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Acute Cardiovascular Responses to the Application of Manual Lymphatic Drainage in Different Body Regions

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Abstract

Background: The purpose of this study was to investigate acute cardiovascular responses to manual lymphatic drainage (MLD) on different parts of the body.
Materials and Methods: Thirty healthy individuals (10 women and 20 men) participated in the study voluntarily. Heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), respiration frequency, and oxygen saturation were measured before and after MLD was applied to different regions of the body (neck, abdomen, anastomosis, arm, and leg). HR, SBP, and DBP were measured with a sphygmomanometer (OMRON, USA) and oxygen saturation was measured with a pulse oximeter.
Results: Increase in DBP was seen after abdominal drainage ($p = 0.038$); reduction in SBP ($p = 0.002$) and DBP ($p = 0.004$) after neck drainage; reduction in SBP ($p < 0.001$) and HR ($p = 0.004$) after arm drainage; and reduction in SBP and DBP after leg drainage. There was no change in the oxygen saturation levels of participants after MLD ($p > 0.05$).
Conclusions: In healthy subjects, the effects of MLD were found to vary according to the region of application. This study signals that the cardiovascular effects of MLD treatment vary in different regions of the body.

Keywords: complex decongestive therapy, heart rate, blood pressure, respiration rate

Background

Manual lymphatic drainage (MLD) is a treatment application developed by Danish biologist Emil Vodder and his wife Estrid Vodder in 1936[1] and improved by Földi.[2] In this application, gentle massage on the skin increases the contraction of the smooth muscles around the superficial lymphatic vessels, thereby increasing the lymphatic flow. MLD allows for the advancement of lymph and tissue fluid and also increases the amplitude and frequency of contraction and relaxation of lymph collectors called lymphangiomotors.[2,3]

One of the most effective methods for increasing lymphangiomotors is MLD.[4] So, lymphatic activity increases significantly after MLD.[3] Today, MLD is one of the four major components of complex decongestive physiotherapy (CDP) and accepted as a gold standard method in the treatment of lymphedema.[5] MLD is frequently used in the treatment of primary and secondary lymphedema[6] and it is known that CDP is useful in patients with lymphedema.[7]

MLD includes pumping, scooping, and rotating massage techniques that can be performed on the neck, abdomen, anastomosis, and extremities.[8] The duration, direction, pressure, and sequence of the techniques used in this massage are characterized as MLD.[9] Before and after the application of MLD, the lymphatic flow rate and the retrograde escape time of the lymph fluid were measured by using "near infrared flourescence" in 12 healthy individuals whose mean lymphatic flow rate increased by 28% and lymphatic fluid was shown to reduce the mean time to escape by 23%.[10] Given the knowledge that lymphatic fluid participates in general circulation,[8] it is thought that an increase in the lymphatic flow rate will lead to an increase in the volume of circulating fluid in the systemic circulation unit. There is a significant lack of knowledge in the literature about whether this increase will raise or lower the workload of the heart.

A limited number of studies has investigated the cardiovascular effects of MLD treatment generally,[1,11,12] but no information has been published about the effects seen in specific regions of application (neck, abdomen, anastomosis,

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arm, and leg). The aim of this study was to determine the acute cardiovascular responses to the application of MLD in different body regions.

There is a lack of information in the literature about what kind of cardiovascular effect MLD has on each region. Information on this subject remains experiential and more anecdotal for clinical practice applications. Identification of this information will be helpful in identifying the indications and contraindications of MLD, minimizing the risky situations that may occur during MLD, and preventing unforeseen events that may occur during MLD in patients requiring MLD therapy.

Materials and Methods

The study was carried out at Gazi University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Oncological Rehabilitation Unit. Healthy individuals were informed about the study and 30 voluntary participants ($n=10$ women, $n=20$ men) were recruited. Permission was obtained from Gazi University Medical Faculty Ethics Committee in October 2017. All participants signed an informed consent form. All applications were made by a physiotherapist who had completed a ''Complex Decongestive Physiotherapy'' training course given by the Földi Schuele in July 2017.

Inclusion Criteria for participation in the current study were:

(1) Being between 18 and 30 years of age
(2) Not having any systemic illness, surgery, trauma, or diagnosis affecting the lymphatic system.

Exclusion Criteria were:

(1) Having any contraindication for MLD (such as thyroid, heart, kidney diseases, cardiac rhythm problems, menstrual cycle and pregnancy, major abdominal surgery, presence of thrombus, etc.)
(2) Taking regular medication.

Evaluation and treatment protocol

Before MLD was administered, the participants had rest for 15 minutes in the supine position to stabilize heart rate (HR), blood pressure, and respiration rate.

Outcome measurements. The evaluation methods for participants are listed below

Demographic characteristics: Age, gender, height, weight, body mass index, dominant arm, and dominant leg were recorded, and the demographic characteristics of the individuals oxygen saturation were recorded before, immediately after, and 3 minutes after MLD in each region). Hemodynamic responses to MLD (blood pressure, HR, respiratory frequency, and the regions that MLD was applied:

(1) Neck
(2) Abdomen
(3) Anastomotic sites (dorsal and ventral, right axillo axillar, left axillo inguinal)
(4) Arm
(5) Leg

Systolic and diastolic blood pressures. Systolic blood pressure (SBP) and diastolic blood pressure (DPB) were recorded by using the OMRON-HEM 710 INT device.[13] The brachial artery was identified after placing the participant's side of the left arm near the palm area facing the body. The sphygmomanometer was wrapped around the upper arm of the cuff, not to cover the brachial artery 2–3 cm above the antecubital space.[14]

The normal range for systolic pressure is 100–140 mmHg (mean 120 mmHg), and diastolic pressure is 60–100 mmHg (mean 80 mmHg).

Heart rate. HR was also measured automatically with the OMRON-HEM 710 INT device.[13] In adults, the normal HR varies between 60 and 100 beats/min. A rate that falls below 60 beats/min is defined as bradycardia, and above 100 beats/min is called as tachycardia.

Respiration rate. The respiration rate is measured without the individual being notified. The respiratory frequency was measured manually and the respiratory rate in 1 minute was recorded. This value is normally 12–16 breaths/min.

Oxygen saturation. This value was assessed with an Oximeter Brand Pulse Oximeter. It has been reported by the World Health Organization that this method of measurement is reliable and normally the level of oxygen saturation varies between 95% and 100%.[15]

Application of MLD

MLD application order for neck drainage. The MLD application sequence was as follows[8,16–17]: effleurage, backward rotation of the shoulders, stimulation of the inferior cervical, superior cervical, occipital, preauricular, and retroauricular lymph nodules and stimulation of the shoulder collectors, and effleurage.

Abdominal deep drainage

The application of MLD to the abdominal region was effleurage, colonic therapy (ascending, descending, and transverse), intense grip combined with respiration, and effleurage.

Lymph drainage of anastomotic region

MLD was performed on the right arm and left leg of healthy individuals so that the treatment could be applied to all anastomotic areas. MLD was performed following neck drainage, abdominal drainage, ventral axilloinguinal/interinguinal anastomosis, dorsal axilloinguinal/interinguinal anastomosis, right arm drainage, and left leg drainage.

Lymphatic drainage of the ventral part of the upper trunk

In this region, MLD was applied in the order of effleurage, excitation of axillary lymph nodes, circles on the side of the trunk, circulation between the sternum and the breast starting from the sternum, breast treatment, the grip of seven, and effleurage.

Lymph drainage of the dorsal part of the upper trunk

The order of application of MLD to this region was as follows: effleurage, excitation of axillary lymph nodes, drainage of the trunk side, placement of the transverse process of the vertebrae at the level of the scapula and administering this region, the grip of seven, and effleurage.

Lower ventral lymph drainage

The hands are placed superficially on the abdominal region and are directed to the lacuna vasorum.

Lymph drainage of the region between dorsal section, hip, lower costa, and crista iliaca

Drainage of this region was applied in the effleurage, circle on the side of the trunk, the grip of seven, drainage of the hip lateral, drainage of the hip medial, paravertebral treatment, and effleurage.

Arm region lymph drainage

The drainage sequence of this region is accompanied by effleurage, excitation of axillary lymph nodes with standing circles, arm medial circles, handwashing on deltoid, combination of lateral pumping and pumping-circle movements, circles around the medial and lateral epicondyle, passive elbow flexion- standing circles, draping of the front-line flexor and extension area with circles, pumping, or circles, circles in the dorsal region of the wrist, circles on the back of the hand, circles on the thumb and other fingers, and effleurage.

Leg region lymph drainage

The order of MLD application consisted of effleurage, excitation of inguinal lymph nodes, standing circles on medial part of thigh, pumping ventral part of thigh, pumping and circles on ventrolateral part of thigh, pumping on patella region, circles on popliteal lymph nodes, circles on medial part of knee, circles under pes ancerinus area, draping of the calf with one hand, pumping the area of the tibialis anterior, draping of the calf with two hands, circles through achilles tendon from submalleoler area, passive joint movements while applying circles on the ankle, circles on dorsal part of the foot, circles on toes, and effleurage.

Statistical analyses

Statistical analyses were performed using IBM SPSS Statistics (version 17) program. The Kolmogrov–Smirnov test was used to examine whether the variables provided the normality assumption. If the quantitative variables for the descriptive statistics provided a normality assumption, the mean and standard deviation, and if available, the median and minimum–maximum values are given. The Kruskal–Wallis test statistic was used because no normality assumption was provided in the comparison of independent groups. If the normality assumption enabled pre- and postcomparison in dependent groups, the paired *t*-test was used and if not, the Wilcoxon test statistic was used. Significance level was taken as <0.05.

Results

The study was completed with 10 healthy women and 20 men. Participants did not indicate a situation that would prevent them from taking part. The age interval of participants is 22 (21–26) years. The average of BMI was calculated as $23.58 \pm 3.58\ kg/m^2$. It was determined that 93.3% of participants had right arm, 6.7% left arm, 86.7% right leg, and 13.3% left leg dominant side. SBP decreased after neck, abdominal, and leg MLD. HR decreased after arm drainage. Also, there was decrease in DBP after neck and leg MLD. An increase in DBP was seen after abdominal MLD. No significant changes were found in other parameters (Table 1).

Discussion

This is the first study to investigate the physiological changes caused by MLD on different parts of the body in detail. MLD is an important component of CDP, which is a gold standard treatment of lymphedema[6] and has many different steps; application starts from the neck and continues on to the abdominal area if there are no contraindications. Previous studies obtained the changes of blood pressure and heart rate at the beginning and at the end of MLD globally. These studies compared the cardiovascular changes that occurred after MLD, before MLD, and only SBP and DBP were examined. Even though the measurements obtained in these studies showed no meaningful change in SBP and DBP,[1] some professionals believe that MLD may cause an increase in blood pressure and therefore its use in patients with systemic hypertension is contraindicated. However, a limited number of studies directly address this issue.[1,11,12] The explanation for observing no difference after MLD can be a result of balancing the differences, which may occur during MLD in SBP, DBP, HR, respiration rate, and saturation. The cardiovascular effects of MLD need to be clearly known to apply this procedure safely. It would also be helpful to know the cardiovascular responses after MLD to different areas of the body as no clear and available information exists. The changes according to MLD can be beneficial. Unlike other studies in the literature, our study provided more detailed information on the changes recorded throughout MLD. It is thought that this study contributes to the literature accordingly.

It is known that patients with lymphedema may have some other comorbid conditions, such as hypertension, and heart and kidney diseases. When MLD treatment is given to patients with lymphedema and chronic venous insufficiency,[9,18] the cardiac responses may have a critical role. This is the first study to examine for each region of the body the acute physiological/hemodynamic changes brought by the application of MLD.

In clinical usage of MLD, some indications and contraindications have been identified for regional applications; however, there has been a lack of information about what effects occurred in which region. To clarify this anecdotal information and to become more objective, this study was needed.

The changes in blood pressure seen during MLD in clinical practice are a matter of debate among health professionals. A limited number of studies has been made in this area, where no significant change in blood pressure was seen in 9 patients with heart failure[12] and in mean arterial pressure in 14 patients with acute brain injury after applying MLD.[11] In the current

TABLE 1. COMPARISON OF PHYSIOLOGICAL RESPONSES TO MANUAL LYMPHATIC DRAINAGE ACCORDING TO REGIONS

	Neck				*Abdomen*				*Anastamosis*				*Arm*				*Leg*			
	Before MLD	*After MLD*	t/Z	p	*Before MLD*	*After MLD*	t/Z	p	*Before MLD*	*After MLD*	t/Z	p	*Before MLD*	*After MLD*	t/Z	p	*Before MLD*	*After MLD*	t/Z	p
HR	74 (54 ± 97)	69.5 (54 ± 98)	*t*: 1.598[a]	*p*: 1.210	68.5 (54 ± 96)	69 (54 ± 99)	Z: 1.033[b]	*p*: 0.302	69.5 (52 ± 97)	68 (51 ± 92)	*t*: 1.601[a]	*p*: 0.120	68 (53 ± 96)	67 (51 ± 88)	***t*: 3.106[a]**	***p*: 0.040**	69.5 (51 ± 100)	64.5 (52 ± 94)	t: −1.366[a]	*p*: 0.185
SBP	120 (90 ± 148)	115.5 (87 ± 153)	***t*: 3.468[a]**	***p*: 0.002**	115 (86 ± 148)	117 (87 ± 148)	*t*: −1.180[a]	*p*: 0.248	115 (86 ± 140)	115 (87 ± 148)	*t*: −2.009[a]	*p*: 0.054	114.5 (86 ± 137)	114 (83 ± 137)	***t*: 4.071[a]**	***p*: 0.000**	116 (87 ± 142)	114 (88 ± 141)	***t*: 2.499[a]**	***p*: 0.018**
DBP	68.5 (54 ± 83)	66 (51 ± 84)	***t*: 3.156[a]**	***p*: 0.004**	62.5 (50 ± 79)	65 (47 ± 89)	***t*: −2.179[a]**	***p*: 0.038**	65 (45 ± 80)	64 (53 ± 80)	*t*: −0.283[a]	*p*: 0.779	66 (53 ± 81)	66.5 (53 ± 76)	*t*: 1.731[a]	*p*: 0.940	66.5 (52 ± 80)	64.5 (54 ± 78)	***t*: 2.289[a]**	***p*: 0.030**
RT	18 (12 ± 28)	18.5 (12 ± 28)	Z: 0.220[b]	*p*: 0.826	18 (12 ± 24)	16 (12 ± 24)	Z: 0.970[b]	*p*: 0.332	16 (10 ± 25)	16.5 (9 ± 24)	*t*: −1.140[a]	*p*: 0.264	17.5 (12 ± 24)	18 (12 ± 26)	*t*: −0.718[a]	*p*: 0.478	18 (12 ± 24)	18 (12 ± 24)	Z: −0.858[a]	*p*: 0.398
SAT	98 (96 ± 99)	98 (97 ± 99)	Z: −1.000[b]	*p*: 0.317	98 (96 ± 99)	98 (97 ± 99)	Z: 1.165[b]	*p*: 0.244	98 (95 ± 99)	98 (96 ± 98)	Z: 1.604[b]	*p*: 0.109	98 (97 ± 99)	98 (97 ± 99)	Z: 0.258[b]	*p*: 0.796	98 (97 ± 99)	98 (97 ± 99)	Z: −1.414[b]	*p*: 0.157

Significant results are shown in bold.
[a]Paired samples *t*-test.
[b]Wilcoxon test $p < 0.05$.
DBP, diastolic blood pressure; HR, heart rate; MLD, manual lymphatic drainage; RR, respiration rate; SAT, saturation; SBP, systolic blood pressure.

study, no certain reasons were found for reduction in SBP after branch drainage and in SBP and DBP after neck MLD. These reductions may originate from activation of the parasympathetic system. Elsewhere, a significant reduction in sympathetic nervous system activation is reported after administering neck MLD to 29 participants with psychological stress.[19] The increase in parasympathetic nerve activation is known to increase relaxation in the whole body.[20] Such findings indicate that neurological changes may occur with sufficient stimulation of the body with MLD. Another explanation for changes after neck MLD can be the activation of baroreceptors.

The increase in DBP seen after abdominal MLD, may be caused by lymph nodes in the abdominal region. Abdominal MLD can lead to excessive absorption of fluid which may make it difficult for the heart to rotate increased blood volume. MLD increases lymphangiomotoria and allows for the general circulation of excess fluid in the interstitial space. During the practice of abdominal MLD, individuals keep their knees in the flexion position as the application may increase DBP. It is known that different body positions cause blood pressure change.[21]

Moreover, deep handling during abdominal MLD may increase reabsorbsion.

The increase in DBP after abdominal MLD may also be a result of increased peripheral resistance. Blood pressure and HR are controlled by complex mechanisms such as ''cardiac output'' and peripheral vascular resistance.[22] It is surprising that only an increase in DBP after abdominal MLD was observed in this study of healthy individuals. We expected that SBP and DBP would show similar increases and decreases. This finding may be due to the small size of the sample.

In MLD application to the arm region only a decrease in the SBP was observed. It is known that MLD has asignificant improvement in transient lymph velocity at the forearm.[3] This improvement may have led to decrease in the SBP. The arm is located close to the heart and it may be that fluid build up during MLD applied to the arm was more easily returned to the systemic circulation. As in the abdominal region, the change of SBP independently from DBP can be attributed to the small amount of change. The reason for the reduction in SBP after MLD in the arm and leg region may be that the participants had been in the supine position for a long time and that previous parasympathetic effects persisted.

Autonomic nerves are spread to many parts of the body through blood vessels, lymphatic vessels, and connective tissue. The lymphatic system and the hypothalamus work together to influence the response of the autonomic nervous system. The precise unexplained role of the lymphatic system and the hypothalamus relationship and of the nerve source in the lymphatic innervations has created difficulties in clearly grasping and interpreting the effects of MLD on the cardiovascular system.[23]

The decrease in HR can be as a result of accelerating the systemic circulation of fluid and reducing the workload of the heart after arm MLD and the localization of the arm being closer to the heart.

It is known that MLD increases circulation in the tissue and oxygenation.[10] However, in the present study, no change in oxygen saturation was observed. Although a significant increase in oxygen saturation had been seen during MLD applied to 14 patients suffering from acute brain injury, it was reported that no significant change in oxygen saturation was observed after treatment.[11]

The decrease in HR and SBP after MLD administration seen in this study may be due to a cumulative effect becoming apparent during MLD. Many factors such as the parasympathetic effect of MLD and study participants being placed in the supine position for a long time may have influenced this effect. It is known that rapid control is directed by baroreflexes activated by arterial baroreceptors, which are one of the most important components of blood pressure control mechanisms. Arterial baroreceptors are located primarily in the carotid sinus and aortic wall. In order for baroreceptors to become active, there must be tension on the vessel wall.

Baroreceptors are induced when the vein wall is stretched. Thus, an increase in blood volume can be regulated by balancing the HR, cardiac output, myocardial contractility, and blood pressure control by means of reflex regulation of peripheral vascular resistance.[24] This mechanism may lead to decreased HR differences after arm MLD.

In general, no change in blood pressure and HR after MLD was observed in this study and can be interpreted as evidence that the participants were healthy individuals, who could readily cope with the changes and make the necessary reflex adjustments. This may not so readily occur in individuals diagnosed with problems related to their circulatory, nervous, and other regulatory systems and reinforces the suggestion in the literature that it would be useful to investigate the possible effects of MLD in these cases.

Conclusion

This study reports that MLD practice caused different hemodynamic responses according to body region in a sample of 30 healthy individuals. The results show a decrease in SBP after neck, abdominal, and leg MLD and lower HRs after arm drainage. DBP values decreased after neck and leg MLD and showed an increase after abdominal MLD. These findings support further investigation of the roles of the circulatory system, nervous system, hormonal system, and kidneys to better inform the practice of MLD and our understanding of its effects.

Limitations

(1) The cardiovascular changes seen during MLD can be observed by other more technologically advanced devices.
(2) The number of participants was limited to a small group of healthy university students who took part voluntarily. Further studies with more data can better explain the results. In patient groups with different diseases, the cardiovascular responses to MLD may be more dramatic, so if they can be observed, it would be helpful in determining indication and contraindication for each part of the body.

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Author Disclosure Statement

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