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Case Study

Effect of proprioceptive neuromuscular facilitation D2 flexion and breathing exercises on lymphedema without a short stretch compression bandage

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Abstract. [Purpose] The aim of this study was to evaluate the effects of proprioceptive neuromuscular facilitation (PNF) D2 flexion and breathing exercises in a patient with lymphedema (LE). [Subject] This report describes a 57-year-old woman with LE in whom a short-stretch compression bandage (SSCB) could not be used for treatment because of skin itching and redness. [Methods] The patient received complex decongestive therapy without a SSCB. Next, PNF D2 flexion and breathing exercises were conducted three times per week for 14 weeks (36 times). [Results] As a result, the circumference of the armpit was reduced by 0.5 cm; that of 10 cm above the elbow, by 1 cm; that of the elbow, by 0.5 cm; that of 10 cm below the elbow, by 1 cm; and that of the back of the hand, by 0.5 cm. A total of 100 mL (9.4%) of body water was eliminated from the right upper extremity, and moisture ratio was reduced by 0.005%. Finally, range of motion was improved to 20° flexion, 60° abduction, 40° external rotation, and 10° internal rotation. [Conclusion] This study showed that PNF D2 flexion and breathing exercises were effective in reducing LE and improving range of motion.

Key words: Lymphedema, Breathing exercise, Proprioceptive neuromuscular facilitation

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INTRODUCTION

Lymphedema (LE) is a condition in which lymphatic transport is compromised, allowing lymph fluid to accumulate between tissues. The accumulation causes progressive fibrosis between the skin and subcutaneous tissue, and is characterized by non-pitting swelling. This fibrosis and swelling damage lymphocytes and weaken the immune system, which eventually progresses to chronic inflammation and degeneration in the lymphatic system and peripheral tissues[1)]. LE causes various problems such as pain, tingling sensation, loss of sensation, muscle weakness, stiffness, and reduced joint range of motion (ROM)[2)].

LE treatment was first introduced in the 1980s in Germany by Dr. Michel Földi and continues to be studied since then[3)]. According to previous studies, complex decongestive therapy (CDT) for LE includes manual lymph drainage, application of a short stretch compression bandage (SSCB), reduction of edema, and skin care. This typical treatment has been shown to be effective[4, 5)]. However, an SSCB does not continuously maintain the pressure and must be rolled back every day[6)]. It can also result in skin redness or itching. If adverse effects on the skin occur and a SSCB cannot be applied, therapeutic exercises cannot be safely performed. Such was the situation in the case presented here in.

CASE REPORT

After right breast resection on June 2, 2006, a 57-year-old woman underwent axillary lymph node dissection and radiotherapy on October 24, 2012. Beginning in December 2013, edema developed in the right upper extremity, for which she presented to the department of rehabilitation. She was diagnosed with LE and received treatment of edema three times weekly. On the day of presentation, the patient reported to the physical therapy department for LE evaluation. A physical therapist partially measured the circumference of the upper extremity by using a tape measure as follows: axillary, at 10 cm above the elbow, at the elbow, and at 10 cm below the elbow, wrist, and hand[7)]. The measurements for the right upper limb were 34, 28, 28.5, 23, 16, and 19 cm, respectively. Those for the left upper limb were 32, 25, 25, 22, 16, and 18 cm, respectively. The moisture ratio between the body water and the intracellular fluid in the upper extremity was measured by performing a biological analysis with InBodyS10 (Biospace Ltd., Seoul, South Korea). As a result, the body water volume in the right arm was 1,550 mL, and the extracellular to total cellular (E/T)

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fluid ratio was 0.384%. The body water volume in the left arm was 1,390 mL, and the E/T fluid ratio was 0.378%. Furthermore, the patient showed a restricted ROM in the right arm as follow 120° flexion, 80° abduction, 15° external rotation, and 15° internal rotation.

On the day of evaluation, the treatment was explained to the patient, and the patient underwent CDT and SSCB application. On the next treatment day, the patient complained of skin itching and redness, and underwent another treatment. Because of the skin condition, CDT was administered without a SSCB three times per week for 14 weeks. After the treatment on March 27, 2014, the patient was reevaluated. The measurements of the upper right limb (axillary, at 10 cm above the elbow, at the elbow, and at 10 cm below the elbow, wrist, and hand) were reduced to 34.5, 29, 24.5, 25, 16, and 18.5 cm, respectively. The body water volume was 1,680 mL (10.8%), and the E/T fluid ratio was 0.387% in the InBody biological analysis. ROM improved to 160° flexion, 120° abduction, 40° external rotation, and 35° internal rotation. However, even though the values of the parameters of the right upper extremity were reduced, the LE increased. Because the SSCB method was not applied, the edema was reduced. Therefore, LE treatment was required.

Next, the patient underwent PNF D2 flexion and breathing exercises three times a week for 14 weeks (36 sessions in total). The starting position for the exercise is the supine position, with the shoulder joint in extension, adduction, and internal rotation; the elbow in extension; and the forearm, wrist, and fingers in pronation. The shoulder was slowly stretched by flexion, abduction, external rotation, elbow extension, and forearm supination, and the wrist and finger were slowly stretched by extension. The arm and ear were 8–10 inches apart, and the thumb was pointed toward the floor. The patient stretched her upper extremities as much as possible and maintained the position. At the same time, breathing was stopped and held for 5 seconds. After that, while exhaling, the arm should be slowly returned to the starting position. This treatment is performed for 10 repetitions (three sets), followed by 1 minute of rest.

This study conformed to the ethical standards of the Declaration of Helsinki (1975, revised 1983). The protocol for this study was approved by the institutional review board of Hanyang University (HYI-15-046-1).

RESULTS

After the PNF D2 flexion and breathing exercises, parameters of the right upper extremity and the body water volume were reduced. Moreover, the restricted ROM of the right side was improved. In the reevaluation on July 1, 2014, the parameters of the right upper extremity (axillary, at 10 cm above the elbow, at the elbow, and at 10 cm below the elbow, wrist, and hand) were reduced to 34, 28, 24, 24, 16, and 18 cm, respectively. The body water volume was reduced to 1,580 mL. In addition, the E/T fluid ratio was improved to 0.382%, and ROM was improved to 180° flexion, 180° abduction, 80° external rotation, and 45° internal rotation.

DISCUSSION

In this study, the effects of PNF D2 flexion and breathing exercises were studied in a patient with upper extremity LE for whom the SSCB treatment method could not used. As a result of the intervention, the circumference of the armpit was reduced by 0.5 cm; that of 10 cm above the elbow, by 1 cm; that of the elbow, by 0.5 cm; that of 10 cm below the elbow, by 1 cm; and that of the back of the hand, by 0.5 cm. A total of 100 mL (9.4%) of body water volume in the right upper extremity was eliminated, and the E/T fluid ratio was decreased by 0.005%. In addition, the ROM of the extremity was improved to 20° flexion, 60° abduction, 40° external rotation, and 10° internal rotation. This study showed that PNF D2 flexion and breathing exercises were effective in reducing LE and improving ROM. This study suggests the CDT method and PNF D2 flexion and breathing exercises for patients for who a SSCB could not be applied.

CDT is already known to be the standard treatment for edema[4, 5]. In addition, it is already known that SSCB compression force helps the natural pumping action of the muscle to increase circulation of venous and lymphatic fluid in edematous areas[3]. However, in a research by Irdesel et al.[8], comparison between a group that maintained pressure during the exercise and an opposition group did not show a beneficial difference in circulation. Therefore, the effects of SSCB had become controversial.

Previous studies have shown that PNF exercise improves joint mobility and muscle function[9–12]. Moreover, in a study by Sharman et al.[9], active PNF stretching was found to be the most effective method to improve ROM. In addition, in a study by Hindle et al.[10], PNF stretching was found to improve ROM, although plyometric, high-intensity, or maximum-intensity exercise reduced muscle consumption. After González-Ravé et al.[11] implemented different exercises for 13 weeks and compared overall ROM and shoulder ROM in PNF groups, ROM improved by 5.91° (70.96°→76.01°) and 5.08° (71.84°→76.88°), respectively, in the manual exercise groups but was reduced by 2.57° (68.11°→66.06°) in the non-exercise group. Their study showed that PNF exercise was effective for increasing ROM. However, in a comparison between the results of their study and those of previous studies, the same results could not be concluded owing to differences in study subjects. Therefore, studies on increasing muscular strength through performance of PNF are needed in order to determine their effect on edema.

Moseley et al.[13] analyzed breathing and gentle arm exercises, and observing LE reduction in the upper extremity by 46 mL (5.8%) immediately after exercise, 50 mL (5.3%) after 30 minutes, 46 mL (4.3%) after 24 hours, and 33 mL (3.5%) after 1 week. This parameter was remeasured 1 month after exercise and was reported to have decreased by 101 mL (9.0%). Although their research method differed, they reported a positive effect on LE reduction because of the combined effects of breathing and upper extremity exercises.

This study is a case report of individual treatment results in one patient, without a control group. Because of this

limitation, correlation could not be conclusively determined between the effects PNF D2 flexion and those of breathing exercises on LE and ROM. Research on the treatment of LE is currently underway. However, no studies have been conducted regarding treatment combined with breathing exercises. Therefore, the present authors referred to studies such as that by Moseley et al.[11] and concluded that PNF D2 flexion and breathing exercises improved LE and ROM. Although this study is a case report of a single patient, its results indicate that these exercises should be studied on a larger scale.

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