Original Article

Physical Therapy Rehabilitation Science

https://doi.org/10.14474/ptrs.2024.13.3.354
eISSN 2287-7584
pISSN 2287-7576

Phys Ther Rehabil Sci
2024, 13(3), 354-367
www.jptrs.org

Short-term Effects of Kaltenborn-Evjenth Functional Glide on Pain, ROM, and Function in Patients with Breast Cancer

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Objective: The purpose of this study was to investigate the effect of Kaltenborn-Evjenth concept functional glide (KEFG) on shoulder pain, range of motion (ROM), upper extremity dysfunction in breast cancer patients.

Design: Cross-sectional study.

Methods: In this study, 42 subjects were randomly assigned and distributed to 21 subjects in the KEFG group and 21 subjects in the Mulligan technique (MWM) group.

Results: After the application of joint mobilization, pain decreased significantly in both groups, and there was no significant difference between the two groups. The ROM of the joint was significantly increased in both groups, and there was no significant difference between the two groups. The SPADI pain was significantly decreased in both groups, and the disability and total components were significant only in the KEFG group, and there was no significant difference between the two groups.

Conclusions: KEFG and MWM were found to be effective in improving shoulder pain, ROM and upper extremity dysfunction in breast cancer patients. KEFG is thought to be an intervention that can yield positive outcomes among breast cancer patients with upper extremity dysfunction.

Key Words: Functional glide, MWM, Mobilization, Impingement syndrome, Breast cancer

Background and necessity

Breast cancer is the second most common cancer among women worldwide after thyroid cancer, and has a relatively good prognosis with a survival rate of 92%; however, the recurrence rate is as high as the survival rate[1]. In general, surgery is performed primarily for breast cancer, and radiotherapy, targeted therapy, endocrine therapy, and chemotherapy are secondarily applied. Two surgical methods are available for the management of breast cancer: total mastectomy and partial mastectomy. Recently, partial mastectomy has been applied to preserve the breast as much as possible, and breast-conserving surgery has been performed after primary surgery[2].

The adverse effects of breast cancer surgery, which usually occur in 40% of patients who undergo this procedure, include decreased shoulder joint range of motion(ROM), decreased levels of upper extremity function, fatigue, lymphedema of the arms, pain, numbness that may radiate from the front of the chest to the side, paresthesia, and fatigue[3, 4]. The most important complications of breast cancer surgery are limited shoulder joint ROM and reduction in upper limb function[5]. The arm is placed in a fixed position, causing pain in the upper extremity during surgery, and damage to the lymph node, pectoralis minor, pectoralis major, and breast tissue[6]. Pectoralis muscle shortening and muscle strength reduction can occur. In addition, radiotherapy and chemotherapy may cause excessive weakness, resulting in more pain in the affected arm and dysfunction of the shoulder

Received: Sep 6, 2024 **Revised:** Sep 26, 2024 **Accepted:** Sep 27, 2024
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joints[7, 8]. If this condition persists, the scapula is pulled forward and lowered, limiting the scapular movement. This weakens the rotator cuff muscles around the shoulder and limits internal rotation, resulting in shoulder impingement syndrome[9, 10]. Impingement syndrome narrows the subacromial space of the supraspinatus[11]. Elevation or abduction of the glenohumeral joint causes abnormal forward-upward dislocation of the humerus against the glenoid fossa and imbalance of cooperative actions such as the coupling force of the surrounding muscle[12, 13]. Exercise, meanwhile, is used as a key intervention for shoulder joint disorders and lymphedema after breast cancer surgery[14]. Several studies have confirmed the changes in physical function and psychosocial factors among breast cancer patients both at home and abroad. In Korea, it has been reported that tai chi[15, 16], the stepwise upper limb exercise program[17, 18], and elastic band exercise[19] were effective in improving the upper extremity function and activities of daily life among breast cancer patients. Outside of Korea, Pilates was applied for 8 weeks to enhance physical function and improve depression[20], and a combination of muscular and aerobic exercise programs was adopted for 17 weeks to improve physical function[21]. However, papers using Kaltenborn’s centralization technique to correct the abnormal forward-upward dislocation of the humerus, which is the cause of direct impingement syndrome, are insufficient. The Kaltenborn–Evjenth concept functional glide(KEFG) is used after a functional massage, before joint mobilization, and at the end of joint mobilization. Functional glide in the shoulder joints is effective in recalibrating the position of the wrong shoulder joint and providing a passive stretch. When the patient's arm moves against the therapist’s resistance and during active rotator cuff movement, gliding of the humeral head toward the restrictive direction occurs in stage 3 of the Kaltenborn phase[22]. On the other hand, movement with mobilization(MWM) via the Mulligan technique is recommended for the shoulder joint, hard-soft tissue, and passive stretching. The physical therapist handles the area with pain on movement and applies a force in the direction of correction while the patient actively raises the arm. In the MWM, the therapist first corrects and connects the patient's joints, and then moves the patient. By contrast, KEFG is performed by a therapist by manually gliding the joint after the patient has overcome the therapist's resistance and has reached the end of the movement.

Previous studies have evaluated the efficacy of MWM following the Mulligan technique in patients with impingement syndrome. It was reported that as a result of applying the MWM of the Mulligan technique to patients with impingement syndrome once a day for 6 days in 3 sets of 10 times, pain improvement and joint ROM were restored[23]. In addition, the efficacy of MWM following the Sham technique was compared with that of MWM following the Mulligan technique in patients with impingement syndrome, and the results showed that MWM following the Mulligan technique was more effective in improving patients’ ROM and upper extremity function[24]. Although several studies have examined the MWM, data on KEFG are limited. Many studies have also evaluated the effect of breast cancer resection on shoulder joint ROM[25, 26]. However, most of these studies focused on investigating the effects of manual lymph drainage(MLD) on the cardiovascular system and muscular motion. Previous studies showed significant differences in lymph edema, pain, shoulder ROM, and quality of life between patients who underwent MLD and those who did not undergo this procedure[27]. A significant difference was observed in the degree of pain and ROM in patients who underwent the complex exercise program compared with those who did not undergo the program[28]. However, few domestic studies have compared the shoulder pain, ROM and upper extremity dysfunction of patients with breast cancer who underwent the KEFG. Therefore, it would be meaningful to understand the clinically significant differences in pain, limited shoulder joint mobility and upper extremity dysfunction in this patient group.

Methods

Subjects

This study included 42 breast cancer patients who met the pain criteria and attended the D hospital in Daejeon. The sample size needed for the study was calculated using G-power 3.1. A total of 36 samples be obtained with an effect size of 0.4, α of 0.05, and power of 0.8. Forty-two patients should be selected considering a dropout rate of 15%[29].

The inclusion criteria of this study were patients who visited the hospital after mastectomy or shoulder surgery; those who had undergone mastectomy or shoulder surgery for more than 2 weeks; the ability to understand and carry out the researcher's instructions; and a positive Neer impingement syndrome test, Hawkins impingement syndrome test, pain during active shoulder elevation, pain during rotator cuff tendon palpation, pain on isometric abduction resistance, and pain above the C5 or C6 dermatome. We included those who had tested positive for 3 or more of these items[2, 30]. The exclusion criteria were: pain in the shoulder due to neurological diseases such as stroke; receipt of a diagnosis of neuromuscular disease such as thoracic nerve root compression; and difficulty understanding the researcher's instructions or explanations due to cognitive problems. We excluded persons with at least one criterion[2, 30]. Before the experiment, all subjects completed the subject's explanation and consent form. Based on the Declaration of Helsinki, the study protocol was approved by the Konyang University Bioethics Committee(approval number, KYU-2020-026-01) before the initiation of the study.

Study procedures

All research subjects were recruited voluntarily through recruitment notices placed on the 11th and 12th floor bulletin boards of Daejeon D Hospital, Republic of Korea, and informed consent forms and experimental procedures were explained before the experiment. In addition, we explained the expected risks and benefits, personal information protection, compensation for losses resulting from research participation, personal information provision, and withdrawal of consent. Before the experiment, a pre-test was conducted, and subjects were selected by excluding those who did not meet the inclusion criteria out of a total of 46 people. After selecting subjects, the pre-test evaluated shoulder pain, ROM and upper extremity dysfunction. After the pre-evaluation, they were allocated to two groups through randomization using an Internet program(Research randomizer: http://www.randomizer.org/). The two groups comprised 21 patients in the KEFG group and 21 patients in the MWM group. The intervention time for each group was 70 minutes/day, 6 times a week, for 1 week. The KEFG group underwent 3 sets of Kaltenborn–Evjenth concept functional dorsal glide and caudal glide 10 times each, and rested for 30 seconds between sets. After 10 minutes of application, 15 minutes of MLD and 45 minutes of conventional physical therapy(CPT) were applied. In the MWM group, 3 sets of Mulligan technique MWM dorsal glide and caudal glide were applied 10 times each, and 30 seconds of rest between sets were applied for a total of 10 minutes, followed by 15 minutes of MLD and 45 minutes of CPT. After that, each group underwent the post-test and follow up test one week after the post-test in the same way as the pre-test. A Kaltenborn–Evjenth manual therapist (who held a physical therapist license, had more than 5 years of clinical experience, and had completed more than 320 hours of training in Kaltenborn–Evjenth education) performed the KEFG, Mulligan technique MWM, pre-test, post-test, and follow up test(post-test 1 week later).

Interventions

Functional glide following the Kaltenborn–Evjenth technique (KEFG)

The patient is placed in a supine position, and the therapist uses a small wedge or sandbag to fix the patient's scapula. The therapist holds the patient's elbow with one hand and places the other hand in front of the humeral head. The patient is given the force to actively flex and abduct the shoulder. At this time, the therapist applies a slight resistance enough not to interfere with the patient's shoulder motion. At the end of the patient's active movement range, the therapist applies a Kaltenborn grade 3 dorsal and caudal glide. Afterward, the therapist releases the resistance and returns the patient's arm to its original position. The therapist performs 3 sets of 10 repetitions.

Mulligan technique Movement with Mobilization (MWM)

The patient is seated in a chair without a back rest. The therapist holds the patient's scapula with one hand and places it on the patient's humeral head with the other hand. While the patient is actively flexing and abducting the shoulder joint, the therapist pushes the patient's humeral head dorsally and caudally. The direction of the force applied by the therapist should be parallel to the glenohumeral joint concavity. The therapist performs 3 sets of 10 repetitions[23].

Manual lymph drainage (MLD)

MLD was performed gently, repeatedly, slowly, and lightly applied low pressure (45 mmHg) to the skin surface to massage the upper limb[31]. MLD was performed for 15 minutes daily, 6 times a week for 1 week.

Conventional Physical Therapy (CPT)

Superficial heat treatment (Sambu Plus, Korea) was applied for 20 minutes to reduce pain. Interferential current therapy (H-401; Hanil-TM, Korea) was applied for 15 minutes at 90–100 Hz and 10–20 mA, which was strong enough to feel comfortable and bearable to the test subject. Ultrasound treatment for pain reduction (HS-501; Hanil-TM, Korea) was applied at 1.2 w/cm² with a continuous waveform for 5 minutes. Laser treatment (HLA-200; Hanil-TM, Korea) was applied for 5 minutes using an IR Laser and He-Ne Laser at 5000Hz[32].

Assessment

Pain

To assess the degree of pain, a 100-mm visual analog scale (VAS), which is commonly used in clinical practice, was used. The number 0 at the left end of the line indicates the absence of pain, while 10 indicates the maximum tolerable pain. The patient should direct the pain level on a straight line. The intra-rater reliability ($r = 1.00$) and interrater reliability ($r = 0.99$) of this evaluation tool are very high[33]. The validity was 0.62–0.91, which was also very high compared with that of other pain assessment tools[34].

Range of Motion (ROM)

A goniometer (Baseline 12-1040, USA) is used to measure the ROM of the shoulder joint. Active flexion, abduction, external rotation, and internal rotation of the shoulder joint in the upper extremity were measured by one researcher. Flexion of the shoulder joint was assessed with the knees and hips flexed and the feet flat on the ground to prevent lumbar extension. The elbow joints were extended, and the forearm and palms were placed in pronation position. The axis of the goniometer was aligned with the acromion of the scapula passing through the humeral head. The fixed arm was placed on the trunk's median axillary line, and the mobile arm was assessed after the humerus' outer midline was located. Abduction of the shoulder joint was assessed with the knee straight, the knees and hips bent, and the feet flat. The arm measurements were taken with the elbow joint extended. The axis of the goniometer was aligned with the anterior part of the scapula acromion through the center of the humeral head. The fixed arm was parallel to the midline of the sternum and located just in front of the trunk. The moving arm was measured while parallel to the midline of the humerus and positioned on the anterior aspect of the arm. The external and internal rotations of the shoulder joints were measured with the knees bent, and the knees bent and the feet flat on the floor. The shoulder joints were abducted, and the elbow joints were bent at 90° while the forearm was in a neutral position. The axis of the goniometer was placed in the direction of the humeral head corresponding to the olecranon process of the ulna passing through the humerus body. The fixed arm was positioned perpendicular to the floor, and the mobile arm was placed on the ulna in the direction of the styloid process of the ulna[35-37]. The intra-rater reliability ranged from 0.80 to 0.93, while the interrater reliability ranged from 0.71 to 0.90 in the shoulder[38]. The validity values were 0.71–0.94 for shoulder flexion, 0.69–0.93 for abduction, 0.94–0.99 for external rotation, and 0.89–0.96 for internal rotation[39].

Upper extremity dysfunction

The Shoulder Pain and Disability Index (SPADI) was used to evaluate upper extremity function. The SPADI tool is a self-administered questionnaire, which assesses two domains: pain degree and discomfort. It consists of 13 questions, including 5 questions about pain and 8 questions about discomfort, and is rated as follows: 0 indicates the absence of pain or discomfort, while 10 indicates severe pain or discomfort. The total score is calculated as the average of 13 items plus the average score. A higher total SPADI score indicates a poorer level of dysfunction of the upper extremities[40, 41]. The reliability of the Korean shoulder pain and disability scale is 0.991 between assessment and re-evaluation, and Cronbach's α was 0.942. The concurrent validities of the Numeric Rating Scale, Disability of the Arm, Shoulder, and Hand Rating Scale, and ROM are 0.946, 0.935, and −0.927, respectively. There is a significantly positive correlation and a significantly negative correlation with the ROM[42].

Statical analysis

All statistical analyses of this study used SPSS version 25.0 to calculate the means and standard deviations. The Kolmogorov–Smirnov test was used to confirm the normality assumption regarding the distributions of the general characteristics and variables of the subjects, and a parametric test was used to establish a normal distribution. In addition, an independent samples *t*-test was used to test for homogeneity between groups. Repeated measures analysis of variance was used to compare changes in the dependent variable before, after, and after one week of intervention. If there was an interaction between time and groups, repeated measures one-way analysis of variance was used to compare the time periods for each group, and an independent samples *t*-test was used to compare the differences between groups. The Bonferroni method was used as a post hoc test. All statistical significance levels (α) of the data were set to 0.05.

Results

The subjects of this study comprised 21 in the KEFG group and 21 in the MWM group, with a total of 42 people. The subjects were all female, and among the general characteristics, there was no significant difference between the two groups in terms of age, height, and weight. Also, there was no significant difference in the initial shoulder pain(VAS), shoulder ROM and SPADI between the KEFG and MWM groups.

Comparison of the pain(VAS) scores

There was a significant difference in the time from repeated measurements of shoulder pain(VAS) score ($F=28.19$, $p=0.001$) and no significant difference in the interaction between group and time.

Table 1 shows the comparison between the two groups and the time period for each group before,

Table 1. Comparison of the VAS between groups ($N=42$)

Variable	Time	KEFG group (n=21)	MWM group (n=21)	*p*
VAS (score)	Pre	6.00(1.79)	5.19(2.06)	0.182
	Post	3.95(1.75)	4.10(1.64)	0.786
	Follow up	4.57(1.60)	4.19 (1.40)	0.416
	p	0.001	0.006	
	Post hoc	Post < Follow up < Pre	Post < Follow up < Pre	

The values are presented mean (SD)
KEFG: Kaltenborn−Evjenth concept functional glide, MWM: Mulligan technique movement with mobilization, VAS: visual analog scale.

after, and 1 week after the experiment to confirm the effect of shoulder joint mobilization on the shoulder pain(VAS) score of the KEFG and MWM groups. There was no significant difference between the two groups before the experiment, after the experiment, and 1 week after the experiment. There was a significant difference between the timing of shoulder pain(VAS) scores before and after the experiment in the KEFG group ($p = 0.001$), a significant difference after the experiment and 1 week after the experiment ($p = 0.026$), and a significant difference before the experiment and 1 week after the experiment ($p = 0.001$). In the MWM group, there was a significant difference before and after the experiment ($p = 0.036$), no significant difference after the experiment and 1 week after the experiment, and a significant difference between the pain(VAS) scores obtained before the experiment and 1 week after the experiment ($p = 0.023$).

Comparison of the shoulder flexion, abduction range of motion

There was a significant difference with time from repeated measurements of shoulder flexion ROM ($F = 85.07$, $p = 0.001$) and a significant difference in the interaction between group and time ($F = 5.44$, $p = 0.008$). And there was a significant difference with time from repeated measurements of shoulder abduction ROM ($F = 53.17$, $p = 0.001$) and no significant difference in the interaction between group and time.

Table 2 shows the comparison between the two groups and the time period for each group before, after, and 1 week after the experiment to confirm the effect of shoulder joint mobilization on the shoulder flexion, abduction ROM of the KEFG and MWM groups. There was no significant difference between the two groups before the experiment, after the experiment, and 1 week after the experiment.

There was a significant difference between the time of shoulder flexion ROM before and after the experiment in the KEFG group ($p = 0.001$), a significant difference after the experiment and 1 week after the experiment ($p = 0.001$), and a significant difference before the experiment and 1 week after the experiment ($p = 0.001$). In the MWM group, there was a significant difference before and after the experiment ($p = 0.001$), a significant difference after the experiment and 1 week after the experiment ($p = 0.001$), and a significant difference before the experiment and 1 week after the experiment ($p = 0.001$). There was a significant difference between the

Table 2. Comparison of shoulder ROM between the groups ($N = 42$)

ROM (degree)		**KEFG group (n = 21)**	**MWM group (n = 21)**	***p***
Flexion	Pre	141.48(17.12)	144.93(14.66)	0.486
	Post	166.63(9.80)	160.24(15.57)	0.121
	Follow up	155.81(11.65)	151.91(17.77)	0.406
	p	0.001	0.001	
	Post hoc	Pre < Follow up < Post	Pre < Follow up < Post	
Abduction	Pre	110.38(33.21)	112.05(38.57)	0.881
	Post	143.78(32.36)	150.29(25.71)	0.475
	Follow up	131.52(33.60)	138.13(30.28)	0.507
	p	0.001	0.001	
	Post hoc	Pre < Follow up < Post	Pre < Follow up < Post	

The values are presented mean (SD)
KEFG: Kaltenborn–Evjenth concept functional glide, MWM: Mulligan technique movement with mobilization, ROM: range of motion.

times of shoulder abduction ROM before and after the experiment in the KEFG group ($p = 0.001$), a significant difference after the experiment and 1 week after the experiment ($p = 0.001$), and a significant difference before the experiment and 1 week after the experiment ($p = 0.001$). In the MWM group, there was a significant difference before and after the experiment ($p = 0.001$), a significant difference after the experiment and 1 week after the experiment ($p = 0.036$), and a significant difference before the experiment and 1 week after the experiment ($p = 0.003$)

Comparison of the shoulder external, internal rotation range of motion

There was a significant difference with time from repeated measurements of shoulder external rotation ROM (F = 17.72, $p = 0.001$) and no significant difference in the interaction between group and time. And There was a significant difference with time from repeated measurements of shoulder internal rotation ROM (F = 21.75, $p = 0.001$) and no significant difference in the interaction between group and time.

Table 3 shows the comparison between the two groups and the time period for each group before, after, and 1 week after the experiment to confirm the effect of shoulder joint mobilization on the shoulder external, internal rotation ROM of the KEFG and MWM groups. There was no significant difference between the two groups before the experiment, after the experiment, and 1 week after the experiment.

There was a significant difference between the time of shoulder external rotation ROM before and after the experiment in the KEFG group ($p = 0.001$), a significant difference after the experiment and 1 week after the experiment ($p = 0.001$), and a significant difference before the experiment and 1 week after the experiment ($p = 0.023$). In the MWM group, there was no significant difference before and after the experiment, there was a significant difference after the experiment and 1 week after the experiment ($p = 0.001$), and there was no significant difference before the experiment and 1 week after the experiment. There was a significant difference between the time of shoulder internal rotation ROM before and after the experiment in the KEFG group ($p = 0.003$), no significant difference after the experiment and 1 week after the experiment, and a significant difference before the experiment and 1 week after the experiment ($p = 0.013$). In the MWM group, there was a significant difference before and after the experiment ($p = 0.004$), a significant difference after the

Table 3. Comparison of shoulder ROM between the groups (*N* = 42)

ROM (degree)		KEFG group (n = 21)	MWM group (n = 21)	*p*
External rotation	Pre	59.14(21.03)	66.50(18.43)	0.235
	Post	74.79(15.15)	75.74(11.88)	0.823
	Follow up	68.97 (18.29)	70.15(13.49)	0.812
	p	0.001	0.037	
	Post hoc	Pre < Follow up < Post	Pre < Follow up < Post	
Internal rotation	Pre	68.00 (27.23)	70.60(27.02)	0.758
	Post	84.43(11.50)	81.48(18.99)	0.546
	Follow up	83.00(8.43)	78.21(20.16)	0.324
	p	0.002	0.002	
	Post hoc	Pre < Follow up < Post	Pre < Follow up < Post	

The values are presented mean (SD)
KEFG: Kaltenborn–Evjenth concept functional glide, MWM: Mulligan technique movement with mobilization, ROM: range of motion.

experiment and 1 week after the experiment ($p = 0.029$), and a significant difference before the experiment and 1 week after the experiment ($p = 0.047$).

Comparison of the SPADI

There was a significant difference with time from repeated measurements of SPADI pain ($F = 22.80$, $p = 0.001$) and a significant difference in the interaction between group and time ($F = 9.82$, $p = 0.001$). There was a significant difference with time from repeated measurements of SPADI disability ($F = 23.11$, $p = 0.001$) and a significant difference in the interaction between group and time ($F = 14.28$, $p = 0.001$). And there was a significant difference with time from repeated measurements of SPADI total ($F = 30.52$, $p = 0.001$) and a significant difference in the interaction between group and time ($F = 16.96$, $p = 0.001$).

Table 4 shows the comparison between the two groups and the time period for each group before, after, and 1 week after the experiment to confirm the effect of shoulder joint mobilization on the SPADI of the KEFG and MWM groups. There was no significant difference between the two groups before the experiment, after the experiment, and 1 week after the experiment.

There was a significant difference between the time of SPADI pain before and after the experiment in the KEFG group ($p = 0.001$), no significant difference after the experiment and 1 week after the experiment, and a significant difference before the experiment and 1 week after the experiment ($p = 0.001$). There was no significant difference in the MWM group before, after, and 1 week after the experiment. . There was a significant difference between the time of SPADI disability before and after the experiment in the KEFG group ($p = 0.001$), a significant difference after the experiment and 1 week after the experiment ($p = 0.001$), and a significant difference before the experiment and 1 week after the experiment ($p = 0.011$). There was no significant difference in the MWM group before, after, and 1 week after the

Table 4. Comparison of SPADI between the groups ($N = 42$)

SPADI		KEFG group(n = 21)	MWM group(n = 21)	*p*
Pain	Pre	71.33 ± 15.78	61.33 ± 21.65	0.096
	Post	57.43 ± 13.06	59.05 ± 21.54	0.770
	Follow up	61.81 ± 16.39	56.19 ± 23.49	0.375
	p	0.001	0.031	
	Post hoc	Post < Follow up < Pre		
Disability	Pre	55.30 ± 15.42	47.80 ± 19.34	0.173
	Post	39.94 ± 15.11	45.78 ± 21.40	0.314
	Follow up	48.33 ± 16.78	44.70 ± 21.00	0.540
	p	0.001	0.098	
	Post hoc	Post < Follow up < Pre		
Total	Pre	61.47 ± 14.71	53.00 ± 19.36	0.119
	Post	46.67 ± 12.90	50.88 ± 20.71	0.434
	Follow up	53.52 ± 16.09	49.12 ± 21.27	0.455
	p	0.001	0.053	
	Post hoc	Post < Follow up < Pre		

The values are presented mean (SD)
KEFG: Kaltenborn–Evjenth concept functional glide, MWM: Mulligan technique movement with mobilization, SPADI: Shoulder Pain and Disability Index.

experiment. And there was a significant difference between the time of SPADI total before and after the experiment in the KEFG group ($p = 0.001$), a significant difference after the experiment and 1 week after the experiment ($p = 0.001$), and a significant difference before the experiment and 1 week after the experiment ($p = 0.001$). There was no significant difference in the MWM group before, after, and 1 week after the experiment.

Discussion

When breast cancer patients undergo resection, the axillary lymph glands and surrounding muscles are removed[43] and causes muscle shortening and contracture compared with the non-surgical muscles[44, 45]. In addition, mastectomy can cause shoulder pain and shoulder impingement syndrome[7, 46], thereby decreasing the quality of life[47]. Therefore, it is clinically important to approach physical therapy interventions for functional recovery in women who have undergone mastectomy.

As a result of self-exercise and mobilization in patients with impingement syndrome[48], there was a significant decrease in night pain, pain when moving the arm (as in flexion), and pain at rest. A study in which mobilization was performed along with an exercise program in patients with shoulder impingement syndrome showed a significant reduction in pain during arm movement[49]. On the contrary, when compared with another study that applied the BeHaS exercise program to breast cancer patients[50], there was no pain reduction, and the researchers mentioned that this was because the subjects were assessed 6 months or more after surgery. In the present study, breast cancer patients with impingement syndrome symptoms were targeted regardless of the postoperative period, and it is thought that there was a significant difference in pain. Most studies that applied mobilization to patients with impingement syndrome significantly reduced pain, and our study also supported this finding by obtaining the same results as many previous studies. In breast cancer patients, the degree of axillary lymph node resection during surgery affects the shoulder ROM, shoulder function, and upper limb edema[51]. As a treatment for this, in a study that applied electrical stimulation together with Maitland mobilization to breast cancer patients[52], as a result of applying Maitland technique grades 3–4 oscillation according to the patient's pain level by finding a range with limited movement, mobilization showed a positive effect on pain and shoulder ROM. Also, in another study that applied mobilization to breast cancer patients[53], mobilization increased shoulder flexion and abduction. In a study that applied shoulder mobilization and scapula exercise program to breast cancer patients[54], both the Maitland mobilization and scapula complex exercise program and the Maitland mobilization and shoulder joint general exercise program showed positive effects on shoulder flexion, abduction, external rotation, and internal rotation ROM. In this study, KEFG and MWM showed significant results in shoulder ROM, and the same results as in many previous studies support our findings. In a study that applied mobilization to patients with shoulder impingement syndrome[55], it was reported that mobilization showed a positively significant difference in the SPADI score of impingement syndrome. In addition, in a study that applied MWM to patients with shoulder impingement syndrome[56], a comparison of the MWM group and the MWM group with exercise showed that there was no statistically significant difference in SPADI between the groups, although there was a difference in SPADI scores before and after. However, a study that applied Pilates to breast cancer patients[57] reported a significant increase only in the disability level. Also, the results were similar to those of a study[58] that reported significant improvement in upper extremity function by applying scapular stabilization exercise to breast cancer patients with different surgical methods. This is thought to be due to the inclusion of mobilization and supports this study by obtaining the same results as in many previous studies other than in this study.

The limitations of this study were as follows.

First, in this study, subjects who had undergone resection due to breast cancer were recruited; however, they were not recruited according to the degree of breast resection such as total mastectomy, partial resection, or conservative surgery. When conducting future research on patients who have undergone breast cancer resection, it will be better to recruit subjects separately.

Second, this study did not distinguish between subjects receiving chemotherapy, radiotherapy, and anti-hormonal treatment when selecting subjects. When conducting future research, it is believed that classifying them and recruiting subjects will increase the accuracy of the research.

Third, since breast cancer patients may have differences before and after the experiment depending on the period after surgery, it would be better to divide the study into 6 months before and after when conducting future research.

Fourth, the Mulligan technique MWM is a mobilization method commonly used for pain control in shoulder impingement syndrome; however, it can cause pain by stretching the pectoralis muscle during shoulder flexion or abduction in breast cancer patients. Therefore, when conducting future research, it will be better to select a safer research method.

Conclusion

In this study, from May 2020 to November 2020, 42 breast cancer patients were divided into the KEFG group and MWM group, with 21 patients each, and joint mobilization was performed 6 times. After that, the following conclusions were obtained by comparatively analyzing the effects on shoulder pain, ROM, upper extremity dysfunction, upper limb edema, handgrip strength, and quality of life.

First, after mobilization was applied, pain was significantly reduced in both groups, and there was no significant difference between the two groups.

Second, after mobilization was applied, the joint ROM was significantly increased in both groups, and there was no significant difference between the two groups.

Third, after mobilization was applied, SPADI pain was significantly reduced in both groups, and SPADI disability and SPADI total were significant only in the KEFG group, and there was no significant difference between the two groups.

Summarizing the above results, shoulder mobilization using KEFG and shoulder mobilization using Mulligan technique MWM were found to be effective for shoulder pain, ROM and upper extremity dysfunction in breast cancer patients. Among them, for upper extremity dysfunction, Mulligan technique MWM showed no improvement in SPADI disability and SPADI total, but KEFG showed an improvement effect. The KEFG is considered to be an intervention method that can have a better effect as a positive aspect for breast cancer patients with upper extremity dysfunction.

Acknowledgment

I would like to express my gratitude to the many people who have helped me to complete this paper.

I would like to express my deep gratitude to Prof. Dong-Kwon Seo, who has helped me a lot since I transferred to Konyang University, filled the gaps in completing this thesis, and made me understand the depth of study. I am grateful to Prof. Byung-Kwon Lee for encouraging me to enroll in graduate school and for filling in the shortcomings of the thesis. I would like to express my gratitude to Prof. Chang-Yong Kim, who helped me a lot in the statistical analysis.

My thanks also go to Prof. In-Hyeop Baek of the Kaltenborn–Evjenth association for making efforts to advance physical therapy in Korea. I would also like to thank Prof. Jae-Kwang Shim who gave me a lot of advice on the experimental method and helped me to proceed with the experiment. Also, I would like to express my gratitude to Prof. Jeong-Ah Kim and Prof. Lasse Thue for teaching me to apply physical therapy in clinical practice.

Lastly, I would like to express my sincere gratitude to my parents who cherished me with love and guided me on the right path.

Conflict of interest

The authors of this study declare that there were no potential conflicts of interest with respect to the research, authorship, and publication.

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Appendix

Shoulder Pain and Disability Index (Korean ver.)

통증 척도

당신의 통증은 어느 정도 입니까?

0 = 통증 없음, 10 = 심한 통증

가장 심할 때	0	1	2	3	4	5	6	7	8	9	10
통증이 있는 쪽으로 누울 때	0	1	2	3	4	5	6	7	8	9	10
높은 선반의 물건에 팔을 뻗을 때	0	1	2	3	4	5	6	7	8	9	10
목 뒤를 잡을 때	0	1	2	3	4	5	6	7	8	9	10
통증이 있는 팔로 밀 때	0	1	2	3	4	5	6	7	8	9	10

종합 통증 점수 : ________ / 50 × 100 = ________ %

(주의 : 만약 대상자가 한 항목을 체크하지 않았다면 40으로 나누어 계산함)

장애 척도

아래 일을 할 때 어느 정도로 힘이 듭니까?

0 = 힘이 들지 않음, 10 = 도움 없이 할 수 없음

머리를 감을 때	0	1	2	3	4	5	6	7	8	9	10
등을 닦을 때	0	1	2	3	4	5	6	7	8	9	10
내의나 겉옷을 입을 때	0	1	2	3	4	5	6	7	8	9	10
앞에 단추가 있는 셔츠를 입을 때	0	1	2	3	4	5	6	7	8	9	10
바지를 입을 때	0	1	2	3	4	5	6	7	8	9	10
높은 선반 위에 물건을 놓을 때	0	1	2	3	4	5	6	7	8	9	10
4.5kg (10 파운드)의 무거운 물체를 들어 나를 때	0	1	2	3	4	5	6	7	8	9	10
바지 뒷주머니에서 무엇인가를 꺼낼 때	0	1	2	3	4	5	6	7	8	9	10

종합 장애 점수 : ________ / 80 × 100 = ________ %

(주의 : 만약 대상자가 한 항목을 체크하지 않았다면 70으로 나누어 계산함)

총합 점수 : ________ / 130 × 100 = ________ %

최소 변화 점수(90% 신뢰도) = 13점