Effects of low-intensity resistance KAATSU training on respiratory and circulatory dynamics in healthy young men

Hayato Ishizaka 1), Yuta Mizushima 1), Azusa Uematsu 2), Mitsuki Hirota 5), Yoshiaki Sato 4), Takashi Mizushima 5), Shigeru Toyoda 6), Toshiaki Nakajima 3,6)

Summary
[Purpose] The purpose of this study was to examine the respiratory and circulatory dynamics and subjective exercise intensity (RPE) during light-load resistance exercise with and without KAATSU and high-load resistance exercise without KAATSU, and to confirm the safety of KAATSU training.
[Method] Ten adult healthy males were included in this study. The trials consisted of 15 times x 3 sets of leg extension exercises with light-load (20% 1RM) with and without KAATSU and high-load (60% 1RM) without KAATSU. We evaluated respiratory and circulatory dynamics by using breath gas analysis and cardiac output measurement, and RPE of respiratory distress and lower limb fatigue in each trial.
[Results] The index of respiratory and circulatory dynamics was quite higher in high-load exercise than in the light-load exercise with and without KAATSU, but did not differ between with and without KAATSU in light-load resistance exercise. The RPE increased as the set progressed, and the RPE of the third set in the high-load without KAATSU was higher than in light-load resistance exercise with or without KAATSU.
[Conclusion] Light-load KAATSU training had less physical and subjective burden because the change in respiratory circulation and RPE was lower, compared with high-load resistance exercise.

Key word: KAATSU training, respiratory and circulatory dynamic, subjective exercise intensity (RPE), safety

1. Introduction
KAATSU training is that a person performs low-load exercise under the conditions with the restricted muscle blood flow, by binding the proximal part of lower or upper extremities with a specially designed cuff. So far, it has been reported that light-load KAATSU training has the same effect of muscle hypertrophy and muscle strength improvement as high-load resistance exercise without KAATSU 1). Mechanical stress, hormone production, cell swelling, active oxygen stress such as nitric oxide and heat shock protein, and increased mobilization of fast muscle fibers are considered to be involved in mechanisms that promote muscle hypertrophy and muscle strength improvement 2). Since KAATSU training can achieve strength training effects even with a light load of about 20% of the 1 repetition maximum (1RM), it is suitable for subjects who have difficulty prescribing high-load resistance training such as the elderly and patients with heart disease, and in rehabilitation patients 3, 4).

When performing KAATSU training for the elderly and patients with heart disease, the influences on hemodynamics and risks are concerned. Previous study reported that there were very few complications and no serious complications in KAATSU training for subjects including the elderly and patients with heart disease 5). In addition, it has been reported that blood pressure, heart rate, and heart rate-pressure product (RPP) increase during KAATSU training, but the changes are within the normal range 6). Based on these facts, it is considered that the influence and risk on the hemodynamics in the elderly and...
Effects of low-intensity resistance KAATSU training on respiratory and circulatory dynamics in healthy young men

Patients with heart disease are very low under the appropriate management in cases of KAATSU training. However, the respiratory and circulatory dynamics during KAATSU training have not been fully investigated. If this point is clarified, it helps risk management of KAATSU training for the elderly and patients with heart disease.

Therefore, the purpose of this study was to compare the respiratory and circulatory dynamics during light-load leg extension exercise under the conditions with or without KAATAU and high-load leg extension without KAATSU.

2. Subjects and methods

Ten healthy young males (age 29.8 ± 7.0 years old) were included in this study as shown in Table 1. The Regional Ethics Committee of Dokkyo Medical University has approved the study protocol, which was conducted according to the Declaration of Helsinki. Each subject provided written consent.

In this study, subjects' both lower limbs were pressurized by wrapping a KAATSU belt around the proximal part of the thigh and using a dedicated device (KAATSU NANO, KAATSU GLOBAL, U.S.A.). The mounting pressure of the KAATSU belt was set to 20 standard KAATSU unit (SKU), and the set pressure was 180 to 200 SKU during KAATSU training. After pressurization of the lower limbs, subjects repeated each toe joint flexion-extension and ankle joint planterflexion-dorsiflexion for 30s, then they performed leg extension in the sitting position on a machine (GX-320, OG wellness). The machine was adjusted so that the center of the knee joint of each subject coincided with the center of rotation of the mechanical lever.

The subjects measured the maximum lift weight (1RM) of the leg extension at least one day before this study. 1RM was estimated from the maximum weight of the number of times in which a subject could be lifted continuously. We defined that 20% of 1RM was light-load and 60% of 1RM was high-load for leg extension exercise. Subjects performed leg extensions 15 times x 3 sets under light-load with and without KAATSU, and high-load without KAATSU. A leg extension was performed for 2 seconds consisted with 1 second extension phase and 1 second flexion phase. Subjects performed 15 leg extensions continuously. To support subjects keep leg extension cycle constant, the experimenter repeatedly called “1, 2” in front of the subject while playing a 60 Hz click sound with the metronome, and counted the number of exercises while performing flexion and extension of the knee joint. There was a 30-second rest between each set and a 5-minute rest between each condition.

The measurement protocol is shown in Fig. 1. Prior to the start of the leg extension, the breath gas analyzer was measured for 60 seconds in a resting state. Considering the fatigue of the subjects, the exercise conditions were performed in random order (with light-load without KAATSU and light-load with KAATSU) for each subject, and finally high-load without KAATSU. We confirmed that the respiratory and circulatory dynamics before the start of 1st set of each condition were approximately similar to the resting state before the start of the experiment. The subjective exercise intensity (rate of perceived exertion...)

---

Table 1. Subjects’ characteristics

| Number | 10 cases |
|--------|----------|
| Age (years) | 29.8 ± 7.0 |
| Height (cm) | 172.5 ± 4.1 |
| Weight (kg) | 64.6 ± 16.3 |
| BMI (kg/m²) | 21.8 ± 5.5 |
| 1RM (kg) | 118.1 ± 20.4 |
| 20%1RM (kg) | 23.5 ± 4.0 |
| 60%1RM (kg) | 69.1 ± 9.6 |

Values are mean ± SD. BMI: body mass index, 1RM: 1 repetition maximum.

---

Figure 1. Measurement protocol
(RPE)) of respiratory distress and fatigue of the lower limbs immediately after the end of each set was evaluated on the Borg scale\textsuperscript{7}. At that time, to eliminate the influence of respiratory distress on the speech response, the subject indicated the RPE by pointing the Borg scale table using their finger.

Breath gas was measured using an exhaled gas analyzer (AE-100i, Minato Medical Science Co., Ltd.). The measurement items are as follows: metabolite equivalents (METs), heart rate (HR), oxygen uptake (VO\textsubscript{2}), carbon dioxide output (VCO\textsubscript{2}), oxygen pulse (VO\textsubscript{2}/HR), ventilatory equivalent for oxygen (VE/VO\textsubscript{2}), ventilatory equivalent for carbon dioxide (VE/VCO\textsubscript{2}), gas exchange ratio (R), respiratory rate (RR), ventilatory equivalent (VE), tidal volume (TV-I), expiratory tidal volume (VE-E), terminal oxygen partial pressure of end-tidal oxygen: PETO\textsubscript{2}, partial pressure of end-tidal carbon dioxide (PETCO\textsubscript{2}), end-tidal oxygen (ETO\textsubscript{2}), end-tidal oxygen concentration (end-tidal) carbon oxygen: ETCO\textsubscript{2}, and energy expenditure (EE). For each index, we evaluated the average value for 30 seconds.

Cardiac output was measured using a non-invasive impedance meter (PhysioFlow Q-Link\textsuperscript{TM}, Manatec). The measurement items are stroke volume (SV), stroke volume index (SVi), cardiac output (CO), cardiac index (CI), contractility index (CTI), ventricular ejection time (VET), early diastolic filling ratio (EDFR), left cardiac work index (LCWi), end diastolic volume (EDV), and ejection fraction (EF). Only numerical values with a signal quality of 80% or more during measurement were used for analysis.

The RPEs of respiratory distress and lower limb fatigue were compared among three sets under each condition (light-load without and with KAATSU, and high-load without KAATSU). We also compared the RPEs of only the third set between each condition. The comparison of each index by the exhaled gas analyzer and the non-invasive impedance type cardiac output meter considers that the 3rd set with increased number of exercises has the most change in respiratory and circulatory dynamics, and the delay in biological reaction due to exercise. Then, only the 3rd set of each condition was compared.

The normality of the obtained data was evaluated by the Shapiro-Wilk test. For each index of exhaled gas analysis and cardiac output, one-way ANOVA based on exercise conditions (light-load without and with KAATSU, and high-load without KAATSU) for the 3rd set of each condition was carried out. For RPE, we performed a one-way ANOVA with the set within each condition as a factor and a one-way ANOVA with the motion condition for the third set of each condition as a factor. When a significant main effect was obtained, a subtest was performed using the Friedman test in which the significance level was adjusted by the Bonferroni method. SPSS statistics Ver.27 was used for statistical analysis, and the significance level was set to 5%.

### 3. Results

Table 2 shows the results of the exhaled gas analysis of the 3rd set. Items that showed a difference between light-load without or with KAATSU and high-load without KAATSU were METs, HR, VO\textsubscript{2}, VCO\textsubscript{2}, VO\textsubscript{2}/HR, VE/VO\textsubscript{2}, R, RR, VE, VE-I, VE-E, ETO\textsubscript{2}, and EE. There was no significant difference in any of the items between light-load without KAATSU and with KAATSU.

Table 3 shows the results of cardiac output measurement in the 3rd set. There was no significant difference in any of the items between light-load without KAATSU and with KAATSU. CO, CI, and LCWi were quite higher in

### Table 2. Comparison of breath gas analysis data at the 3rd set of each condition

|                  | N-KAATSU20% | KAATSU20% | N-KAATSU60% |
|------------------|-------------|-----------|-------------|
| METs (ml/min/kg) | 2.83 ± 0.68 | 2.96 ± 0.61 | 4.86 ± 0.95* |
| HR (bpm)         | 81.9 ± 12.9 | 84.0 ± 9.7  | 110.7 ± 17.6† | 1206.8 ± 235.6‡ |
| VO\textsubscript{2} (ml/min/kg) | 685.4 ± 184.1 | 710.0 ± 154.2 | 1605.8 ± 340.7 |
| VCO\textsubscript{2} (ml/min/kg) | 658.5 ± 175.4 | 673.8 ± 145.6 | 1605.8 ± 340.7 |
| VO\textsubscript{2}/HR (ml/beat) | 8.24 ± 1.7 | 10.5 ± 1.5 | 10.51 ± 1.5 |
| VE/VO\textsubscript{2} (ml/mL) | 29.7 ± 2.5 | 30.7 ± 2.6 | 37.4 ± 6.8 |
| VE/VCO\textsubscript{2} (ml/mL) | 30.8 ± 2.8 | 32.9 ± 2.7 | 29.9 ± 7.1 |
| R                 | 0.10 ± 0.07 | 0.10 ± 0.07 | 0.10 ± 0.07 |
| RR (bpm)         | 20.0 ± 14.4 | 21.2 ± 14.5 | 34.8 ± 10.1 |
| VE (L/min)       | 20.0 ± 14.4 | 21.2 ± 14.5 | 34.8 ± 10.1 |
| TV-I (mL)        | 800 ± 130.0 | 830 ± 130.0 | 1684 ± 257.6 |
| TV-E (mL)        | 974.5 ± 146.8 | 999.8 ± 119.2 | 1674.9 ± 245.8 |
| PETCO\textsubscript{2} (Torr) | 4.5 ± 1.5 | 4.5 ± 1.5 | 4.5 ± 1.5 |
| ETO\textsubscript{2} (%) | 14.4 ± 0.3 | 14.3 ± 0.4 | 15.0 ± 0.7 |
| ETCO\textsubscript{2} (%) | 4.6 ± 0.5 | 6.3 ± 0.5 | 6.4 ± 0.6 |
| EE (KJ/d)        | 5057.6 ± 1104.6 | 19241.1 ± 5304.3 |

Values are mean±SD. Metabolic equivalents (METs), heart rate (HR), oxygen uptake (VO\textsubscript{2}), carbon dioxide output (VCO\textsubscript{2}), oxygen pulse (VO\textsubscript{2}/HR), ventilatory equivalent for oxygen (VE/VO\textsubscript{2}), ventilatory equivalent for carbon dioxide (VE/VCO\textsubscript{2}), gas exchange ratio (R), respiratory rate (RR), ventilatory equivalent (VE), tidal volume (TV-I), expiratory tidal volume (VE-E), terminal oxygen partial pressure, of end-tidal oxygen: PETO\textsubscript{2}, partial pressure of end-tidal carbon dioxide (PETCO\textsubscript{2}), end-tidal oxygen (ETO\textsubscript{2}), end-tidal oxygen concentration (end-tidal) carbon oxygen: ETCO\textsubscript{2}, and energy expenditure (EE) P<0.05, N-KAATSU20% vs. KAATSU20%*, N-KAATSU20% vs. N-KAATSU60%†, KAATSU20% VS N-KAATSU60%‡.
Effects of low-intensity resistance KAATSU training on respiratory and circulatory dynamics in healthy young men

Table 3. Comparison of the non-invasive cardiac output data at the 3rd set of each condition

| Condition | rest | N-KAATSU20% | KAATSU20% | N-KAATSU60% |
|-----------|------|-------------|-----------|-------------|
| SV (ml)   | 81.6 ± 17.2 | 87.4 ± 11.7 | 84.5 ± 16.1 | 98.0 ± 18.2 |
| Svi (ml/m²) | 44.9 ± 8.6 | 48.3 ± 6.2 | 46.5 ± 8.4 | 54.2 ± 10.2 |
| CO (L/min) | 5.4 ± 1.5 | 7.6 ± 1.8 | 8.0 ± 2.2 | 12.1 ± 2.7 |
| CI (l/min/m²) | 3.0 ± 0.7 | 4.2 ± 0.9 | 4.4 ± 1.1 | 6.7 ± 1.5 |
| CTT | 191.4 ± 80.0 | 206.2 ± 86.2 | 192.8 ± 95.9 | 239.8 ± 104.8 |
| VET (ms) | 228.8 ± 97.6 | 285.8 ± 82.7 | 272.2 ± 39.9 | 240.4 ± 61.6 |
| EDFR (%) | 50.3 ± 16.7 | 60.1 ± 25.3 | 58.3 ± 17.8 | 66.9 ± 13.2 |
| DFW (kg.m/m²) | 3.6 ± 1.2 | 5.1 ± 1.5 | 5.4 ± 1.7 | 8.0 ± 2.0 |
| EDV (ml) | 155.2 ± 57.1 | 166.6 ± 73.9 | 158.9 ± 48.7 | 168.8 ± 29.2 |
| EF (%) | 56.6 ± 13.4 | 57.7 ± 14.1 | 56.3 ± 14.9 | 59.4 ± 12.0 |

Values are mean ± SD. P<0.05 vs. 1 set vs. 2 set: *, 1 set vs. 3 set: ‡, rest vs. 1 set: §, rest vs. 2 set: †. N-KAATSU20% vs. KAATSU20%: *, N-KAATSU20% vs. N-KAATSU60%: †, KAATSU20% vs. N-KAATSU60%: ‡.

Table 4. RPE comparison between sets, and between the 3rd set of each condition

| Condition          | 1 set        | 2 set        | 3 set        |
|--------------------|--------------|--------------|--------------|
| Breathing difficulty | N-KAATSU20% | 9.4 ± 1.6    | 10.4 ± 1.1   | 11.6 ± 1.3‡ |
| KAATSU20%         | 10.9 ± 1.8   | 11.5 ± 1.5   | 12.2 ± 1.0   |
| N-KAATSU60%       | 13.9 ± 1.2   | 15.8 ± 1.4*  | 17.6 ± 1.6** |†,‡ |
| KAATSU20%         | 9.5 ± 1.7    | 11.3 ± 0.8   | 12.5 ± 1.1** |†,‡ |
| N-KAATSU60%       | 11.9 ± 1.5   | 13.0 ± 1.1*  | 13.9 ± 1.2†  |
| KAATSU20%         | 15.5 ± 1.0   | 17.6 ± 1.3*  | 18.8 ± 0.9** |†,‡ |

Values are mean ± SD. P<0.05 vs. 1 set vs. 2 set: *, 1 set vs. 3 set: ‡, KAATSU20% vs. N-KAATSU60%: †, KAATSU20% vs. N-KAATSU60%: ‡.

Discussion

In this study, to clarify the characteristics of respiratory and circulatory dynamics during light-load KAATSU training, we compared the breath gas analysis and RPE, and 2) In high-load exercise (60% 1RM), many of the indicators related to exhaled gas analysis and cardiac output were higher than those in light-load exercise with and without KAATSU.

At light-load exercise (20% 1RM), the exercise intensity was about 3 METs both with and without KAATSU, and there was no effect of KAATSU on the respiratory and circulatory dynamics. On the other hand, high-load exercise (60% 1RM) without KAATSU was about 4.9 METs, and the respiratory rate, ventilation volume, and oxygen intake increased compared with light-load exercise with and without KAATSU. Takano et al. (2005) reported that SV decreased by reducing venous return due to KAATSU. The mechanism underlying an increase in CO during KAATSU is due to an increase of HR during exercise, because CO is expressed by SV × HR. In this study, there

high-load without KAATSU than in light-load without KAATSU and with KAATSU.

Table 4 shows the RPE of respiratory distress and lower limb fatigue under each condition. A comparison of RPEs for respiratory distress showed a significant increase in the 3rd set of light-load without KAATSU, compared to the second set (P<0.05). There was no significant difference between the sets in cases of light-load with KAATSU.

In cases of high-load without KAATSU, the 2nd set was higher than the 1st set, and the 3rd set was extremely higher than the 2nd set (P<0.05, respectively). A comparison of RPE sets for lower limb fatigue showed a significant increase in the 3rd set compared to the first and second sets of light-load without KAATSU (P<0.05). The 2nd and 3rd set of light-load with KAATSU showed a significant increase compared to the 1st set. In cases of high-load without KAATSU, the 2nd and 3rd sets were larger than the 1st set (P<0.05, respectively).

Regarding the RPE of respiratory distress and lower limb fatigue, when comparing only the third set between each condition, both indexes were significantly higher in the case of high-load without KAATSU than in the case of light-load with or without KAATSU.
was no difference not only in CO but also in CI and LCWI between light-load exercise with and without KAATSU. This discrepancy seems to be due to the difference in the device used for KAATSU and the set pressure.

The respiratory quotient (R) was less than 1.0 for both the light-load without KAATSU and with KAATSU in the 3rd set. However, it was about 1.14 for high-load without KAATSU, which was near to the R of 1.15 at the maximum load of the general exercise test\(^1\). Thus, it is likely that the high-load training without KAATSU puts a high load on the respiratory and circulatory system.

Under each condition, the RPE for respiratory distress and lower limb fatigue gradually increased as the number of sets progressed. Based on this result, it is considered that even with a light load of 20% of 1RM, respiratory distress and lower limb fatigue accumulate as the number of exercises progressed. However, since there was no difference between both RPEs of light-load with and without KAATSU, KAATSU does not affect the subjective load during light-load exercise (20% 1RM) in our experimental condition.

The RPE in the 3rd set of high-load without KAATSU was close to the upper limit with respiratory distress of about 18 and lower limb fatigue of about 19. On the other hand, in the 3rd set of light-load with KAATSU, the subject felt “easy” to “slightly tight” with about RPE of 12 for respiratory distress and of 13 for lower limb fatigue. These results suggest that the light-load KAATSU training increased respiratory distress and lower limb fatigue as the number of exercises progressed, but it is considered that at least the 3rd set can be carried out without imposing a severe subjective burden on the subject.

Taken together, the present study showed that the respiratory and circulatory dynamics during the light-load KAATSU training were lower than those in the high-load training, and approximately the same to the light-load exercise without KAATSU. The subjective exercise intensity (RPE) related to respiratory distress and lower limb fatigue were lower than those in high-load exercise. A systematic review reports that light-load KAATSU training has the same or similar muscle-strengthening and muscle-hypertrophy effects as high-load training\(^1\). These suggest that the light-load KAATSU training is thought to be a training that can be expected to have muscle strengthening and muscle hypertrophy effects with less physical and subjective burden compared to high-load resistance training.

Some of the limitations of this study are described. First, although there is a delay in the biological reaction in the exhaled gas analysis, the method of this study had to measure the parameters for 30 seconds during exercise. Additionally, the numerical values obtained from the exhaled gas analysis change from moment to moment during exercise, but the analysis averaged the data during exercise. Thus, the true peak value of each index may appear after the end of exercise, so each index may be underestimated. The second is the characteristics of the subject. Although this study targeted healthy young adult males, many of the subjects who prescribe light-load KAATSU training are elderly people or patients with reduced physical fitness. Since it is assumed that elderly people and patients with heart disease have lower exercise tolerance than healthy young males, even 20% of 1RM set as a light-load used in this study may be high. Further studies are needed to examine the respiratory and circulatory dynamics and cardiac output in light-load KAATSU training for the elderly with heart disease. Finally, the set pressure for KAATSU was 180-200 SKU, but it was necessary to consider the set pressure that suits each subject.

5. Conclusion

Light-load KAATSU training had less physical and subjective burden because the change in respiratory circulation and RPE was lower, compared with high-load resistance exercise.

Acknowledgements

This study was supported in part by JSPS KAKENHI Grant Number 19H03981 (to T.N.) and 20K11166 (to A.U.), and JSPS (to H.I.)

References

1) Centner C, Lauber B (2020) A Systematic Review and Meta-Analysis on Neural Adaptations Following Blood Flow Restriction Training: What We Know and What We Don’t Know. Front Physiol 4:887.
2) Pearson SJ, Hussain SR (2013) A review on the mechanisms of blood-flow restriction training-induced muscle hypertrophy. Sports Med 45: 187-200.
3) Ogawa H, Nakajima T, Shibasaki I, Nasuno T, Kaneda H, Katayanagi S, Ishizaka H, Mizushima Y, Uematsu A, Yasuda T, Yagi H, Toyoda S, Hortobágyi T, Mizushima, Inoue T, Fukuda H (2021) Low-Intensity Resistance Training with Moderate Blood Flow Restriction Appears Safe and Increases Skeletal Muscle Strength and Size in Cardiovascular Surgery Patients: A Pilot Study. J Clin Med 10:547.
4) Ishizaka H, Uematsu A, Mizushima Y, Nozawa N, Katayanagi S, Matsumoto K, Nishikawa K, Takahashi R, Arakawa T, Sawaguchi T, Yasuda T, Yamaguchi S, Ogawa H, Shibasaki I, Toyoda S, Hortobágyi T, Fukuda H, Inoue T, Mizushima T, Nakajima T (2019) Blood Flow Restriction Increases the Neural Activation of the Knee Extensors During Very Low-Intensity Leg Extension Exercise in Cardiovascular Patients: A Pilot Study. J Clin Med 8: 1252.
5) Nakajima T, Kuroko M, Iida H, Takano H, Oonuma H, Morita T, Meguro K, Sato Y, Nagata T, TATTSU Training Group (2006) Use and safety of KAATSU training: Results of a national survey. Int. J. KAATSU Training Res 2: 5-13.
6) Neto GR, Novaes JS, Dias I, Brown A, Vianna J, Maria MS (2016) Effects of resistance training with blood flow restriction on hemodynamics: a systematic review. Clin Physiol Funct Imaging 37: 567-574.
7) Landers J (1984) Maximum based on reps. Natl. Strength Cond. Assoc 60: 60-61.
8) Stendardi L, Grazzini M, Gigliotti F, Lotti P, Scano G (2005) Dyspnea and leg effort during exercise. Respir Med 99: 933-942.
9) Takano H, Morita T, Iida H, Asada K, Kato M, Uno K, Hirase K, Matsumoto A, Takenaka K, Hirata Y, Eto F, Nagai R, Sato Y, Nakajima T (2005) Hemodynamic and hormonal responses to a short-term
low-intensity resistance exercise with the reduction of muscle blood flow. Eur J Appl Physiol 95: 65-73.

10) Mezzani A, Corrà U, Bosomini E, Giordano A, Giannuzzi P (2003) Contribution of peak respiratory exchange ratio to peak VO, prognostic reliability in patients with chronic heart failure and severely reduced exercise capacity. Am Heart J 145:1102-1107.

Authors’ affiliations
Ishizaka H, Mizushima Y. Department of Rehabilitation, Dokkyo Medical University, Tochigi, Japan
Uematsu A. Department of Sociology, Otemon Gakuin University, Osaka, Japan
Hirota M, Mizushima T. Department of Rehabilitation, Dokkyo Medical University, Tochigi, Japan
Sato Y. Center for KAATSU Research of Harvard Medical School, Massachusetts, USA
Toyoda S. Department of Cardiovascular Medicine, School of Medicine, Dokkyo Medical University, Tochigi, Japan
Nakajima T. Department of Medical KAATSU Training, Dokkyo Medical University, Tochigi, Japan