JAM
Japanese Acupuncture and Moxibustion

Original Research

Validity of the Meridian test as an effective assessment tool for evaluating the physical condition of university rugby players

Okuma Yoshihiro [1, 2, 3], Waki Hideaki[1)], Yoshida Naruto[1)], Miyazaki Shogo[1)], Hisajima Tatsuya[1)], Takahashi Hidenori[1)], Miyakawa Shumpei[2)], Mukaino Yoshito[4)]

1) Faculty of Health Care, Department of Acupuncture and Moxibustion, Teikyo Heisei University
2) Division of Sports Medicine, Graduate School of Comprehensive Human Sciences, University of Tsukuba
3) TOYOTA VERBLITZ, Rugby team
4) Faculty of Sports and Health Science, Fukuoka University

Abstract
[Objective] This study aimed to validate the efficacy of the Meridian test (M-Test) for use as an assessment tool for evaluating physical condition. In this study, factors related to conditioning were evaluated in university rugby players during a training camp.
[Materials and Methods] Ten rugby players were recruited in the study and underwent conditioning evaluation at a training camp. The following variables were assessed: secretory immunoglobulin A (sIgA) levels, the Profile of Mood States (POMS) scores, morning heart rates, $\%\Delta HR_{30}$ (the rate of decrease in heart rate for 30 s after exercise), and scores for the M-Test, which evaluates motion-induced pain and identifies the affected meridian, enabling the selection of an appropriate acupuncture point for pain reduction based on the concept of meridians. POMS scores and sIgA levels were measured twice, on the first and final days of the training camp. Morning heart rate, $\%\Delta HR_{30}$, and M-Test results were all measured each day of the training camp.
[Results] POMS fatigue scores and total M-Test scores were significantly higher and sIgA levels and $\%\Delta HR_{30}$ significantly lower on the final day relative to those on the first day, indicating a worsening in physical condition. Total M-Test scores correlated significantly with POMS fatigue scores ($r = 0.53$, $p < 0.05$), sIgA level ($r = -0.38$, $p < 0.05$), and $\%\Delta HR_{30}$ ($r = -0.27$, $p < 0.05$).
[Conclusion] The M-Test may be useful for assessing the physical condition of university rugby football players during a training camp.

Key words: *Meridian test (M-Test), secretory immunoglobulin A (sIgA), Profile of Mood States (POMS),* $\%\Delta HR_{30}$

I. Introduction

The societal importance of sports is increasing, as evidenced by the popularity of the Olympics and Paralympics, which will be held in Tokyo in 2020. Accordingly, acupuncturists who cooperate with physicians and other medical professionals in the field of sports medicine will need to ensure not only good communication skills but also the safety and efficacy of their treatments[1)]. Naturally, accurate differentiation of athletes' physical and mental conditions and the selection of suitable treatment methods are the most important issues, and there is a particular need for simple and consistent methods.

To date, numerous markers have been used to determine the physical conditions of athletes. Objective markers, such as the secretory immunoglobulin A (sIgA) level, morning heart rates, and urinary status, have been used to evaluate Japanese national team members performing in various sports[2)]. Repeated high-intensity exercise is a cause of decreased performance in competitive athletes[3)] and has been reported to increase the risk of upper respiratory tract infections (i.e., the common cold)[4,5)] consequent to a decrease in the levels of sIgA, which normally acts to prevent pathogenic microbial infections[6,7)]. The amount of sIgA secreted in

Corresponding author: Okuma Yoshihiro, Faculty of Health Care, Department of Acupuncture and Moxibustion, Teikyo Heisei University, 2-51-4 Higashiikebukuro, Toshimaku, Tokyo, 170-8445, Japan

saliva reflects the extent of accumulated fatigue from training and has therefore been used to evaluate athletes' physical conditions[8]. Heart rate has also been used to evaluate physical and athletic conditions. For instance, accumulated fatigue has been reported to elevate the morning heart rate and to reduce the rate of heart rate recovery during a 30-s period after exercise (%ΔHR_{30})[9,10]. In addition, the Profile of Mood States (POMS)[11], which evaluates psychological conditions, and the Functional Movement Screen (FMS)[12], which evaluates mobility, stability, and body interconnectivity, have received recent attention. However, these objective measurement has much that the on-site measurement is difficult by an expense, a measurement matter of time. Therefore, we focused on the Meridian test (M-Test), a marker of subjective pain and tightness that accompany body movements.

The M-Test[13,14] is based on the Eastern medical concept of meridians and comprises 30 basic motions (Figure 1) designed to determine abnormal physical movements and their related meridians. These basic motions stretch the meridians, and the resulting pain and tightness are used to determine which joints and muscles are linked to the abnormality. The M-Test can reveal an

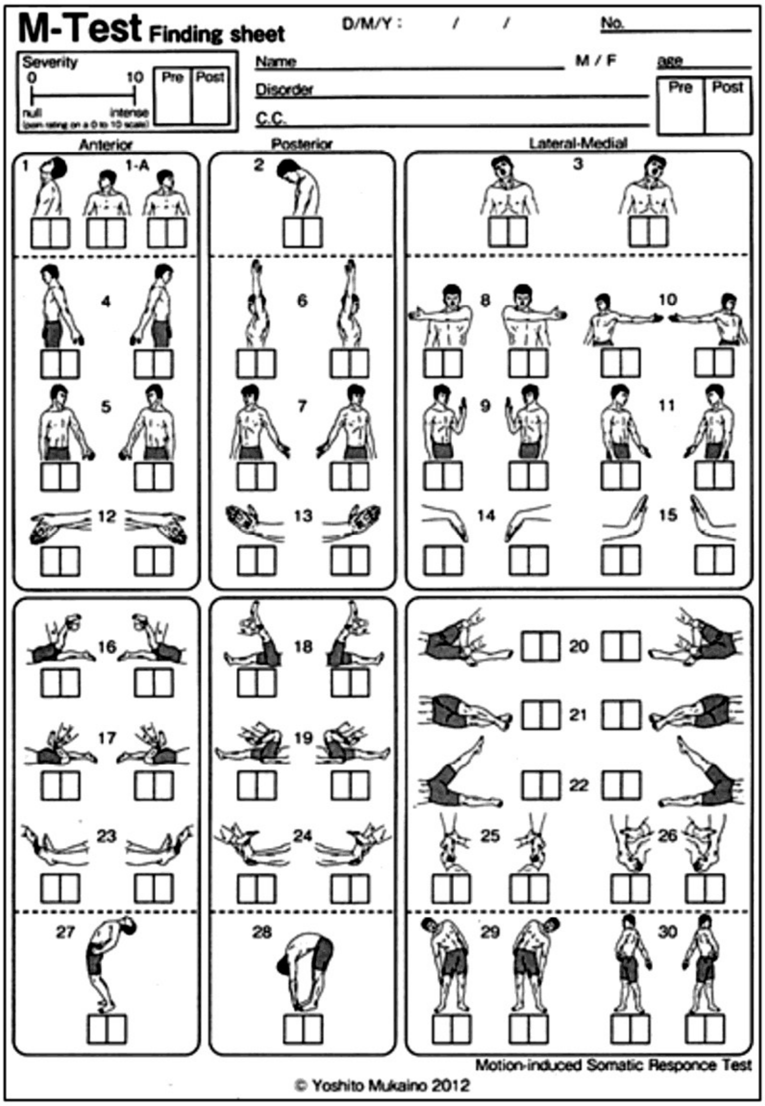

Figure 1 Meridian Test (M-Test) finding sheet

imbalance in physical motion based on the characteristics of both the individual athlete and his or her sport and can determine which meridians, acupuncture points, and therapeutic procedures should be used to improve these abnormal movements. Subsequent treatments then provide acupuncture therapy adapted to the characteristics of both the athlete and the sport and facilitate smooth physical movements. Further, because the M-Test involves movements similar to those used in regular orthopedic exams rather than complex physical motions, all motions can be performed in approximately 8 min. Accordingly, this test provides a simple and rapid evaluation of an athlete's physical condition that can be used to determine treatment plans. Several studies have reported the usefulness of the M-Test for evaluating physical condition[15-17]. Among them, we reported that The M-Test may be a useful parameter for assessing an athlete's physical condition, because it correlates significantly with the $\%\Delta HR_{30}$ and the Fatigue score of the POMS. However, few have examined its usefulness relative to the aforementioned objective markers.

Therefore, in this study, we investigated the physical conditions of university rugby players during a training camp by evaluating sIgA levels, morning heart rates, $\%\Delta HR_{30}$, POMS scores, and M-Test scores to verify the usefulness of the M-Test as a method of evaluating physical condition.

Ⅱ. Materials and Methods

1. Study design

In this study, sIgA levels, morning heart rates, $\%\Delta HR_{30}$, POMS scores, and M-Test scores were evaluated in university rugby players during a 9-day summer training camp. Changes in each measurement item throughout the camp, as well as the relationships between items, were evaluated.

2. Subjects

The subjects were 10 male university rugby players (5 forwards and 5 backs; mean age: 21.0 ± 0.7 years; mean height: 174.8 ± 6.6 cm; mean weight: 79.6 ± 9.4 kg). All athletes were free of injuries and impairments and were able to participate in practices and matches. The subjects initially received an explanation of the study and provided their informed consent to participate. This study was approved by the research ethics committee of Teikyo Heisei University.

3. Procedure

Measurements were performed during a summer training camp held August 19–27, 2014, at Sugadaira Kogen, Nagano Prefecture, Japan. For 5 days (from August 21 [day 3] to August 25 [day 7]), practice was held in the morning and a match was played in the afternoon. On all other days, practices were held in both the morning and afternoon. August 26 (day 8) was a rest day, with no practices or matches. Figure 2 shows the measurement items methods (additional details are given below).

4. sIgA

sIgA, which has been shown to decrease in response to transient or continuous high-intensity exercise, was measured twice via saliva sampling with a Salivette (Sarstedt AG, Nümbrecht, Germany) immediately after waking on day 1 (first day) and on day 9 of the camp (last day). The subjects first gargled with 100 ml of mineral water, and then chewed on sterilized cotton packaged with the Salivettes for 2 min. The collected pieces of cotton were stored at 4ºC and later centrifuged at 3,500 rpm to extract saliva, which was stored at -20ºC until analysis. An enzyme-linked immunosorbent assay (ELISA) was used to quantify sIgA levels.

day	0 (travel day)	1 (first day)	2	3	4	5	6	7	8	9 (last day)
saliva sampling		△								△
POMS	●								●	
Morning heart rate		□	□	□	□	□	□	□	□	□
$\%\Delta HR_{30}$		◆	◆	◆	◆	◆	◆	◆		◆
M-Test	*	*	*	*	*	*	*	*	*	*

Figure 2 Measurement items and methods.

5. POMS short form

The athletes' psychological conditions were evaluated twice using the POMS short form on day 0 (travel day) and on day 8 of the camp, after the evening meeting. These meetings were held after each day's practices and matches after the athletes had bathed and eaten. Six factors were evaluated to calculate the T score: tension-anxiety, depression-dejection, anger-hostility, fatigue-inertia, vigor-activity, and confusion-bewilderment[11].

6. Morning heart rate

Participants' heart rate was measured every day during the camp (day 1 [first day] to day 9 [last day]). A Polar Heart Rate Monitor RS800CX (Polar Electro Inc., Lake Success, NY, USA) was used to measure the heart rate. The subjects slept with a chest band, which was used to measure the heart rate for 1 min after waking while the subjects remained lying down.

7. $\%\Delta HR_{30}$

The $\%\Delta HR_{30}$ is the rate at which the heart rate decreases over a 30-s period after exercising for 4 min at an intensity at or below the ventilatory threshold (VT). This marker varies according to the training load on the previous day and has been reported to be a useful method for evaluating physical condition[9]. In this study, maximal oxygen uptake (VO_2max) was estimated from the time required by subjects to run 1,500 m at their actual running speed. This parameter was used to determine the 50% VO_2max intensity speed for each individual[18]. The subjects ran approximately 500 m in 4 min. Measurements were conducted on the field every day before morning practice, except on the rest day (day 8), for a total of 8 measurements. After the subjects ran for 4 min at their individual speeds, they rested while standing for 1 min. The heart rate was measured at 30s after exercise and subtracted from the heart rate measured immediately after exercise. $\%\Delta HR_{30}$ was calculated by dividing this difference by the heart rate measured immediately after exercise.

8. M-Test

The M-Test was performed 10 times (from day 0 [travel day] to day 9 [last day]) after the evening meeting. All 30 M-Test motions were performed twice as active movements. Pain and/or tightness felt during the motions were evaluated subjectively using a visual analog scale (VAS). In this study, the VAS scores for all 30 motions were totaled to yield a total M-Test score, which was used in comparisons.

9. Statistical analyses

Changes in the sIgA levels and POMS scores between day 1 or 0 of the camp, respectively, and day 9 were compared using a paired t-test or the Wilcoxon signed-rank test. A one-factor analysis of variance (ANOVA) was used to compare changes over time in the morning heart rate, $\%\Delta HR_{30}$, and M-Test scores. Multiple comparisons were conducted when significant primary effects were observed over time (measurement day) using Dunnett method to adjust the significance level. The degree of correlation between each measurement item was examined using Pearson's product-moment coefficients or Spearman's rank correlation coefficients. Accordingly, the sIgA levels measured on day 1 and on day 9 were compared with the morning heart rate and $\%\Delta HR_{30}$ data measured on the same days and the POMS and M-Test data measured the preceding evenings. POMS scores measured after dinner on day 0 (travel day) and day 8 were compared with M-Test data from those evenings and with sIgA levels, morning heart rates, and $\%\Delta HR_{30}$ data collected the following mornings. The morning heart rates and $\%\Delta HR_{30}$ data were compared with M-Test data from the preceding evening. SPSS 22.0 (SPSS, Inc., Chicago, IL, USA) was used for analysis. The significance level was set at 5%.

Ⅲ. Results

Changes in each measurement item over time

1. sIgA

sIgA levels decreased significantly on day 9 of the camp (the last day) relative to those on day 1 (first day) (Figure 3).

2. POMS

Only the POMS fatigue score increased significantly on day 8 of the camp relative to that day 0 (travel day) (Figure 4).

3. Morning heart rate

No significant changes in the morning heart rate were observed (Figure 5A).

4. $\%\Delta HR_{30}$

$\%\Delta HR_{30}$ declined as the camp proceeded. The ANOVA revealed a significant main effect of time (measurement day) ($F[3.78, 33.94] = 3.68$, $P = 0.02 < 0.05$), and therefore a multiple comparison was performed. Significant decreases relative to day 1 (first day) were observed on days 7 and 9 (last day) (Figure 5B).

5. M-Test

M-Test scores increased as the camp proceeded. ANOVA revealed a significant effect of time (measurement day) ($F[3.48, 31.23] = 17.14$, $P = 0.01 < 0.05$), and therefore a multiple comparison was performed. Significant increases in the total score relative to that on day 0 (travel day) were observed on days 2, 3, 4, 5, 6, 7, 8, and 9 (the last day) (Figure 6).

6. Degree of correlation between measurement items

The total M-Test score correlated significantly with sIgA level ($r = -0.38$, $P < 0.05$), $\%\Delta HR_{30}$ ($r = -0.27$, $P < 0.05$), and POMS fatigue score ($r = 0.53$, $P < 0.05$). Furthermore, the sIgA level correlated significantly with the $\%\Delta HR_{30}$ ($r = 0.52$, $p < 0.05$), and the POMS anger-hostility score ($r = -0.45$, $P < 0.05$). All other results are shown in Figure 7.

Ⅳ. Discussion

In this study, the sIgA level, POMS score, morning heart rate, $\%\Delta HR_{30}$, and M-Test score were evaluated in university rugby players during a training camp to investigate the usefulness of the M-Test for evaluating physical condition.

sIgA secretion, which is regulated by lymphocytes[19], has been shown to decrease in response to continuous

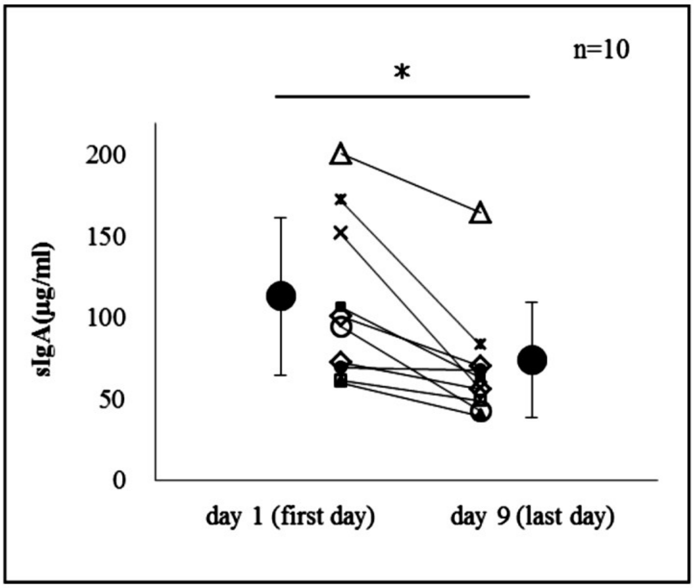

Figure 3 Changes in sIgA.

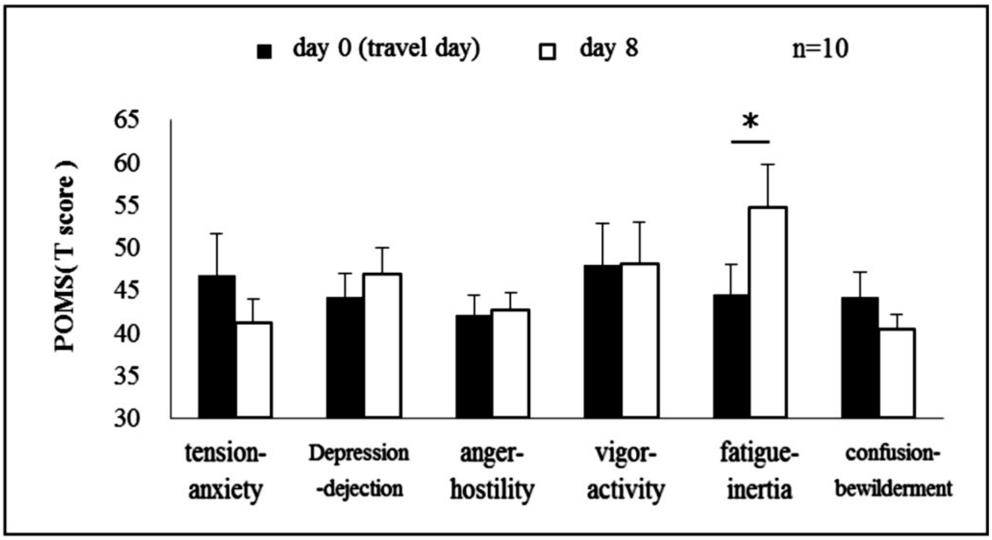

Figure 4 Changes in Profile of Mood States (POMS) scores.

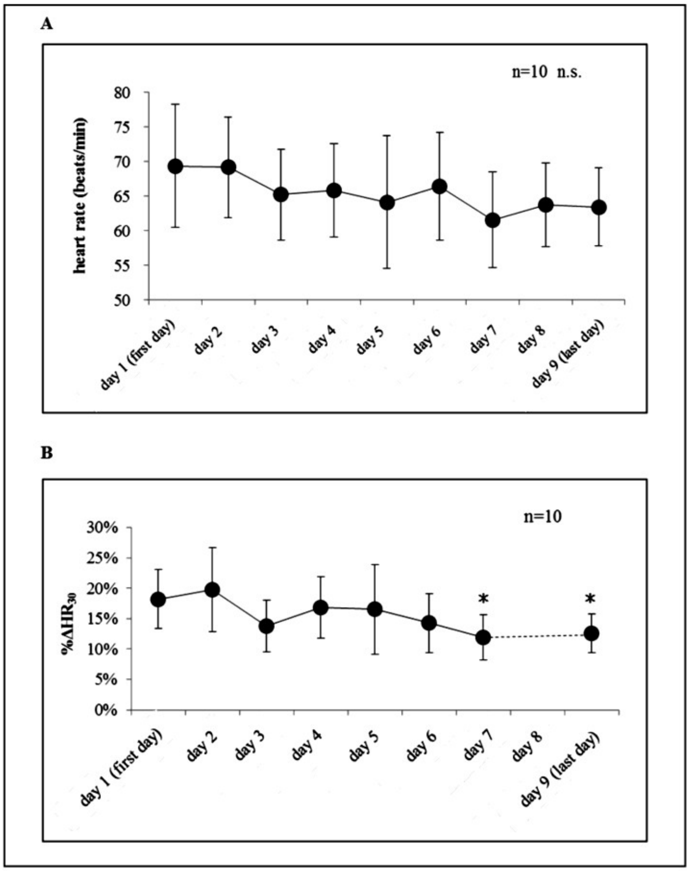

Figure 5 Changes in heart rate
Figure 5A Changes in the morning heart rate.
Figure 5B. Changes in %ΔHR30

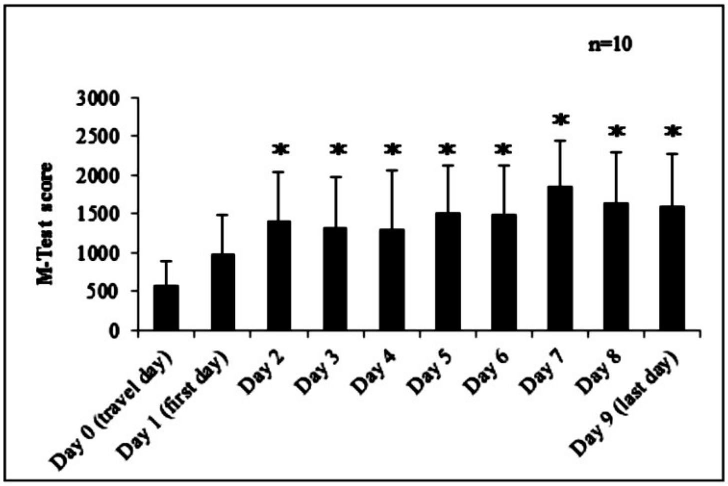

Figure 6 Changes in the total M-Test score.

	total M-Test socre	sIgA	%ΔHR$_{30}$	tension-anxiety	Depression-dejection	anger-hostility	vigor-activity	fatigue-inertia	confusion-bewilderment
total M-Test socore	1.00								
sIgA	-0.38 *	1.00							
%ΔHR$_{30}$	-0.27 *	0.52 *	1.00						
tension-anxiety	0.05	-0.16	0.24	1.00					
depression-dejection	0.36	-0.26	0.05	0.55 *	1.00				
anger-hostility	0.33	-0.45 *	0.13	0.70 *	0.75 *	1.00			
vigor-activity	0.19	-0.42	0.17	0.05	0.13	0.49	1.00		
fatigue-inertia	0.53 *	-0.10	-0.21	0.26	0.19	0.41 *	-0.26	1.00	
confusion-bewilderment	-0.02	-0.11	0.43 *	0.56 *	0.42 *	0.45 *	0.37	-0.21	1.00

Figure 7 Degree of correlation between measurement items.

high-intensity exercise. Therefore, it has been reported that sIgA level assesses immune function and accumulated fatigue[8]. Similarly, %ΔHR$_{30}$, which represents heart rate recovery post-exercise load (a decrease indicates delayed recovery), varies according to the training load and has been reported as a useful method for evaluating physical condition[9]. In this study, the objective physical condition markers sIgA and %ΔHR$_{30}$ decreased significantly from day 1 to day 9 of the camp, indicating a worsening physical condition. The POMS scores, which represent psychological condition, and the M-Test scores, which subjectively evaluate pain and tightness that accompany movement, increased and worsened, respectively, during the measurement period.

Moreover, the total M-Test score correlated significantly with sIgA level, %ΔHR$_{30}$, and POMS fatigue score. POMS reflects mental and physical fatigue. Therefore, it is thought that a value of POMS as the physical fatigue was related to a value of M-test increasing by accumulation of fatigue. In addition, it is reported that the accumulation of fatigue causes a decrease in %ΔHR$_{30}$ and the salivary sIgA [8,17]. Thus, it is guessed that correlation was shown in a value of m-test and %ΔHR$_{30}$ and the salvary sIgA. This result suggests that the M-Test, in addition to its current use as a means of determining treatment and therapy plans, could be useful for evaluating the physical condition of university rugby football players during a training camp. If, as suggested above, the M-Test is used as a marker of the physical condition of a university rugby player, frequent evaluations of changes in M-Test scores could serve as a screening method to prevent drastic deterioration in physical condition (e.g., overtraining syndrome).

We believe that the M-Test, in addition to its role in determining treatment and therapy plans, would be a useful tool for evaluating the physical condition of university rugby football players during a training camp. However, in this study, we did not verify how intervention-related fluctuations in the M-Test score affected the sIgA level, %ΔHR$_{30}$, or POMS score, nor did we examine the effect of the intervention. In a previous study[17], weekly acupuncture treatments were administered to university rugby players according to the M-Test results. After 8 treatments (2 months), smaller reductions in the players' POMS activity scores and %ΔHR$_{30}$ were observed relative to those in a control group that did not receive treatment. To investigate the usefulness of the M-Test for evaluating physical condition further, additional cases and the effects of interventions need to be examined and verified. In addition, it is necessary to perform ROC analysis to determine whether the M-Test can be used as an early screening method for identifying deterioration in the other measurement items.

Ⅴ. Conclusions

In this study, the sIgA level, POMS score, morning heart rate, %ΔHR$_{30}$, and M-Test score were evaluated in university rugby players during a training camp to investigate the usefulness of the M-Test for evaluating physical condition. The total M-Test score correlated significantly with the sIgA level, %ΔHR$_{30}$, and POMS fatigue score. This result suggests that the M-Test, in addition to its current use as a means of determining treatment and therapy plans, could be useful for evaluating the physical condition of university rugby football players during a training camp.

Conflict of interest

This study received a 2014 acupuncture and moxibustion research grant from the Foundation for Training and Licensure Examination in Anma-Massage-Acupressure, Acupuncture, and Moxibustion.

References

1) Kondo H, Ikemune S, Izumi S, Kaneko Y, Sakuraba Y, Fujimoto H et al. Introducing the Efforts of Acupuncture and Moxibustion Committee of Sports: aiming for the Tokyo 2020 Olympic and Paralympic Games and further, J Jpn Soc Acupuncture and Moxibustion. 2014; 64: 171-173, in Japanese.
2) Japan Sport Council, Annual Report of Japan Institute of Sports Sciences 2013, Tokyo, Shobi Printing, 2014, 23-24, in Japanese.
3) Pyne DB, Gleeson M. Effects of intensive exercise training on immunity in athletes, Int J Sports Med. 1998; 19: 183-191.
4) Neville VJ, Molloy J, Brooks JH, Speedy DB, Atkinson G. Epidemiology of injuries and illnesses in America's Cup yacht racing, Br J Sports Med. 2006; 40: 304-311.
5) Robinson D, Milne C. Medicine at the 2000 Sydney Olympic Games: the New Zealand health team, Br J Sports Med. 2002; 36: 229.
6) Gleeson M, McDonald WA, Pyne DB, Cripps AW, Francis JL, Fricker PA et al. Salivary IgA levels and infection risk in elite swimmers, Med Sci Sports Exerc. 1993; 31: 67-73.
7) MacKinnon LT, Jenkins DG. Decreased salivary immunoglobulins after intense interval exercise before and after training, Med Sci Sports Exerc. 1993; 25: 678-683.
8) Akimoto T, Nakahori C, Aizawa K, Kimura F, Fukubayashi T, Kono I. Acupuncture and responses of immunologic and endocrine markers during competition. Med Sci Sports Exerc. 2003; 35(8): 1296-1302.
9) Sugahara J, Hamada Y, Nabekura Y, Nishijima T, Matsuda M. The simplified evaluation of post-exercise vagal reactivation and application in athletic conditioning, Jpn J Phys Fitness Sports Med. 1999; 48: 467-476, in Japanese.
10) Sugahara J, Yukawa H, Shirai K, Saito M, Nabekura Y, Matsuda M. Usefulness of post-exercise vagal reactivation for evaluating the condition of athletes, Res Phys Ed. 2000; 45: 611-618, in Japanese.
11) Yokoyama K, POMS short form—handbook and case studies, first edition, Tokyo, Kanekoshobo, 2005, 7-9, in Japanese.
12) Bodden JG, Needham RA, Chockalingam N.The effect of an intervention program on functional movement screen test scores in mixed martial arts athletes.J Strength Cond Res. 2015; 29(1): 219-25.
13) Mukaino Y, Sports acupuncture: the meridian test and its applications, first edition, Seattle, Eastland Press, 2008.
14) Mukaino Y. Sports acupuncture and moxibustion handbook—a meridian kinematics approach using the M-Test, second edition, Tokyo, Bunkodo, 2012, in Japanese.
15) Izumi S, Miyakawa S, Miyamoto T, Kaneoka K, Hiura M. The evaluation of the condition of collegiate boxers using the Meridian Test, Jpn J Clin Sports Med. 2007; 15: 385-394, in Japanese.
16) Kozuki Foundation sports research subsidy program. Preliminary research on self-conditioning tactics for low back pain in athletes – an intervention by static stretching with the M-Test as an evaluation marker. 2009. http://www.kozuki.or.jp/ronbun/spresearch/spres06_izumi.pdf#search='MTest' (accessed January 28, 2015) , in Japanese.
17) Okuma Y, Mukaino Y. The effect of continuing acupuncture treatment based on the M-Test for collegiate rugby players, Jpn J Clin Sports Med. 2010; 18: 264-273, in Japanese.
18) Daniels J, Daniels' Running Formula, second edition. Tokyo, baseball magazine, 2012, in Japanese.
19) Neville V, Gleeson M, Folland JP. Salivary IgA as a risk factor for upper respiratory infections in elite professional athletes, Med Sci Sports Exerc. 2008; 40: 1228-1236.