

# Key considerations when conducting KAATSU training

T. Nakajima, T. Morita, Y. Sato

*Int. J. KAATSU Training Res.* 2011; 7: 1-6

Correspondence to:  
T. Nakajima, MD: Department  
of Ischemic Circulatory  
Physiology, KAATSU Training,  
University of Tokyo, 7-3-1  
Hongo, Bunkyo-ku, Tokyo,  
Japan 113-8655  
masamasa@pb4.so-net.ne.jp

See end of article for  
authors' affiliations

KAATSU training is a novel training method conducted under special conditions of restricted muscle blood flow of the limbs with a specially-designed KAATSU belt. In 2006, we conducted a questionnaire survey across the whole of Japan to investigate the status of KAATSU training. After that, we have performed KAATSU training mainly for patients with cardiovascular diseases at a total of approximately 700 people per year, and no serious side effects of note have been found. However, it has also been applied for various purposes such as to increase the muscle strength and prevent the muscular atrophy of all kinds of patients including older people. And, in near future, it may be used to train more seriously affected patients with cachexia or sarcopenia. Therefore, in this review, we introduce the main matters reported over the five years since the questionnaire survey was conducted. In addition, we outline key considerations concerning the implementation of KAATSU training centered mainly on our previous experience and reports reached to us.

**Key words:** KAATSU training, side effects, petechial hemorrhage, contraindication, restricted muscle blood flow

## INTRODUCTION

KAATSU training refers to training conducted when pressure is applied in moderation to the base of the limbs with a specially-made belt and the muscle blood flow is restricted (Sato et al., 2007). Differing to hemostasis with a tourniquet, which completely stops the flow of blood in arteries and veins, KAATSU training is undertaken while accumulating blood (pooling) in the upper or lower limbs. A wide variety of loading methods include stretching, self-weight, walking, cycling, strength-training machine, and thera-band. It is said that over 200,000 people are currently conducting KAATSU training to improve the muscle strength of able-bodied people, sportsmen and older people, and for health maintenance purposes. There are also now hopes that it can be applied to the rehabilitation of patients with a variety of diseases (Sato et al., 2007; Nakajima et al. 2010). However, because it is a training method conducted under special circumstances, such as restricting blood flow, abundant experience and caution is believed necessary for implementation and indication. Newly-developed KAATSU devices may be launched in the near future, and to conduct safely, spread and develop KAATSU training, we will outline key considerations concerning the implementation of KAATSU training centered mainly on our previous experience and reports reached to us. However, there is a possibility that key considerations will be added or changed in the future due to the increased number of cases.

## 1) Key considerations concerning KAATSU training

The characteristics of KAATSU training are as follows. :

Point 1) Short-term and low-intensity loads

KAATSU training with high-intensity loads has little effect, but it may be rather dangerous. Needless to say, restricting blood flow for a long time should be avoided.

Point 2) Hemostasis with a tourniquet should be avoided

Point 3) KAATSU training should, in principle, be conducted by KAATSU trainers and instructors

This is believed to be one of the reasons why serious complications have been seldom occurred until now.

We conducted a questionnaire survey in 2006 across the whole of Japan to investigate the status of KAATSU training (Nakajima et al., 2006). According to responses gained from 106 facilities across Japan, KAATSU training was widely provided for people in their teens to their eighties. Main side effects include petechial hemorrhage beneath the skin, chills, numbness, and dizziness. Petechial hemorrhage beneath the skin was discovered when applying pressure, particularly to the upper limbs, at the beginning of KAATSU training. However, this disappeared as the training progressed and was not a problematic side effect. Paralysis caused by nerve compression was also not discovered.

We have conducted KAATSU training mainly for patients with cardiovascular disease at a total of approximately 700 people per year since 2007, and no serious side effects of note have been found.

However, it has been applied for various purposes such as to increase the muscle strength and prevent the muscular atrophy of all kinds of patients including older people, and it is speculated that it will be used to train more seriously affected patients with cachexia or sarcopenia in near future.

We will therefore introduce the main matters reported over the five years since the questionnaire survey was conducted.

**1) Brain hemorrhage:** there was one reported case of brain hemorrhage during KAATSU training. It is known that sudden deaths very rarely occur while playing sports. Sudden deaths have even been reported in golf, running, and gateball. While there have been no reported sudden deaths during KAATSU training to date, sufficient caution is required. As underlying diseases of sports-related sudden deaths, it is said that hypertrophic cardiomyopathy, cardiomegaly (cause unknown), coronary artery malformation, coronary artery sclerosis, aortic rupture, and brain hemorrhage are common among people aged 35 years and below, while 80% of people aged over 35 years are affected by coronary artery sclerosis and brain hemorrhage. Accordingly, the discovery of cardiocirculatory diseases is vital when giving medical checkups to sportsmen and, needless to say, blood pressure management is particularly important. Consideration must also be given to breathing methods during muscle training (exhale when applying effort).

KAATSU training uses low-intensity loads which raise blood pressure less than high-intensity loads (rise to 250-300mmHg or more with high-intensity loads). In addition, hormones (catecholamine) which cause increased heartbeat and blood pressure during exercise increase slightly during KAATSU training, compared to exercises when muscle blood flow is not restricted (Takano et al., 2005; Iida et al., 2007). Therefore, caution is required when dealing with patients with high blood pressure, heart disease, and other diseases.

**2) Petechial hemorrhage beneath the skin:** This refers to red or purple bodily spots caused by microbleeding (collapsed capillary vessels). Petechial hemorrhage beneath the skin is normally harmless and disappears within a few days. But, there were a few cases of petechial hemorrhage beneath the skin not disappearing and continuing for a while, however, they disappeared in the course. Although it may be unconnected, there were some cases of purpura, such as purpura pigmentosa chronica, when conducting KAATSU. This continued for a few months and then disappeared. They sometimes emerge as symptoms of thrombocytopenia (caused by side effects from treatment for certain types of infectious diseases),

caused by interference with platelet function and as a clotting factor defect, so careful examination by a dermatologist is recommended.

Point 4: Explain prior to KAATSU training that petechial hemorrhage beneath the skin may occur after KAATSU training, particularly of the upper limbs.

This normally disappears after a few days and does not really obstruct continuation of KAATSU training, but it is vital to explain that there are very rare cases of it becoming serious. This can be particularly problematic if not explained to young women. Specifically, cases of people visiting for beauty are a problem. Even patients taking anti-coagulant therapy are not really a problem, but if their condition is serious then training should be stopped. Patients that are administered vibration machines concurrently with medicine have not been a problem so far, but there has been one case of worsening petechial hemorrhage beneath the skin after KAATSU training.

**3) Rhabdomyolysis:** One case with a serum CPK level > 10,000 IU/L has been reported both in Japan and abroad. When feeling unwell in a hot and humid environment, repeated hard training may lead to rhabdomyolysis. In addition to the hardness of the training, patients are more susceptible when dehydrated. KAATSU training uses low-intensity loads so rhabdomyolysis is considered less likely to occur than when using high-intensity loads. Nevertheless, it is necessary to be cautious such as cancel training when the patient is sick and provide frequent fluid replacement during training. In addition, heat stroke can occur more easily as it becomes hotter, so ensure that patients are replenished with sufficient fluids and electrolytes.

**4) Cases of numbness lasting for days:** While there have been no reports of paralysis, be sure to adhere to the KAATSU training time and not take too long, and attach the KAATSU belt to the correct area.

**5) Venous thrombosis:** One case has been reported. However, appropriate application of pressure in KAATSU training does not lead to a worsening coagulation system. Rather, it induces a fibrinolytic state, which helps to restrict thrombus formation (Nakajima et al., 2007; Madarame et al., 2010). In addition, because KAATSU training is 15 to 20 minutes long, it is believed to contribute to the safety of this treatment by not restricting blood flow for a long time. But, out of 10,000 people, 1 to 3 ordinary people, 3 to 11 women in a normal pregnancy, 30 to 40 women after normal childbirth, and 100 women that give birth by Caesarean section have venous thrombosis. Therefore, while KAATSU training is

not thrombogenic unless reckless things are done, some of the subjects receiving KAATSU training have venous thrombosis from the beginning. Echocardiography is recommended for suspected cases before starting KAATSU training.

**6) Venous injury and induration:** This has continued for one to two months in women in their thirties and forties, and is sometimes accompanied by pain. After cancelling the KAATSU training and taking a wait-and-see approach, it disappeared after one to two months. When KAATSU pressure becomes strong or the appropriate pressure is not applied especially to the upper limbs, this may eventually lead to venous damage.

Pay attention to the following.

○ Repeat pressurization and depressurization, get blood vessels accustomed to this training, and apply the appropriate pressure

○ The blood vessels of people who take no exercise will not be accustomed to this training, so take care when applying high pressure

○ Adhere to the KAATSU training time.

## II) Key considerations when conducting KAATSU training

We will now provide information on basic treatment information required for general exercise therapy as it will serve as a useful reference for safety purposes when conducting KAATSU training. Basic treatment information required for general exercise therapy is shown in Table 1. Basic treatment information includes: 1) subjective symptoms; 2) previous medical history; 3) existence of lifestyle-related diseases; 4) family medical history; 5) lifestyle habits. It also includes resting electrocardiograms if possible and careful examination based on exercise tolerance tests will also be required as appropriate.

**Table 1.** Basic treatment information required for exercise therapy

Basic treatment information	Necessity of an exercise tolerance test	Other action
Subjective symptoms		
Chest pain / chest discomfort / palpitation / shortness of breath	Yes	
Dizziness / fainting / intermittent claudication	Yes	
Spondylosis symptoms / joint symptoms		Orthopedic examination and guidance
History of disorder		
Cardiovascular disease	Yes	
Orthopedic disorder		Orthopedic examination and guidance
Existence of lifestyle-related diseases		
High blood pressure	Assessed severity	
Diabetes	Assessed severity	
Hyperlipidemia	Assessed severity	
Obesity	Assessed severity	
Family medical history*		
Myocardial infarction and sudden deaths in first degree relatives	Yes	
Lifestyle habits		
Exercise / diet / smoking / alcohol		Lifestyle guidance
Resting electrocardiogram		
Myocardial infarction	Yes	
ST-T segment abnormality	Yes	
Ventricular arrhythmia	Yes	
Other important observations	Yes	

\* A family medical history of relatively young sufferers such as father or first degree male relative aged under 55 or mother or first degree female relative aged under 65 who have undergone myocardial infarction and coronary revascularization or died suddenly.

Table 1 and 2 are cited from the following papers, and changed: (1) Edited by Japanese Circulation Society et al. Guidelines for diagnosing and treating cardiovascular disease. 2000-2001 Joint Research Group Report. Guidelines for exercise therapy for cardiovascular disease (JCS 2002) (Group head: Saito) (2) Manual for prescribing exercise therapy. Journal of the Japan Medical Association, 116 (3), 1996.

**Table 2.** Indications and contraindications for exercise therapy for lifestyle-related diseases

Disease	Indication	Conditional indication	Contraindication
High blood pressure	140-159/90-94 mmHg	160-179/95-99 mmHg Men aged over 40 or women aged over 50 that are in treatment and don't have a contraindication value should undergo an exercise tolerance test if possible.	180/100 mmHg or more CTR of 55% or more visible on a chest roentgenogram Life-threatening arrhythmia or ischemic change shown by an electrocardiogram (excluding times when safety was confirmed by an exercise tolerance test) Uric protein of 100 mg/dl or hypertensive change in the fundus oculi (more than IIb)
Diabetes	Fasting blood glucose - 110 - 139 mg/dl	Fasting blood glucose - 140 - 249 mg/dl Men aged over 40 or women aged over 50 that are in treatment and don't have a contraindication value should undergo an exercise tolerance test if possible.	Fasting blood glucose – 250 mg/dl or more Urinary ketone body (+) Diabetic retinopathy (+)
Hyperlipidemia	TC : 220 - 249 mg/dl or TG : 150 - 299 mg/dl	TC: 250 mg/dl minimum or TG: 300mg/dl or more Men aged over 40 or women aged over 50 that are in treatment should undergo an exercise tolerance test if possible.	
Obesity	BMI : 24.0 - 29.9	BMI : 24.0 - 29.9 and lower limb joint damage Orthopedic examination and exercise restriction	BMI : 30 or more

TC: Total cholesterol; TG: Triglycerides; BMI: Body Mass Index (body weight (kg) / height (m)<sup>2</sup>)

Recently, KAATSU training is often used to train metabolic syndrome and obese patients. Table 2 shows indications and contraindications of normal exercise therapy for lifestyle-related diseases. At a blood pressure of 180/100 mmHg or more, exercise therapy is generally contraindication, so it would be better to give treatment at 160-179/95-99 mmHg. For cases of poorly-controlled diabetic retinopathy and extreme obesity with a BMI of 30 or greater, careful examination for the coexistence of ischemic heart disease is recommended. It is believed that such indications will serve as a useful reference when conducting KAATSU training.

Key considerations when administering KAATSU training to older people and a variety of patients are listed as follows.

- 1) Pay attention to restricted blood flow
  - Adhere to the basics of KAATSU to prevent hemostasis with a tourniquet
  - Take care not to allow overload

- Neurally-mediated syncope; refer to the paper (Sato et al., 2007) for details
  - Search for complications (heart diseases, etc.)
- 2) During training, pay attention to the following:
    - Sufficient stretching and fluid replacement
    - Patients falling
  - 3) Get an expert opinion for high-risk matters and don't provide training for unknown cases.

### III) Clinical conditions and diseases to watch out for when conducting KAATSU training

Vascular endothelial damage, stagnation of blood, and hypercoagulability are origins of pulmonary infarction and deep-vein thrombosis. KAATSU training is not a tourniquet, which completely stops the flow of blood in arteries and veins, and according to our past examinations of able-bodied people, it does not lead to an impairment of the coagulation system. Rather, it induces a fibrinolytic state, which has an antithrombotic effect (Nakajima et al., 2007;

Madarame et al., 2010). In addition, there have been no reports of pulmonary infarction. However, due to the stagnation of blood occurring during KAATSU training, pulmonary infarction and deep-vein thrombosis risk scores used by surgeons to conduct safer KAATSU training will be introduced.

Point 5: Using risk factors in determining KAATSU training indication

- 5 points History of deep-vein thrombosis (DVT); hereditary thrombotic tendency; antiphospholipid antibody syndrome
- 4 points Pregnant women
- 3 points 1) Varicose veins of legs; 2) prolonged immobility (incapable of 8 hours thromboprophylaxis rehabilitation); 3) atrial fibrillation or heart failure
- 2 points 1) People aged over 60 years old; 2) BMI > 30; 3) hyperlipidemia; 4) malignancy; 5) using lower limb tourniquet; 6) using oral contraceptives or adrenocortical steroids; 7) quadriplesia; 8) high hemoglobin level
- 1 point 1) People aged 40 to 58 years old; 2) women; 3)  $25 < \text{BMI} < 30$

The higher the number of points the greater the risk, and the higher the combined number of points for several risks the greater the risk. KAATSU training for people corresponding to 5 points (history of deep-vein thrombosis; hereditary thrombotic tendency; and antiphospholipid antibody syndrome) should be avoided. Caution is required when dealing with pregnant women, who have impairment of the coagulation system in the latter stages of pregnancy. We do not conduct training for these pregnant women in principle. While there have been no reports of KAATSU affecting varicose veins of legs, a review of this is needed in the future. Older people and bedridden patients are considered to be suitable for KAATSU training, but it is necessary to exercise care when providing KAATSU training for people that originally had thrombosis. In addition, some patients get thrombosis in the early postoperative period and extreme caution needs to be exercised for such patients.

Since KAATSU training predominately involves the restriction of blood flow, reduced stroke volume and cardiac output may be discovered depending on the extent of applied pressure (Takano et al., 2005; Iida et al., 2007). Even though KAATSU training reduces the preload and places little stress on the heart, it can encourage a lower cardiac output for patients with a significantly reduced heart pumping ability, so extreme caution is required. It is therefore necessary to carefully consider reducing KAATSU pressure or only applying it to upper limbs or one-side, as well as

liaising with doctors for such cases. In addition, it is necessary to stop loading if overload is suspected, depending on the patient's symptoms. In any case, it can only be carried out under close supervision, and even more careful examination is required in the future.

Point 6: In principle, KAATSU training should not be provided or expert advice should be obtained when dealing with hemodynamically unstable patients, especially patients suffering from cardiovascular diseases etc.

## CONCLUSION

As we move increasingly towards an aged society, it is estimated that rehabilitation for patients with low exercise capacity and various complications such as cardiovascular diseases will increase more and more. KAATSU training is expected to attract increasing attention. Accordingly, we hope that you fully understand and pay heed to the characteristics of KAATSU training, and conduct sensible and effective training.

Point 7: To conduct safe as well as effective KAATSU training

1. Confirm there are no contraindications that are identical to ordinary exercise therapy
2. KAATSU training should either not be provided or expert advice should be obtained when dealing with hemodynamically unstable patients
3. KAATSU training is a contraindication or caution should be exercised when dealing with thrombotic disease patients
4. Explain about petechial hemorrhage beneath the skin and numbness etc. when starting training
5. Training tailored to individuals' physical capacity and condition
  - Apply appropriate as well as safe and effective pressure
  - Never be too eager to gain results
  - Avoid hemostasis with a tourniquet.
6. Build a relationship of trust with patients
7. There is a possibility that presyncope and fainting will occur, but pay attention to prodromal symptoms and take preventive measures such as fluid intake.
8. Older people, bedridden patients and postoperative patients often have venous thrombosis prior to the training so exercise caution.
9. Ensure blood pressure is ( $< 160 / > 95$  mm Hg)
10. Implement safety measures such as AED
11. Avoid conducting KAATSU training over a long time. Upper limbs: 10-15 minutes; Lower limbs: 15-20 minutes
12. In principle, never conduct training when the patient is sick. Never continue performing

KAATSU training, when a guest or patient feels bad during the training.

13. When unsure about a patient's medical condition, consult a specialist or go straight to a medical institution if you need to seek other medical help

.....

#### References

**Iida H**, Kurano M, Takano H, Kubota N, Morita T, Meguro K, Sato Y, Abe T, Yamazaki Y, Uno K, Takenaka K, Hirose K, Nakajima T (2007) Hemodynamic and neurohumoral responses to the restriction of femoral blood flow by KAATSU in healthy subjects. *Eur J Appl Physiol* **100**: 275-285.

**Nakajima T** (2010) KAATSU training and thickening of the muscle. In: Kozuki M et al. (Eds.) *Latest Rehabilitation Medicine for Rehabilitation Physicians and Healthcare Professionals* (in Japanese), Advanced Medical Series 40, Advanced Medical Technology Institute, Japan, pp 292-297.

**Nakajima T**, Kurano M, Iida H, Takano H, Oonuma H, Morita T, Meguro K, Sato Y, Nagata T, Kaatsu Training Group (2006) Use and safety of KAATSU training: Results of a national survey. *Int J KAATSU*

*Training Res* **2**: 5-14.

**Nakajima T**, Takano H, Kurano M, Iida H, Kubota N, Yasuda T, Kato M, Meguro K, Sato Y, Yamazaki Y, Kawashima S, Ohshima H, Tachibana S, Nagata T, Ishii N, Morita T (2007) Effects of KAATSU training on haemostasis in healthy subjects. *Int J KAATSU Training Res* **3**: 11-21.

**Madarame H**, Kurano M, Takano H, Iida H, Sato Y, Ohshima H, Abe T, Ishii N, Morita T, Nakajima T (2010) Effects of low-intensity resistance exercise with blood flow restriction on coagulation system in healthy subjects. *Clinical Physiology and Functional Imaging* **30**: 210-213.

**Takano H**, Morita T, Iida H, Asada KI, Kato M, Uno K, Hirose 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.

**Sato Y**, Ishii, N, Nakajima, T, Abe T (2007) *The theory and practice of KAATSU training*, Kodansha.

#### Authors' affiliations

**T. Nakajima, T. Morita**, Department of Ischemic Circulatory Physiology, KAATSU Training, University of Tokyo, Tokyo, Japan

**Y. Sato**, KAATSU International University, Sri Lanka