time interval of blood sampling between before and after hot-spring hydrotherapy was approximately 24 hours. Measurements of the total and differential leukocyte counts and 3 catecholamines levels in the peripheral blood.

The adrenaline and noradrenaline are secreted by various stress (stimulation); the former from the adrenal medulla and the latter from both the adrenal medulla and the end of sympathetic nerve. They express these functions through the adrenergic receptors (ARs) and regulate the target organ. The adrenergic receptor has two types of α and β , and there are multiple subtypes (α_1 , α_2 , β_1 , β_2 , β_3) [4]. These subtypes present the vascular (α_1), the presynaptic terminal (α_2), the heart (β_1), the bronchial muscle of the lung (β_2), fat cells (β_3), respectively. The α -receptor stimulation causes bronchodilatation and vasodilatation, the β_1 -receptor stimulation causes an increase in heart rate and lipolysis, and the β_2 -receptor stimulation causes bronchoconstriction, vasodilatation, and muscle glycogen resolution. The adrenaline provides heart activation by effect on α - and β -receptors, and the noradrenaline provides blood pressure rises by strongly effect on α -receptors. In addition to the above, it has been reported that the ARs are present on leucocyte membranes [21-23] and that

the level of expression of β -ARs in lymphocytes was examined by radio-ligand (^{125}I -iodopindolol) binding, but the details of subtype of β -receptors have not been disclosed. The subtypes of the AR are able to be analyzed by flow cytometry (FCM) method. In this study, we described how hot spring hydrotherapy influences leukocyte, lymphocyte subpopulations expressing $\beta 2$ -AR and the levels of catecholamine in human peripheral blood (Figure 6 and 7).

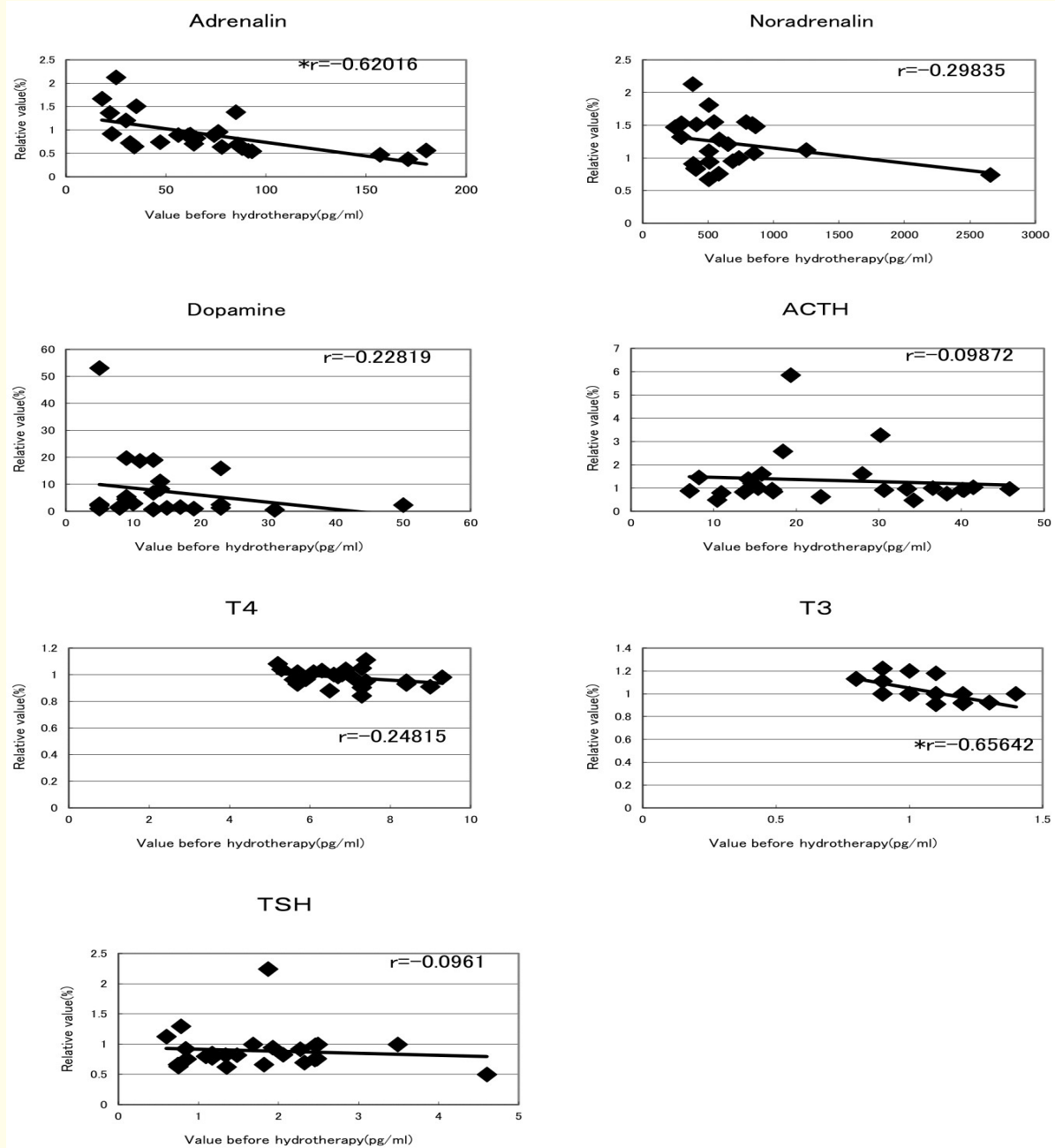


Figure 6: Emotional hormone by HSH via whole body.

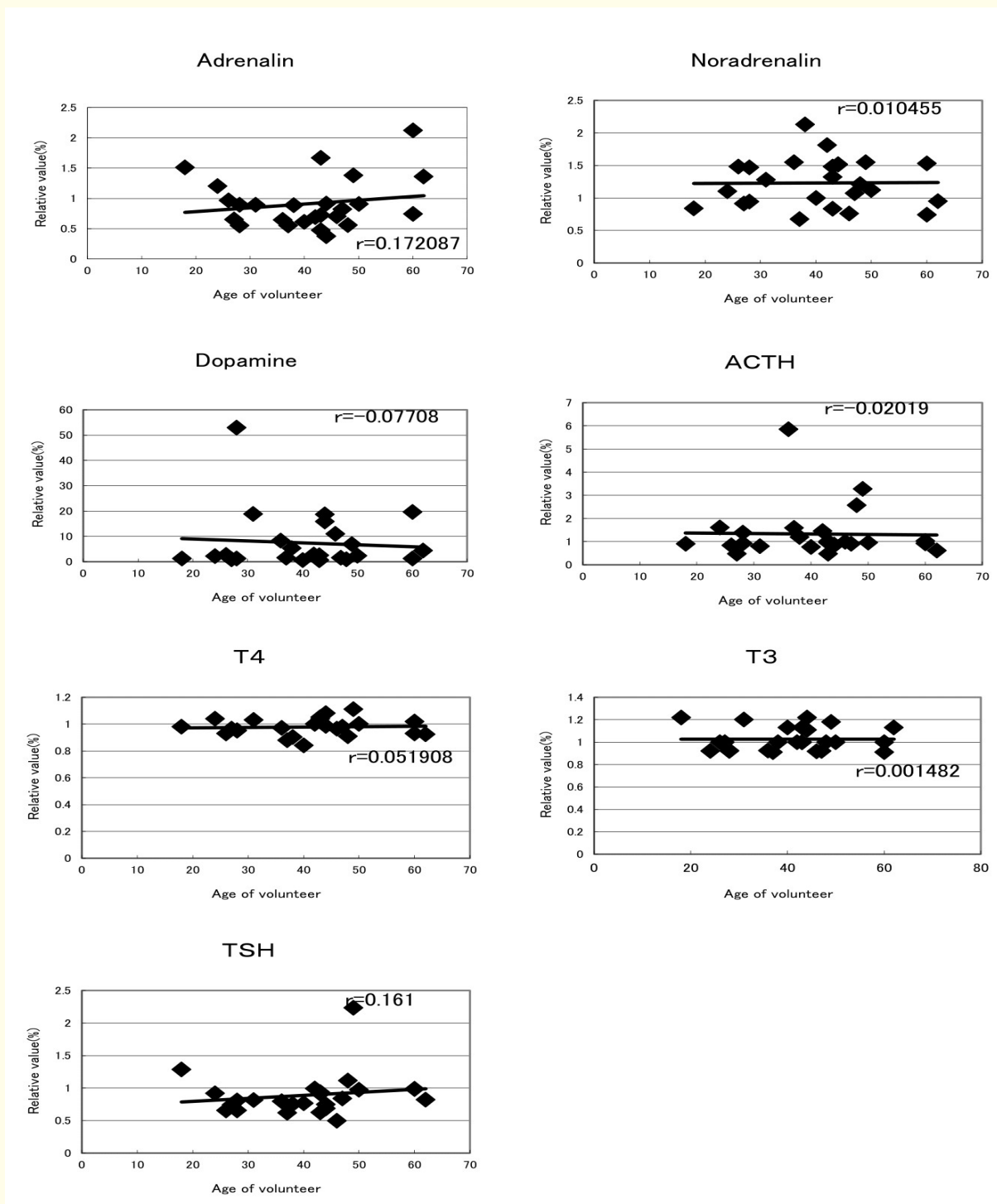


Figure 7: Emotional hormone by HSH via foot and leg hydrotherapy.

Discussion

Every creatures in the world including human expose to the risk of immunodeficiency in daily life [1-12]. The factors that influence the acquired immune activity is systemic metabolic disorder such in diabetes mellitus, malnutrition, extreme stress, senile and side effect by cellular activity in cancer cell. So we have to select daily an appropriate menu to regulate immune function through leukocyte storage. The menu had been summarized and listed as CAM: complementary and alternative Medicine. One of the major menu is TCM in western medicine world, some trying to integrate Western Medicine and Eastern Medicine. We have been trying to regulate the immune responsiveness through much mature for fragile daily condition from circumstance stress and so on. The main menu were, acupuncture, hot-spring hydrotherapy, light exercise etc. In this article, we would like to show the regulatory mechanism of the hot spring hydrotherapy. The circumstance, the balneotherapy using the effectiveness of hot-springs hydrotherapy, except for cases of contraindication, has been medically useful approved to be effective in many stress-related disorders and the improvement of dysfunction of the biological rhythm disturbance as well as chronic disease. The mechanism of effects has been reported in many studies, but many things are still unclear. Repeated stimulation may cause fatigue or regulation of nervous system [33-35]. Fatigue refers to the decrement of response with repeated stimulation. The reports showed that the cutaneous mechanoreceptors showed in excitability as a consequence of repeated mechanical stimulus by the sensitization refers to the response increment resulting from novel, moderate heat stimulation, and it is the main phenomenon in the hypothalamus system. According to HSH research, a part of volunteer reported to locations on the body, controlled by hearing ability, and they felt strong warmth or heat spreading around the stimulating site during HSH. Because the occurrence of this heat-sensitization response is often related to obvious better therapeutic effects, HSH has been widely used to treat various types of symptoms. Although the heat-sensitization response mainly depends on the selection of the sensitive for associating with pathological state, may also be a beneficial way to promote the effectiveness of hot spring hydrotherapy.

Conclusions

We have measured the number of leukocyte subsets, granulocyte and lymphocyte ratio after hot spring hydro therapy. The conclusions were as following:

- 1) Hot spring hydro therapy for a short duration proved to regulate an emotional hormones, adrenaline and dopamine also regulate in the serum level
- 2) The mode of change was constitution/condition dependent manner.
- 3) After the whole body HSH, 10 - 20 db were got up their performances in 2000, 4000 and 8000Hz.
- 4) Under the 70 ager, 5 - 10 db were also leveled up the performances.
- 5) The recovery of hearing loss was effective by whole body HSH but not b Foot-Leg one.

Conflict of Interests

No conflict of interest exists in this work.

Authors Contribution

Daisuke Sakamoto: First Author, Literature search and Editing of manuscript.

Kazuhiro Okamoto: Literature search.

Yuma Katoh: Editing of manuscript.

Nobuo Yamaguchi: Concept and design.

Bibliography

1. Kurashige S., et al. "Immune response in Sarcoma10-bearing mice". *Annual Report Gunma University* 1 (1980): 36-44.
2. Yamaguchi N., et al. "Aspect of QOL Assessment and Proposed New Scale for Evaluation". *Open Journal of Immunology* 5 (2015): 147-182.
3. Kishida K., et al. "Geranial irradiation and lymphocyte subpopulation in acute lymphatic leukemia". *Journal of Pediatrics* 92 (1978): 785-786.
4. Yamaguchi N., et al. "Maternal Bias of Immunity to Her Offspring: Possibility of an Autoimmunity Twist out from Maternal Immunity to Her Young". *Open Journal of Rheumatology and Autoimmune Diseases* 3.1 (2013): 40-55.
5. Murgita R A and Tomasi Jr T B. "Suppression of the Immune Response by alpha -Fetoprotein". *The Journal of Experimental Medicine* 141.2 (1975): 269-286.
6. Paul G., et al. "CD4+ but Not CD8+ T Cells Are Required for the Induction of Oral Tolerance". *International Immunology* 7.3 (1995): 501-504.
7. Koshimo H., et al. "Maternal Antigenic Stimulation Actively Produces Suppressor Activity in Offspring". *Developmental and Comparative Immunology* 13.1 (1989): 79-85.
8. Zoeller M. "Tolerization during Pregnancy: Impact on the Development of Antigen-Specific Help and Suppression". *European Journal of Immunology* 18.12 (1988): 1937-1943.
9. Auerback R and Clark S. "Immunological Tolerance: Transmission from Mother to Offspring". *Science* 189.4205 (1974): 811-813.
10. Shinka S., et al. "Immunological Unresponsiveness in Mice. I. Immunological Unresponsiveness Induced in Embryonic Mice by Maternal-fetal Transfer of Human-Globulin". *Biken Journal* 17.2 (1974): 59-72.
11. Aase J M., et al. "Mumps-Virus Infection in Pregnant Women and the Immunologic Response of Their Offspring". *The New England Journal of Medicine* 286.26 (1972): 1379-1382.
12. Cramer DV., et al. "Immunologic Sensitization Prior to Birth". *American Journal of Obstetrics and Gynecology* 120.3 (1974): 431-439.
13. Wang XX., et al. "Variation of Cell Populations Taking Charge of Immunity in Human Peripheral Blood Following Hot Spring Hydrotherapy Quantitative Discussion". *The Journal of Japanese Association of Physical Medicine, Balneology and Climatology* 62.3 (1999): 129-134.
14. Matsuno H., et al. "Variation of Cell Populations Taking Charge of Immunity in Human Peripheral Blood Following Hot Spring Hydrotherapy Qualitative Discussion". *The Journal of Japanese Association of Physical Medicine, Balneology and Climatology* 62.3 (1999): 135-140.
15. Yamaguchi N., et al. "Effect of Acupuncture on Leukocyte and Lymphocyte Subpopulation in Human Peripheral Blood-Quantitative discussion". *The Journal of Japanese Association of Physical Medicine, Balneology and Climatology* 65.4 (2002): 199-206.
16. Wan W., et al. "Effect of Acupuncture on Leukocyte and Lymphocyte Subpopulation in Human Peripheral Blood Qualitative discussion". *The Journal of Japanese Association of Physical Medicine, Balneology and Climatology* 65.4 (2002): 207-211.
17. Wang XX., et al. "Effect of physical exercise on leukocyte and lymphocyte subpopulations in human peripheral blood". *Cyto Research* 8 (1998): 53-61.

18. Kitada Y., *et al.* "Regulation of peripheral white blood cells in numbers and functions through hot-spring bathing during a short term - studies in control experiments". *Journal of Japanese Society Balneology Climatology Physiological Medicine* 63.3 (2000): 151-164.
19. Yamaguchi N., *et al.* "Acupuncture Regulates Leukocyte Subpopulations in Human Peripheral Blood". *Evidence-Based Complementary and Alternative Medicine* 4.4 (2007): 447-453.
20. Yamaguchi N., *et al.* "Hydrotherapy can Modulate Peripheral Leukocytes: An Approach to Alternative Medicine". *Advances in Experimental Medicine and Biology* 546 (2004): 239-251.
21. Bylund DB., *et al.* "International union of Pharmacology nomenclature of adrenoceptors". *Pharmacological Review* 46.2 (1994): 121-136.
22. Ignarro LJ and Colombo C. "Enzyme release from polymorph nuclear leukocyte lysosomes: regulation by autonomic drugs and cyclic nucleotides". *Science* 180.4091 (1973): 1181-1183.
23. Dulis BH and Wilson IB. "The β -adrenergic receptor of live human polymorph nuclear leukocytes". *Journal of Biological Chemistry* 255.3 (1980): 1043-1048.
24. Ostberg JR., *et al.* "Regulation of immune activity by mild(fever-range) whole body hyperthermia: effect on epidermal Langerhans cells". *Cell Stress Chaperones* 5.5 (2000): 458-461.
25. Huang Y H., *et al.* "Effect of in vitro hyperthermia on proliferative responses and lymphocyte activity". *Clinical Experimental Immunology* 103.1 (1996): 61-66.
26. Bicknell PG. "Sensorineural deafness following myringoplasty operations". *Journal of Laryngology and Otology* 85.9 (1987): 957-961.
27. Schwetz F. "Das Absinken der Horkurve in höheren Frequenzbereich nach Stapesplastik". *Archiv für Ohren-, Nasen- und Kehlkopfheilkunde* 179.6 (1962): 545-549.
28. Mats H., *et al.* "Balneotherapy in Dermatology". *Dermatological Therapy* 16.2 (2003): 132-140.
29. Elenkov IJ and Chrousos GP. "Stress hormones, Th1/Th2 patterns, pro/anti-inflammatory cytokines and susceptibility to disease". *Trends in Endocrinology and Metabolism* 10.9 (1999): 359-368.
30. Abo T and Kumagai K. "Studies of surface immunoglobulins on human B lymphocytes. 2. Physiological variations of Sig+ cells in peripheral blood". *Clinical Experimental Immunology* 33.3 (1978): 441-452.
31. Abo T. "Studies on the bioperiodicity of the immune response. 1. Circadian rhythms of human T, B and K cell traffic in the peripheral blood". *Journal of Immunology* 126.4 (1981): 1360-1363.
32. Suzuki S., *et al.* "Circadian rhythm of leukocytes and lymphocytes subsets and its possible correlation with the function of the autonomic nervous system". *Clinical Experimental Immunology* 110.3 (1997): 500-508.
33. Maisel AS., *et al.* "Beta-adrenergic receptors in lymphocyte subsets after exercise. Alterations in normal individuals and patients with congestive heart failure". *Circulation* 82.6 (1990): 2003-2010.
34. Sanders V M., *et al.* "Differential expression of the β 2-adrenergic receptor by Th1 and Th2 clones". *Journal of Immunology* 158.9 (1997): 4200-4210.
35. Landmann RMA., *et al.* "Changes of immune-regulatory cells induced by psychological and physical stress: relationship to plasma catecholamine". *Clinical Experimental Immunology* 58.1 (1984): 127-135.

Volume 8 Issue 4 April 2019

© All rights reserved by Daisuke Sakamoto., *et al.*