LYMPHATIC RESEARCH AND BIOLOGY
Volume 00, Number 00, 2021

DOI: 10.1089/lrb.2020.0083

Compression Pressure Variability in Upper Limb Multilayer Bandaging Applied by Lymphedema Therapists

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Abstract

Background: Multilayer bandaging (MLB) is often used for lymphedema treatment. Even experienced lymphedema therapists have difficulty applying bandages correctly. The aim of this study was to demonstrate upper limb MLB pressure variability applied by lymphedema therapists.
Methods and Results: Twenty-four lymphedema therapists were asked to apply MLB to the healthy volunteer's upper limb. The participants consisted of 20 females and 4 males with a mean age of 43.4 (range: 24–62) years. They included licensed massage therapists, nurses, a judo therapist, an occupational therapist, and a medical doctor. Twenty therapists (83.3%) had clinical experience applying MLB. Compression pressure was measured with PicoPress at 5 cm proximal to the wrist, immediately after the application (phase 1) and after exercise (phase 2). The mean MLB pressure was 67.7 ± 5.0 mmHg in phase 1 and 55.3 ± 4.1 mmHg in phase 2, which were significantly different ($p = 1.2 \times 10^{-10}$). There was a weak negative correlation between how long the therapist had been practicing MLB and MLB pressure ($R = 0.29$). Seventeen participants (70.8%) expressed that they had a target pressure in mind when performing MLB. Among the 17 participants, there was no correlation between the target and actual pressures ($R = -0.055$). Only three participants (17.6%) had an actual MLB pressure within 5 mmHg of their target.
Conclusions: The mean MLB pressure was 55.3 ± 4.1 mmHg, which was thought to be too high for the upper limb. Education about applying appropriate MLB pressures to the limbs is necessary.

Keywords: lymphedema, complete decongestive therapy, CDT, bandaging, pressure, multilayer bandaging

Introduction

Lymphedema sometimes occurs after breast or gynecologic cancer treatment.[1,2] Complete decongestive therapy (CDT) is the standard treatment for lymphedema of the extremities.[3,4] If CDT is not effective, then surgical treatment, including lymphaticovenous anastomosis, lymph node transfer, or liposuction, may be performed.[5–9] CDT includes compression therapy, manual lymph drainage, skin care, and exercise.[10–13] Of these, compression therapy plays a key role in decreasing the volume of affected limbs.[14,15] Multilayer bandaging (MLB) is used in the intensive CDT treatment phase.[16,17] It is effective and more cost effective than elastic stockings.

Even experienced lymphedema therapists have difficulty applying bandages with adequate equal pressure on the entire limb. We previously reported variability in lower limb MLB pressure applied by lymphedema therapists.[18] However, applying MLB with the necessary and sufficient pressure for treatment is essential to achieving superior results without producing medical device-related pressure ulcers.[19] Thus far, no reports analyzing upper limb MLB pressure variability based on therapist characteristics exist.

In this study, MLB pressure applied to the upper limb of a healthy volunteer by a certified lymphedema therapist was measured. By knowing the status of the pressure applied, we should be able to improve the safety and effectiveness of MLB practices. The aim of this study was to demonstrate upper limb MLB pressure variability applied by lymphedema therapists.

Materials and Methods

For this study, lymphedema therapists attending continuing education seminars for lymphedema treatment were interviewed, of whom 24 agreed to participate. The therapists had passed training courses A through C, which are based on

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the Földi method, and met the requirements according to the Instructional Procedures for Professional Lymphedema Training in Japan, which includes 33 hours of lecture and 67 hours of practical training. Training courses A and B took place in Japan, and training course C took place at Földi college in Germany.

The participants consisted of 20 females and 4 males with a mean age of 43.4 (range: 24–62) years. Sixteen (66.7%) were licensed massage therapists, 6 (25.0%) were nurses, 1 (4.2%) was a judo therapist, 1 (4.2%) was an occupational therapist, and 1 (4.2%) was a medical doctor. Twenty therapists (83.3%) had clinical experience applying MLB, and the mean training duration was 59.3 (range: 2–168) months.

First, each participant was asked if they had a target pressure for MLB, and if they did, how much their target pressure was. In some cases, the target pressure is based on their references, while it was based on their experiences in other cases. Then, participants were instructed to apply MLB to the entire length of a healthy volunteer's upper limbs, while presuming the volunteer was a lymphedema patient with an International Society of Lymphology (ISL) classification of stage 2a.[20] The healthy volunteer was a 46-year-old female with no history of venous or lymphatic disorders in the upper limbs. The bandage was applied to the arm of the healthy volunteer in the sitting position with the arm stretched forward. The bandage used was short stretch material (Rosidal K; Lohmann & Rauscher, Rengsdorf, Germany) over tubular stockings and with a 12-cm wide soft sponge roll (Rosidal Soft Foam Padding: Lohmann & Rauscher, Rengsdorf, Germany). The width of the Rosidal K could be individually selected. The participants were permitted to select their preferred materials and performed MLB on the volunteer as they would on a patient. In most cases, participants applied tubular stockings and soft roll sponges (or padded bandages) first, and then they selected various widths of short stretch bandaging as they usually do.

Compression pressure was measured with a PicoPress device (Microlab Elettronica SAS, Padua, Italy) (Fig. 1),[18] and the measuring probe was attached to the palmar side of the forearm, 5 cm proximal to the wrist. After the participants applied MLB, the pressure was measured twice: once immediately after applying MLB (phase 1) and again after 10 repetitions of flexing and extending the wrist, elbow, and fingers, as well as in the resting state (phase 2). Applied bandages were removed soon after the pressure measurement was finished.

Student's *t*-test was used during phase 2 to evaluate the differences in MLB pressure between sexes. One way analysis of variation was applied to compare the MLB pressure among job categories and therapist training courses. A significance level was set at $p < 0.05$. Pearson's correlation coefficient was also used to evaluate the correlation between phase 2 pressure and therapist characteristics.

Results

The mean MLB pressure was 67.7 ± 5.0 mmHg in phase 1 and 55.3 ± 4.1 mmHg in phase 2, which was significantly different ($p = 1.2 \times 10^{-10}$) (Fig. 2). There was a weak negative correlation between how long the therapist had been practicing MLB and MLB pressure ($R = 0.29$) (Fig. 3).

Seventeen participants (70.8%) expressed that they had a target pressure in mind when performing MLB, while 6 (25.0%) did not (the other participant was unknown). Among the 17 participants with a target pressure goal, two had a target of less than 30 mmHg, 12 targeted 30–45 mmHg, and 4 targeted more than 45 mmHg (range: 25–55 mmHg). There was no correlation between the target and actual pressures ($R = -0.055$) (Fig. 4). Only three participants (17.6%) had an actual MLB pressure within 5 mmHg of their target. Twelve (70.6%) had a pressure over 5 mmHg stronger than their target, and 2 (11.8%) had a pressure over 5 mmHg weaker than their target.

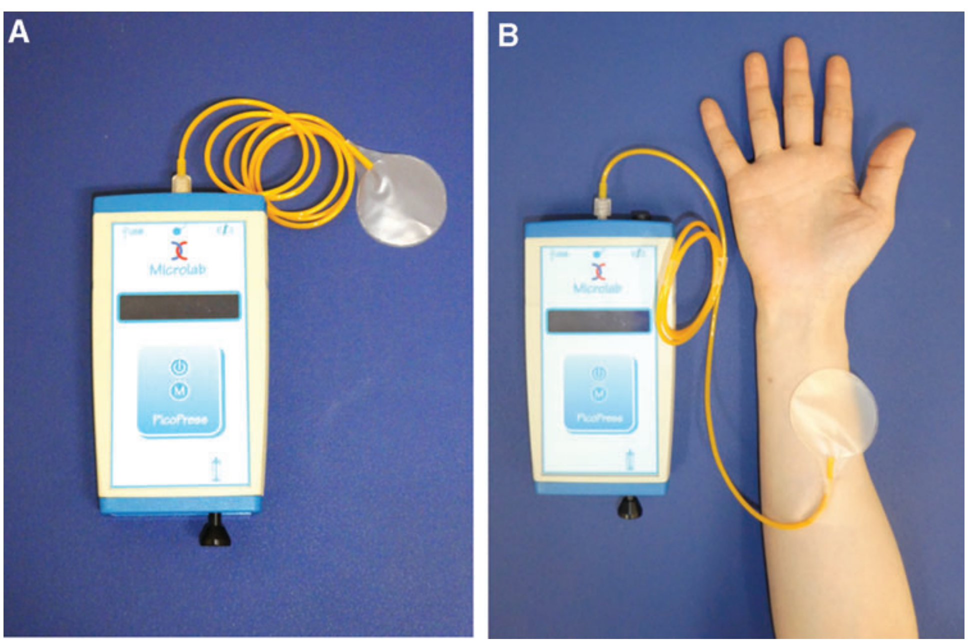

FIG. 1. **(A)** PicoPress used to measure MLB pressure. **(B)** PicoPress measuring probe placed at the palmar side of the forearm, 5 cm proximal to the wrist of a healthy volunteer (*arrow*). MLB, multilayer bandaging. Color images are available online.

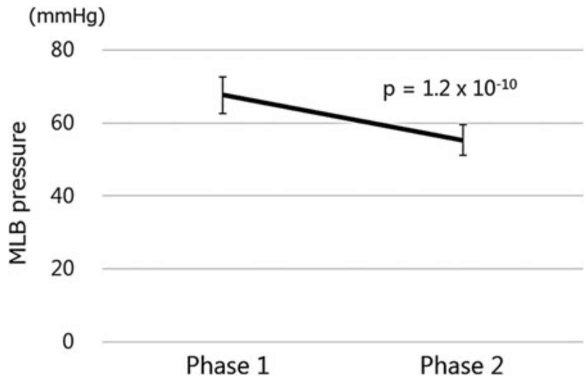

FIG. 2. Mean MLB pressure immediately after application (phase 1) and exercises (phase 2). It was 67.7 ± 5.0 mmHg in phase 1 and 55.3 ± 4.1 mmHg in phase 2, which were significantly different ($p = 1.2 \times 10^{-10}$).

There were no significant differences in MLB pressures between therapist job categories (Fig. 5). The correlation coefficient between MLB pressure and participant age was 0.078, showing no correlation. There was a tendency for pressure to be higher for male participants; however, it was not significant ($p = 0.66$) (Fig. 6). There were no significant differences between pressure and the training course the participants completed (Fig. 7) or between pressure and years of experience ($R = -0.15$).

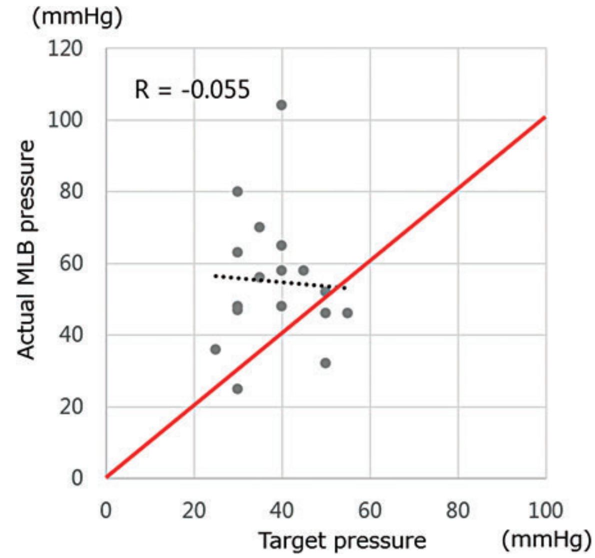

FIG. 4. Correlation between self-reported target and actual pressures. *Dotted line* indicates the regression line. There was not a correlation ($R = -0.055$). The number of the participants whose actual MLB pressure was within ±5 mmHg from their target pressure was only 3 (17.6%). Twelve participants (70.6%) had stronger MLB pressure than their own target pressure by over 5 mmHg, and 2 (11.8%) participants had weaker pressure than their own target pressure by over 5 mmHg. Color images are available online.

Discussion

In this study, upper limb MLB pressure variability applied by lymphedema therapists to a healthy volunteer was reported. The mean MLB pressure was 67.7 ± 5.0 mmHg in phase 1 and 55.3 ± 4.1 mmHg in phase 2, which tended to decrease as the therapist experience increased. The pressure of MLB decreased after exercise due to its slack and also due to a reduction of limb volume even in an edema-free extremity. It corresponded to the previous studies.[14,18] Although applying the bandages at an appropriate pressure is essential for successful treatment, an actual appropriate pressure for upper limb lymphedema has not been determined. Partsch et al. reported the results of a randomized controlled trial (RCT) where there were no differences in the therapeutic effects of pressures between 20–30 mmHg and 44–58 mmHg, and patients tolerated lower pressures better with fewer complaints about pain or discomfort.[21,22] Comparing the results of the current study to those of the previously reported RCT, MLB pressure was found to be higher in the current study and seemed to be too high to be applied to the upper limbs. The therapist with the most experience might have learned adequate upper limb pressure during on-the-job training, which explained the results of the current study.

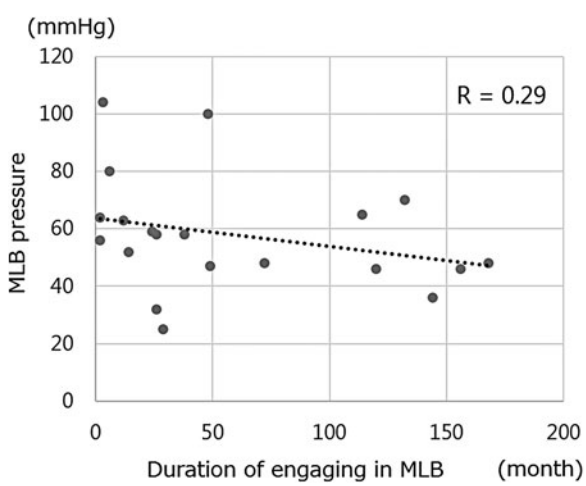

FIG. 3. Correlation between length of therapist experience with MLB and MLB pressure. There was a weak negative correlation, although it was not significant ($R = 0.29$, $p = 0.22$).

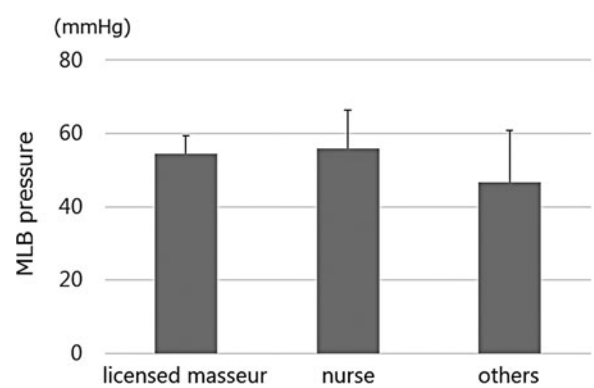

FIG. 5. Mean MLB pressure related to each therapist job category. There was not a significant difference in the MLB pressures between the different job categories. There was not a significant difference in MLB pressure between the training course which the participants had finished. The *vertical lines* in each *column* indicate the standard error.

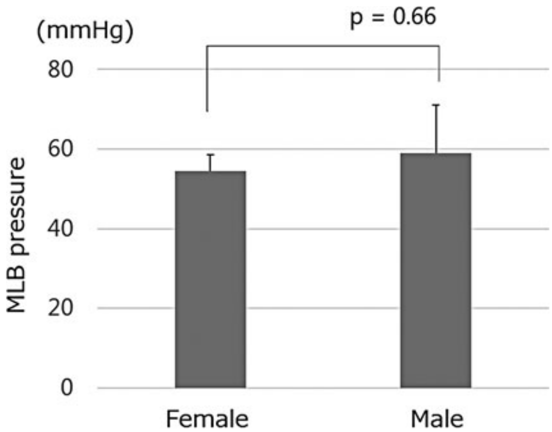

FIG. 6. Mean MLB pressure related to therapist sex. There was tendency that the MLB pressure was higher in male, but it was not significant ($p = 0.66$). The *vertical lines* in each *column* indicate the standard error.

In this study, 70.8% of the participants had a personal target MLB pressure. This percentage was higher than the results from our previous study on the lower limbs (29.1%). This is partially because many participants in the current study were also included in the previous study. They learned in previous seminars that adequate lower limb MLB pressure is >45 mmHg,[9] and they applied MLB to the upper limbs in the same manner. However, the appropriate pressure for the upper limbs is thought to be lower than that for the lower limbs. Based on Laplace's law, compression pressure increases as the limb radius decreases.[23] The upper limb radius is smaller than the lower limb; therefore, compression pressure increases in the upper limb if therapists apply bandaging in the same manner as the lower limbs. Therapists should keep this in mind when applying MLB.

The self-reported target pressures varied from 25 to 55 mmHg, and only 17.6% of the participants achieved a pressure within 5 mmHg of their target pressure. Two issues arise from these results. First, a universally accepted appropriate pressure should be determined and taught in therapist training. Second, therapists toned to train themselves to achieve their personally targeted MLB pressure. Since there is less of a chance for lymphedema therapists to apply MLB to the upper limbs over the lower limbs, continuing education seminars that include skill practice with pressure measurements are necessary to maintain a more precise technique.

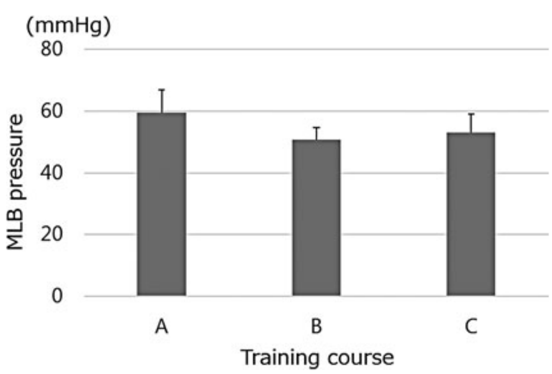

FIG. 7. Mean MLB pressure related to the training course therapists completed. There was not a significant difference in MLB pressure between the training course **(A–C)**. The *vertical lines* in each *column* indicate the standard error.

Recently, some reports about measuring compression pressure in lymphedema treatments have been published.[18,22–25] These authors claim that applying appropriate pressure is important in compression therapy. In lymphatic surgery, imaging examinations, including lymphoscintigraphy, indocyanine green lymphography, lymphatic ultrasound, or photoacoustic lymphography, are important.[26–34] With these examinations, surgeons can understand individual lymphatic function and determine the appropriate procedure; thus, the reliability and success rates of lymphatic surgery have improved. Similarly, continuing MLB education and training for therapists will ensure adequate lymphedema treatment and increase the effectiveness of therapist techniques. The "adequate treatment" or "adequate MLB pressure" is still unknown, and they should be customized according to the severity of lymphedema. Future research to elucidate the adequate MLB pressure for each lymphedema severity, based on various examinations, is required.

A limitation of this study was the small number of participants. In addition, the subject the therapists applied MLB to was a healthy volunteer, and the situation may differ when treating lymphedema patients. Future research using a larger participant group and actual lymphedema patients is necessary.

In conclusion, when the lymphedema therapists applied upper limb MLB on a healthy volunteer, the mean pressure was 55.3 ± 4.1 mmHg, which was thought to be too high for the upper limb. The pressure decreased as participant experience increased. Although the self-reported target pressures varied from 25 to 55 mmHg, only 17.6% of the participants achieved a pressure within 5 mmHg of their target. MLB for upper limbs is different from the lower limbs, and separate education about applying appropriate MLB pressures to the upper and lower limbs is necessary.

Ethics Approval

This study was approved by the Ethics Committee of the Kuretake College of Medical Arts & Sciences (approval no. 17-005).

Author Disclosure Statement

No competing financial interests exist.

Funding Information

No funding was received for this article.

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