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ORIGINAL ARTICLE

Variability in compression pressure of multi-layer bandaging applied by lymphedema therapists

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Abstract

Background The success in multi-layer bandaging (MLB) relies on the technique of the therapists. The purpose of this study was to elucidate the compression pressure of MLB by lymphedema therapists.

Methods We investigated the pressure of MLB applied by 48 lymphedema therapists. The average age was 43.5 (range 23–66) years old. Seventeen (35.4%) of the therapists had the clinical experience of MLB. We prepared ordinary compression materials and asked them to apply MLB to the whole lower limb of healthy volunteers, presuming moderate lymphedema. We attached the probe of Picopress at the Achilles tendon-muscle junction and measured the pressure three times: phase 1, resting condition; phase 2, after ankle exercise; and phase 3, after knee bend.

Results The average pressure in phases 1–3 was 51.9, 48.9, and 45.5 mmHg, respectively. Only 13 (27.1%) of the therapists achieved 50–59 mmHg which is suitable for lymphedema treatment and the pressure varied by the training courses. The pressure decreased as the blank period got longer after finishing training courses ($R = -0.39$).

Conclusions The pressure of MLB varied in different therapists and different training courses. This fact indicated the necessity of uniform curriculum in training courses including measurement of the bandaging pressure.

Keywords Lymphedema · Complete decongestive therapy · CDT · Bandaging · Pressure · Multi-layer bandaging

Introduction

The standard treatment for lymphedema is a conservative treatment called complete decongestive therapy (CDT). CDT includes compression therapy, manual lymph drainage, skin care, and physical exercise under compression [1, 2]. Compression therapy is reported to reduce the volume of lymphedematous limbs [3, 4]. Compression increases the interstitial pressure and decreases filtration from the capillaries into the interstitium [5, 6]. It is mainly performed using compression garments or bandaging. Multi-layer bandaging using short-stretch bandage is effective in reducing the volume of the swelling limbs [7].

There are many kinds of materials which are used for multi-layer bandaging, and applying bandage at the proper pressure is difficult. The pressure varies from patient to patient or from therapist to therapist. The consensus document of International Society of Lymphology published in 2013 recommends the highest compression level up to 60 mmHg tolerated by the patient is likely to achieve good result [2]. Protz et al. reported that only 9.3% of the therapists successfully achieved the pressure of 50–60 mmHg in the investigation for 891 healthcare providers who had finished seminar on compression therapy [3]. The success in bandaging relies on the technique of the therapists, while failure in bandaging damage the quality of life of the patients [8, 9]. Besides, once the bandaging treatment fails, patients will not want to restart the next compression therapy.

In the current study, we investigated the pressure of the multi-layer bandaging applied by the lymphedema therapists, and analyzed the distribution of the pressures. The information from this study would be a help for lymphedema therapist

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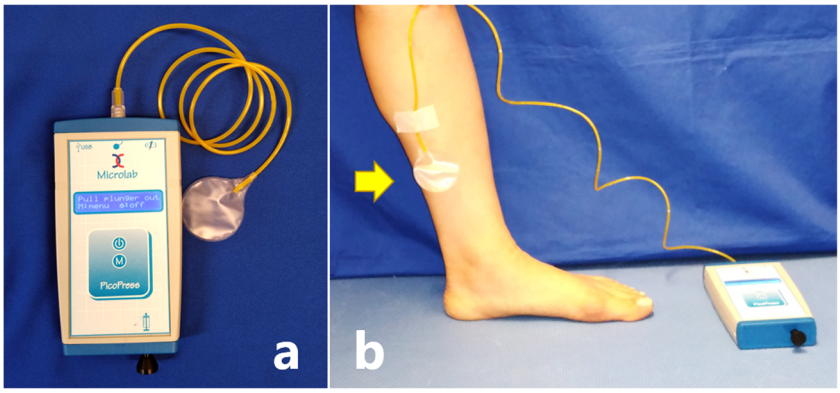

Fig. 1 **a** Picopress (Microlab Elettronica SAS, Padua, Italy) to measure the bandaging pressure. It has a balloon at the end of the probe. **b** We attached the probe of Picopress at the Achilles tendon-muscle junction of the lower leg of either healthy volunteer (arrow). Measurement was performed at the long sitting position

to adjust their compression pressure in multi-layer bandaging or to establish a training program for lymphedema therapists. The purpose of this study was to elucidate the distribution of the compression pressure of multi-layer bandaging by lymphedema therapists.

Patients and methods

We investigated the compression pressure of multi-layer bandaging applied by lymphedema therapists who had passed through the training courses A-F which met the requirement of "Instructional procedures for professional lymphedema training" in Japan. The requirement includes 33 h of classroom lectures and 67 h of practical training. Training course A and B are courses based on Földi method. Training course is based on Vodder method. Training course D is Földi college in Germany. Training course E and F are held in aromatherapy school and lymphedema clinic. We asked lymphedema therapists who attended brush-up seminars for lymphedema treatment to join this study and 48 therapists who agreed with it were included in this study. The MLB procedures were performed in the seminar room. Forty-four were female and the other 4 were male. The average age was 43.5 (range, 23–66) years old. Twenty-two (45.8%) were licensed masseurs, 22 (45.8%) were nurses, 2 (4.2%) were judo therapists, and 2 (4.2%) were physiotherapist. Seventeen (35.4%) of the therapists had the clinical experience of multi-layer bandaging after finishing the training courses, while the other 31 (64.6%) did not.

The therapists were asked to apply multi-layer bandaging to the whole lower limb of a healthy volunteer, presuming lymphedema of stage 2a in the classification of International Society of Lymphology. Three healthy volunteers joined this study. They were a 46-year-old male, a 46-year-old female, and a 45-year-old female. None of them had a history of venous or lymphatic disorder in the lower limbs. We measured the pressure of the bandaging and compared the results with the therapists' age, years of experience, or graduated training course.

We prepared the compression material as below: short-stretch bandage (Rosidal K, 6 cm, 8 cm, 10 cm, and 12 cm, Lohmann & Rauscher GmbH & Co. KG), roll sponge (Rosidal soft, 12 cm, Lohmann & Rauscher GmbH & Co.KG), padding bandage (Orthowrap, 15 cm; Alcare Co., Ltd.), tubular stockinette (tg, 8.5 cm, Lohmann & Rauscher GmbH & Co.KG), and elastic conforming bandage (Mollelast, 6 cm, Lohmann & Rauscher GmbH & Co.KG). Therapists could choose whatever they like and performed bandaging as they usually do. In Japan, there are several schools to teach conservative treatment for lymphedema and the procedure of bandaging is somewhat different among them. In most cases, they first applied elastic conforming bandage to the toes. Then, they applied tubular stockinette as the first layer, padding bandage as the second layer, and short-stretch bandages as the third layer.

We used Picopress (Microlab Elettronica SAS, Padua, Italy) to measure the pressure (Fig. 1a). It has a balloon at the end of the probe. After attaching it at the proper site, measurers applied bandage. Picopress was activated by inflating the balloon. It has already reported to be used in measurement of compression pressure with a high accuracy [10, 11].

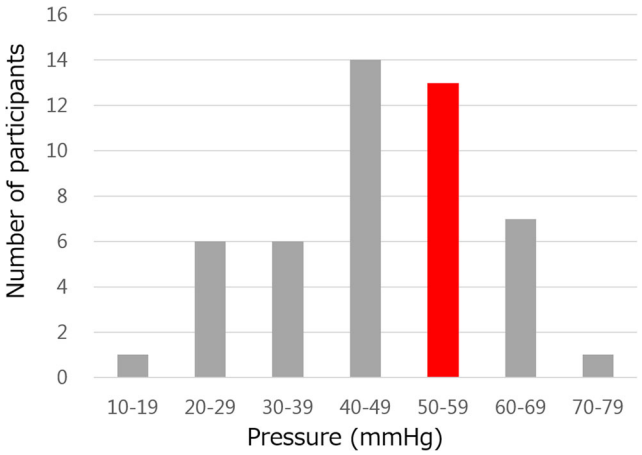

Fig. 2 The distribution of the pressure at phase 3, after 10 times of knee bend. Only 13 (27.1%) of the therapists achieved 50–59 mmHg which is suitable for lymphedema treatment. Pressure was not enough in 27 (56.2%) therapists

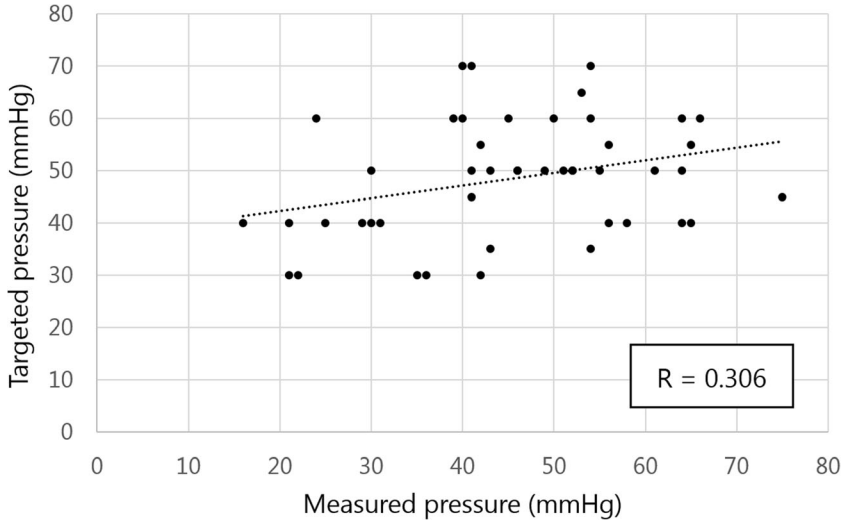

Fig. 3 We compared the targeted pressure which the therapists declared and the measured pressure in 46 therapists who declare their target pressure. The number of the therapists who achieved a pressure within 5 mmHg from the targeted pressure in phase 3 was 11 (23.9%), and that within 10 mmHg was 23 (50.0%). Fourteen therapists (30.4%) applied bandages with the pressure which was less than targeted pressure by more than 10 mmHg. On the contrary, 9 therapists (19.6%) applied bandages with the pressure which was more than targeted pressure by more than 10 mmHg

We attached the probe at the Achilles tendon-muscle junction of the lower leg of either healthy volunteer (Fig. 1b). After the therapists applied multi-layer bandaging to them, we measured the pressure three times: phase 1, under resting condition soon after applying bandaging; phase 2, after 10 times of dorsal and plantarflexion of the ankle; and phase 3, after 10 times of knee bend. Each measurement was performed at the long sitting position.

Also, we conducted an interview to the therapists to ask whether they had considered of a target pressure when they apply multi-layer bandaging. And if they have, we asked them how much the pressure was.

We performed Student's *t* test to evaluate the pressure difference between sex of the therapists, the job category, and training course using excel. We also calculated Pearson's correlation coefficient and *p* value to evaluate the correlation between the pressure and the age of the therapists. Significance level was set at 0.05.

This study was approved by the ethical committee in Kuretake College Of Medical Arts & Sciences (approval number: 17-005).

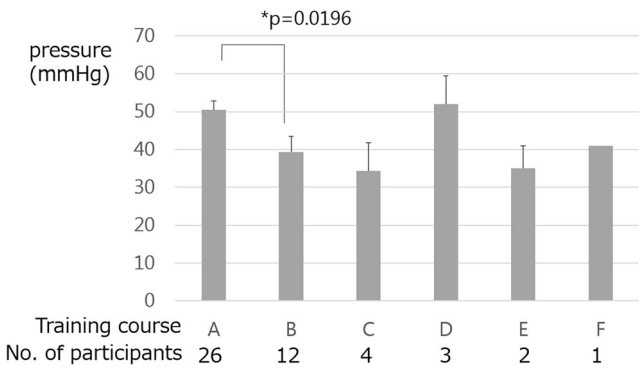

Fig. 4 The comparison of the bandaging pressure among the training courses which therapists finished. Compression pressure varied by the training courses. There was a significant difference between the bandaging pressures of therapists of course A and B ($p = 0.020$)

Results

The average pressure in phases 1–3 was 51.9, 48.9, and 45.5 mmHg, respectively. The pressure was decreased after dorsum and plantar flexion and knee bent movement. Figure 2 indicates the distribution of the pressure at phase 3. Only 13 (27.1%) of the therapists achieved 50–59 mmHg which is suitable for lymphedema treatment. Six of them were nurses and 7 were masseurs. The degree of the pressure was not enough in 27 (56.3%) therapists. There was not a significant difference among the job category (between licensed masseur and nurse, $p = 0.94$). There was a little correlation between the pressure and the age of the therapists, though it was not significant ($R = 0.18$, $p = 0.21$). There was not a significant difference between the sex of the therapists ($p = 0.60$).

We compared the targeted pressure which the therapists declared and the measured pressure in 46 therapists who declare their target pressure (Fig. 3). The number of the therapists who achieved a pressure within 5 mmHg from the targeted pressure in phase 3 was 11 (23.9%), and that within 10 mmHg was 23 (50.0%). Fourteen therapists (30.4%) applied bandages with the pressure which was less than targeted pressure by more than 10 mmHg. On the contrary, 9 therapists (19.6%) applied bandages with the pressure which was more than targeted pressure by more than

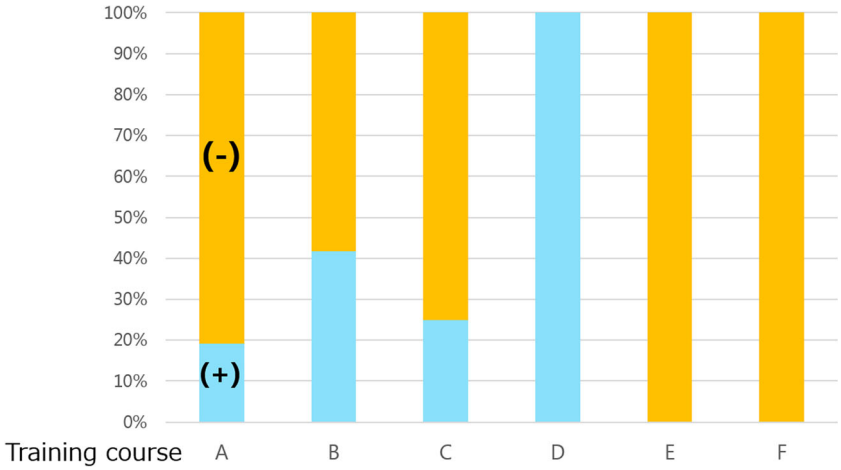

Fig. 5 The percentage of the patients who had a target of compression pressure in their clinical experiences. The percentage was different among the training courses. All the therapists graduated from training course D had the target pressure. On the contrary, none of the therapists who finished training course E and F did

10 mmHg. Only 14 therapists (29.2%) had their target pressure in their clinical treatment.

Compression pressure varied by the training courses which the therapists had finished (Fig. 4). We performed Student's *t* test between course A and B because the numbers of the therapists who had finished other courses were not enough. There was a significant difference between the pressures of therapists of course A and B ($p = 0.020$).

Figure 5 indicates the percentage of the patients who had a target in compression pressure. The percentage was different among the training course. In total, the number of the therapists who had the target pressure was 14 (29.1%).

Finally, we investigated the therapists who did not have a clinical experience of multi-layer bandaging after finishing training courses. The compression pressure decreased as the length of blank period got longer (Fig. 6). There was a weak negative correlation between the pressure and the length of the blank period ($R = -0.39$).

Discussions

In this study, we investigated the compression pressure of the multi-layer bandaging applied by lymphedema therapists. The pressure was different for different therapists and different training course. About 70% of the therapists did not set a target pressure, though applying proper pressure is essential in multi-layer bandaging. From these results, the necessity of unified training program is suggested.

CDT is the golden standard in the treatment of lymphedema. It contains compression therapy, manual lymph drainage, skin care, and exercise. It can reduce the volume of the affected limb, pain, and the frequency of cellulitis. When CDT does not give sufficient effect, surgical treatments are sometimes performed, including lymphaticovenous anastomosis [12, 13], lymph node transfer [14], or liposuction [15].

In the current study, the average pressure soon after applying bandages was 51.9 mmHg, and it decreased after exercising to 45.5 mmHg. The international consensus recommends multi-layer lymph bandaging with a pressure > 45 mmHg [16]. The pressures which were measured in the current study seemed not sufficient as a therapeutic pressure for the extremities with lymphedema. On the other hand, Partsch reported that there is an upper limit beyond which further increase in pressure is counterproductive, and it is 50–60 mmHg for lower limbs [17]. Therefore, maintaining suitable pressure is important in bandaging. The decrease in pressure after exercising

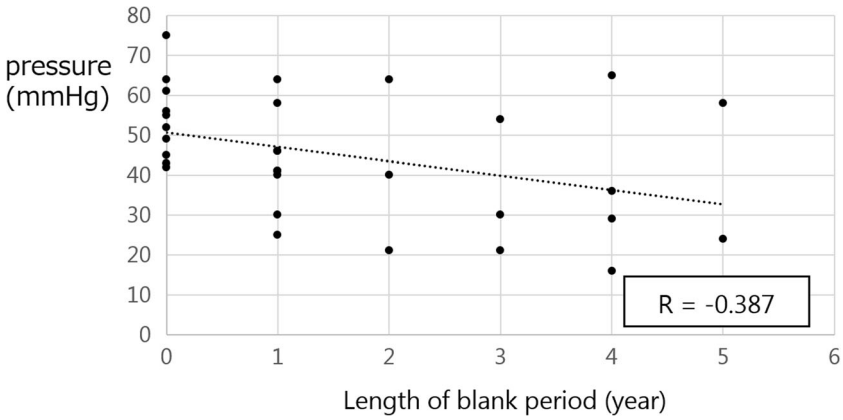

Fig. 6 The relationship between the bandaging pressure and the blank period after finishing the training courses. The compression pressure decreased as the blank period got longer. There was a weak negative correlation between the pressure and the length of the blank period ($R = -0.39$)

coincides with the past study [3]. Therapists should consider this phenomenon and apply bandage slight tightly compared to the targeted pressure.

In the current study, the number of the therapists who could apply bandages at the intended pressure was small. Only 26.2% therapists could perform bandaging within 5 mmHg from the targeted pressure. It is natural that the pressure of bandaging varies in different therapists and varies depending on the daily condition of the therapist. Besides, in the present study, the pressure decreased as the blank period after finishing training courses gets long. Only 14 therapists (29.2%) had their target pressure in their clinical treatment.

These findings indicate the necessity of changing training programs for therapists. We propose that therapists should measure the pressure of bandaging during training courses, although it is not common in Japan so far. And the uniform curriculum among the several training courses which includes the measurement of bandaging pressure should be established. Routine measurement of bandaging pressure in their clinical treatment or daily training must be helpful, too. Brush-up seminar including practical training is necessary to reduce the blank period after finishing the training courses. In Japan, it is said that about half of the therapists who finished training courses cannot get engaged in lymphedema treatment in their daily practice due to the institutional or personal reasons. To consolidate the system that the skilled therapists can gain clinical experiences should be necessary.

Achieving the appropriate pressure is the key in successful bandaging for lymphedema. Bandaging with too low pressure is ineffective despite time and effort. On the contrary, bandaging with too high pressure may lead to circulatory deficit or nerve damage. To maintain the bandaging pressure and ensure the quality of the therapists, review of the educational system for lymphedema therapist is essential.

The limitation of this study was that bandaging was applied to healthy volunteers. As lymphedema is gradually released after application of bandaging, the pressure must gradually decrease in lymphedematous limbs. Therefore, therapists may have to apply bandaging thicker than they do in the current study to achieve high pressure. Future research is necessary to elucidate the difference between the bandaging for healthy people and lymphedema patients. Also, the appropriate pressure to treat lymphedema has not been determined yet [7].

In conclusions, the pressure of bandaging varied in different therapists and different training courses. There was a tendency of decreasing in pressure as the blank period after finishing training courses got longer. This fact indicated the necessity of uniform curriculum in training courses including measurement of the bandaging pressure and establishing brush-up courses to maintain the bandaging techniques.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest. We agree to allow the journal to review the data in this study if requested.

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