



Original Article

Application of massage for ankle joint flexibility and balance

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Abstract. [Purpose] The purpose of this study is to examine the effect of calf muscle massage on ankle flexibility and balance. [Subjects and Methods] The study's subjects were 32 healthy college students, divided into two groups according to the massage methods applied. Both groups received five-minutes of massage to each calf, making a total of ten minutes. Massage group A received effleurage, tapotement and pressure, and massage group B received effleurage, friction and petrissage. The functional reaching test and the modified one leg standing test were performed to measure the flexibility and balance of the ankles both before and after the massage application. [Results] In the functional reaching test performed after the calf muscle massage intervention, both groups showed significant increases. However, no significant differences were found between the two groups. In the modified one leg standing test, massage group A showed a significant increase in flexibility and balance after the intervention only when the left foot was used for support. Massage group B showed a significant increase when each foot was used for support. A significant difference between the groups was only observed only when the left foot was used for support. [Conclusion] Calf muscle massage may be effective for enhancing the flexibility and balance function of the ankle joint. In particular, a combined application of friction and petrissage massage techniques may be more effective for increasing ankle joint flexibility. Therefore, the application of calf massage can be considered an appropriate method for improving balancing ability.

Key words: Ankle flexibility, Balance, Calf muscle massage

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INTRODUCTION

Massage is defined as the systematic manual manipulation of the body by movements such as rubbing, kneading, pressing, rolling, slapping, and tapping for therapeutic purposes. These movements promote circulation of the blood and lymph, relaxation of muscles, relief from pain, restoration of metabolic balance, and sundry other benefits both physical and mental¹⁾. Physical therapists in different parts of the world use therapeutic massage in clinical settings to facilitate relaxation and to treat pain, increase muscle compliance and range of joint movement, decrease stiffness, diminish anxiety, and improve mood state²⁾.

It has been suggested that the benefits of massage may help healthy people to enhance their dynamic balance³⁾. Balance

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may be maintained by using an ankle strategy, hip strategy, or both strategies at the same time. In particular, the ankle strategy functions in the early stages of balancing to facilitate control over external sway^{4, 5}). The soleus muscle, which provides stability to the ankle joint and acts in push off at the end of the stance phase during walking. The gastrocnemius muscle maintains the weight center of the basal area through continuous muscle contraction during walking and generates sufficient muscle strength to maintain stability during exercise of the lower limbs^{6, 7}).

The plantar-flexion torque of the ankle joint, which generates sufficient momentum at the end of the stance phase, is an important factor in human walking. The plantar-flexion torque of the ankle joint is an important factor that generates propulsion by connecting with the motion of the sole as it pushes against the floor and moves the lower limbs forward. However, as the plantar-flexion torque decreases due to a limited range of motion of the ankle joint or ankle instability⁸), walking ability diminishes as the momentum through the ankle joint decreases⁹). Hence, research on interventions involving ankle joint plantar-flexion through management of the calf muscle is required to assist in ankle flexibility and stable walking. In particular, the ability to create plantar-flexion torque diminishes in older people due to weakened muscle strength in their lower limbs. This decreases the momentum arising from the ankle joint and eventually decreases walking ability⁹). Research into intervention methods that can be applied easily to older people and to those who have problems with their plantar-flexion torque due to fatigue in daily life is particularly important.

This study attempts to investigate the effects of applying massage to calf muscle on the flexibility and balance of the ankle. It also examines the investigation of massages.

SUBJECTS AND METHODS

This study was conducted with 32 healthy university students in Korea: fourteen males in their 20s (ages: 21.50 ± 0.45 years, height: 173.38 ± 4.03 cm, weight: 66.75 ± 1.74 kg) and fourteen females in their 20s (ages 21.3 ± 0.35 years, height: 161.75 ± 6.25 cm, weight: 51.75 ± 8.25 kg). Subjects were required to be injury free in their ankles, lower legs and feet.

The Ethics Committee of Kangwon National University approved (KWNUIRB-2015-06-006-001) the research protocol with criteria based on the Declaration of Helsinki and good clinical practice. All subjects read and signed an informed consent form prior to the study beginning.

The students were randomly assigned to the two intervention groups (massage A group: effleurage, tapotement and pressure technique or the massage B group: effleurage, friction and petrissage technique). A type of massage that is not very difficult for students to apply was selected and performed on each of the two groups. This is because we considered that the massage methods applied by students, who were not massage experts, would also be easily applicable for individuals who are members of the general public.

Five-minutes of massage was applied to each calf giving a total of 10 minutes. During the research period, the research subjects were instructed to avoid heavy exercises to their calves to put excessive burdens on their calf muscles from heavy exercise or other activity during their daily lives. Before the massage, the subjects performed the light exercise of climbing up and down the five-story building once, which is considered an ordinary daily activity, followed by a five-minute rest. Research subjects wore shorts and received massage in the prone position. Calf massages were performed by a student who was not a massage expert, but who had completed a therapeutic massage course. Massage intensity and pressure strength were controlled at a similar level through a test before the massage was applied. A functional reaching test (FRT) was performed to measure flexibility and balance of the ankles both before and after the intervention, and a modified one leg standing test (OLST) was performed to measure static balance.

In assuming the correct posture for the FRT, the subjects stood straight, in a comfortable position, and the measuring ruler was located right in front of the measuring shoulder at the acromion height of the subject. Before starting the measurement, the shoulder joint of the subject was placed in a 90 degree forward flexion and the elbow and wrist joints were placed in complete extension so that the subject stretched his or her arms and hands straight out in front. While holding this position, the third metacarpophalangeal joint and the front point of the ruler were matched to define the baseline location. The subject then pushed the ruler with both arms as far as possible, and the distance that the ruler moved forward was measured¹⁰).

The OLST is a test that investigates balance by checking how long the subject can maintain balance on one leg. It has been used as a tool for measuring static balance in a number of studies, including one by Riemann et al¹¹). This study, a modified OLST was performed which implemented one leg standing under conditions where the ground was unstable and visibility was blocked to prevent the ceiling effect, since this study was using a sample of healthy adults. The subjects were told to stand on one leg with their eyes closed on a trampoline that provided instability of ground. The length of time on right and left leg were each measured and the test was conducted twice with each leg to provide an average value. During the OLST for this study, the subjects spread out both arms and initially stood on both legs. They then bent the knee on the opposite side to the leg to be used for support. The length of time that the subject could stand on one leg was measured for both the right and left legs, and the measurement procedure was conducted twice, so the average value could be used in order to minimize measurement and training errors. After receiving the massage intervention, the OLST was repeated using the same procedure.

Data were analyzed using the SPSS (version 21.0) statistical analysis program. The paired t-test was used to test the significance of changes following the intervention with each group; the independent t-test was used to test the significance of differences between the two groups. Significance was accepted for values of $p < 0.05$.

Table 1. Change of one leg standing test after massage (sec)

Supported leg		Massage A	Massage B
Rt	Pre	6.24 ± 1.7	5.57 ± 1.3
	Post	6.11 ± 1.9	8.14 ± 1.4**
Lt	Pre	6.24 ± 1.7	5.49 ± 1.0
	Post	9.24 ± 2.3**	7.25 ± 1.4**

Mean ± SD, Massage A: effleurage, tapotement and pressure; Massage B: effleurage, friction, and petrissage; **p<0.01

Table 2. Change of functional reaching test after massage (cm)

	Massage A	Massage B
Pre	35.5 ± 5.3	35.7 ± 5.0
Post	41.6 ± 5.9**	40.5 ± 5.7**

Mean ± SD, Massage A: effleurage, tapotement and pressure; Massage B: effleurage, friction, and petrissage; **p<0.01

RESULTS

The results of the OLST were investigated for any differences before and after the calf massage, and for any differences between groups.

Massage group A, to whom effleurage, tapotement and the pressure technique were applied, showed statistically significant differences in the OLST values before (6.24 ± 1.7 sec) and after (9.24 ± 2.3 sec) the massage intervention when supporting the body on the left leg (p<0.01). There were no statistically significant differences in the OLST values before (6.24 ± 1.7 sec) and after (6.11 ± 1.9 sec) on the right leg. Massage group B, to whom effleurage, friction and petrissage were applied, showed statistically significant differences on both sides (p<0.01) (Table 1).

Both massage group A and massage group B showed statistically significant differences in the FRT before and after the massage intervention (p<0.01) (Table 2). In the Massage group A, FRT values increased from 35.46 ± 5.3 cm before exercise to 41.61 ± 5.9 cm after massage. and In the Massage group B, FRT values increased from 35.72 ± 5.0 cm before exercise to 40.49 ± 5.7 cm after massage.

DISCUSSION

This study attempted to examine the differences between static and dynamic balance when local massage is applied to the calf using normal adults as research subjects with the purpose of exploring the effect of massage to balance. In this study, effleurage, petrissage, friction, tapotement, and pressure massage techniques were applied.

Effleurage is beginning of a session and end of each session. Effleurage must always follow the direction of venous return back to the heart and the direction of lymphatic drainage towards the nearest group of lymphatic nodes. This increases the arterial blood flow, bringing oxygen and nutrients to the tissues more quickly. Friction is aimed directly at the site of injury to mobilize muscle; separate adhesions in muscle, tendon, or scar tissue; and restore fibers to a more normal alignment for freer movement. Petrissage almost always follows effleurage to further warm the muscle tissue. It can be applied with two hands or one, and is done toward the heart on the extremities. The alternate squeezing and releasing action of the hands on the tissues again increases the circulation to the area, removing waste products and bringing oxygen and nutrients to the area, thus improving the condition of the tissues. Tapotement is various parts of the hand striking finishing a section of the body stimulate the tissues either by the tissues at a fairly rapid and stimulate the tissues either by direct mechanical force or by reflex action. Pressure is the amount of force a stroke applies to the tissue. If the intent is to reach deep into the tissue and break up adhesions^{12, 13}. Among physical therapists working in Saudi Arabia, friction is reported to be the most commonly used technique in therapeutic massage².

In this study, there was significant difference between the two legs in the group to whom effleurage, petrissage and friction were applied, and who performed a modified OLST before and after the application. However, in the group where effleurage, pressure and tapotement were applied, the difference after massage was only evident when the subjects were being supported on their left legs. The effects of the massage were therefore stronger in the group to which effleurage, petrissage and friction were applied. This result may have been due to the type of massage techniques that were applied. The friction technique employed for massage group B is applied to tendons and scar tissue, and it breaks up muscle adhesions. The petrissage technique mobilizes deep muscle tissue or the skin and subcutaneous tissue and increases local circulation. Therefore, these techniques may have been useful for increasing flexibility. Friction affect not only the deepest part of the muscle tendon or joint capsule gives a stimulating effect on the nervous system and tapotement is very efficient in revitalizing sore and tired muscles. Therefore, more effective at both legs in the group B that includes the friction.

In this study, significant differences in the FRT were evident before and after the massage application. However, there was no between-group difference. It is conjectured that the massage brought about no significant differences because the period of massage application was too short.

Grant et al.¹⁴ randomly performed tapotement and petrissage and examined their effect on ankle flexibility. In this research, no significant correlation was observed in the flexibility achieved by the two massage approaches, although the ankle joint flexibility of the left leg showed a significant result, which indicates a result similar to that of our study.

Gentle mechanical pressure provided by massage can change neuronal excitability as characterized by reduced amplitude of the H-reflex^{3, 15}. Massage-facilitated relaxation has also been found to increase parasympathetic activity¹⁶, to reduce hormonal stress levels¹⁷, to increase muscle compliance and range of joint movement¹⁸, to decrease passive stiffness¹⁹ and active stiffness¹⁷. As the eyes are shut during the OLSST, visual information is restricted; we can therefore say that the test measures the maintenance of balance by using the proprioceptive senses. Proprioceptive sensing by the feet is a very important factor in that it can affect the overall postural control of the body²⁰. Weerapong et al.¹³ argue that massage can also affect biomechanical mechanisms, which supports the results of this study.

In conclusion, it was shown that calf massage is effective in improving the flexibility and balance ability of the ankle joint. Massage applied to the calf seems to be a useful method that can be easily applied to those who feel fatigue in their ankles, or to elderly people who have diminished balancing abilities due to problems with their plantar-flexion torque. However, the types of massage used in this study resulted in no difference in effectiveness. This implies that any massage can be applied to the calf to induce improvements in the flexibility of the ankle joints. Massage has high usability in terms that it can easily be applied at home since it has a broad range of applications and no special qualifications are required.

The danger of falling is expected to decrease if balancing ability is improved by the application of calf massage. Because this decrease is likely to reduce the medical expenses incurred by falls and contribute to enhancing the ability of elderly people to perform daily activities, additional research related to falls and ankle flexibility is required.

We believe that the results of this study can be used as a resource for applying calf massage therapy not only to healthy people but also to patients and the elderly.

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