


Effects of preoperative personal education on shoulder function and lymphedema in patients with breast cancer

A consort

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Abstract

Background: To compare the incidence and severity of ipsilateral shoulder dysfunction and lymphedema of 2 groups of patients needing to undergo unilateral breast cancer surgery, one of which had only received printed education materials and the other group which had received educational materials plus preoperative education.

Methods: We selected 61 patients who had been diagnosed with unilateral breast cancer and planned to undergo surgery. Before surgery, patients were randomly assigned, either to a control group that only received printed education materials about exercise for shoulder pain relief and lymphatic edema prevention following breast cancer surgery, or to an experimental group that received the printed education material with personal education. Participants were evaluated at 1, 3, 6, and 12 months after the surgery. To evaluate the impairment of shoulder function, we measured the passive shoulder range of motion (ROM), the degree of pain as visual analog scale (VAS), the short version of the disability of arm, shoulder, and hand (short DASH) scores, and the shoulder pain and disability index (SPADI). We checked arm circumferences to evaluate lymphedema.

Results: There was no significant difference in demographic or clinical variables between the control and experimental groups. The experimental group showed significantly less limitation in abduction ($P = .042$) and forward flexion ($P = .039$) in the 6 months following surgery. Change in the VAS, short DASH, and SPADI scores were 1.633 ($P < .001$), 2.167 ($P < .001$), and 4.1 ($P = .003$) at 1 month following surgery, respectively. These then decreased with time. These changes started before shoulder ROM and arm circumference changes had occurred, which had started 3 months following surgery.

Conclusions: Preoperative education might be helpful for the prevention of a shoulder ROM limitation, and we need to focus on pain and disability in patients immediately following breast cancer surgery, and then on ROM and lymphedema.

Abbreviations: DASH = disability of arm, shoulder, and hand, OR = odds ratios, ROM = range of motion, SPADI = shoulder pain and disability index, VAS = visual analog scale.

Keywords: breast cancer, lymphedema, shoulder function, shoulder motion, shoulder pain

1. Introduction

Female breast cancer forms 10% of new cancer diagnosed annually. It is also the leading cause of cancer deaths worldwide for women.^[1] Increased levels of obesity, westernized eating habits, and reduced breastfeeding have major impacts on the high incidence of breast cancer among all female cancers.^[2]

Shoulder dysfunction and lymphedema are some of known chronic complications that occurs after breast cancer surgery.

These not only causes cosmetic problems, but they also affect psychosocial adjustment, quality of life, and functional status.^[3,4] In particular, surgical trauma and radiation therapy increase the incidence of complications by inducing damage to the axillary lymphatic system.^[5] Shoulder dysfunction is one of the common complications following breast cancer surgery. After axillary lymph node dissection, 73% of women showed limitation of shoulder movement, tension, edema, pain, loss of arm sensation, and limitations of daily life. These complications are caused by

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tissue and nerve damage. They usually resolve within 3 months, but some also can become chronic.^[6,7] In a study of 141 early breast cancer patients, shoulder function was examined at 18 months after the treatment.^[8] About half of patients in their study complained of shoulder dysfunction, and 48% had limitation of shoulder joint range of movements (ROM). The frequency of lymphedema is generally about 30%, but the reported rate varies from 2% to 83%.^[9] Lymphedema can occur immediately upon or several years following breast cancer treatment. However, most cases occur within the first 18 months.^[9] This edema is different from the postoperative edema that may occur immediately following surgery. Lymphedema can cause discomfort and disability, which may lead to soft tissue infections and lymphadenitis, and to systemic and sometimes life-threatening infections.^[10]

Several studies have reduced shoulder dysfunction and lymphedema by physiotherapy, rehabilitation and education.^[4,6,11] Lacombe et al^[4] investigated the effects of early physiotherapy following breast cancer surgery to prevent lymphedema, and they found that postoperative physiotherapy was effective at least 1 year following surgery. In a randomized controlled trial by Beurskens et al,^[6] rehabilitation after axillary lymph node dissection for breast cancer treatment reduced shoulder pain and improved shoulder function and quality of life. There was also a prospective surveillance model consisting of preoperative evaluation and education, initial reevaluation after exercise, exercise program, and continuous surveillance for the prevention and treatment of shoulder dysfunction and lymphatic edema following breast cancer surgery.^[11] Rehabilitation reduced the incidence of breast cancer-related complications, for both short-term and long-term morbidity by enabling early detection and treatment of disability.^[11]

There are additional evidences of improvement in shoulder disorders and lymphedema, especially in improved outcomes from early intervention with prospective surveillance models.^[11] Therefore, the importance of pre-operative education emerged as a theory of self-regulation. According to this theory, individuals tend to cope with an illness based on an understanding of their experience.^[12] When individuals are informed about improving their ability to cope with healthcare events, it can be useful in clinical practice.^[12] This implies that patients themselves need adequate information to understand complications such as shoulder pain and lymphedema following breast cancer surgery.^[11] If a healthcare professional, such as a primary care physician fails to educate their patients about the risks of lymphedema or ways to reduce lymphedema, the patient's lack of information about this disease eventually makes them feel dissatisfied with the healthcare professional. This is also unsatisfactory for proper management of complications following breast cancer surgery.^[12,13] In contrast, a study by Sugden et al^[8] found that exercise advice following early breast cancer treatment had no impact on shoulder movement limitation. Therefore, effects of information about exercise need to be clarified.

So far, previous studies were retrospective or prospective observational studies, and there was not a randomized control study for preoperative education. The purpose of this study is to compare the incidence and severity of ipsilateral shoulder dysfunction and lymphedema in 2 groups of patients needing unilateral breast cancer surgery, 1 of which had only received printed education brochures, and the other of which had received both education brochures as well as personal education.

2. Methods

2.1. Study design

This is a prospective randomized controlled study with blinded assessor and patient (to outcome), conducted in the Department of Rehabilitation Medicine at a university hospital. This study was performed in line with the principles of the Declaration

of Helsinki. Approval was granted by the Institutional Review Board of Gyeongsang National University Hospital. The trial has been registered prospectively with the Clinical Research Information Service (KCT0002841). It was conducted from May 2018 to February 2020.

2.2. Participants

Participants were recruited over a 22-month period. Sixty-one patients with unilateral breast cancer who had been scheduled to undergo surgery at our institution from May 2018 to February 2020 were enrolled. The inclusion criteria were as follows: subjects aged between 30 and 60 years; diagnosis of unilateral breast cancer; undergo surgery at our institution. Subjects were excluded under one of the following conditions: previous medical history of breast cancer; terminal state; unilateral or bilateral upper extremity disease with pain or limitation of shoulder motion or edema due to other reasons; secondary arthritis of the shoulder due to surgery including shoulder joint, major trauma, or hemiparesis; systemic disease associated with the development of shoulder disease such as diabetes or thyroid disease; poor cooperation due to problems such as cognition.

2.3. Intervention

Subjects were informed about the clinical trial and consent was obtained. Randomization was conducted through block randomization. Prior to the clinical trial, sequences in permuted blocks with equal numbers of "control" and "intervention" assignments were obtained using a "shuffling envelope" procedure. A code manager not involved in the study carried out this procedure. At an outpatient visit, before starting education, a physiotherapist not involved in the study obtained the sequentially numbered, opaque, sealed envelope containing patient's assigned intervention and informed the patient of the group assignment. After confirming the group assignment, education brochures and personal education were provided. The educational brochures provided information about prevention of lymphatic edema (Supplemental Digital Content 1, <http://links.lww.com/MD/H418>) and exercise of shoulder pain relief (Supplemental Digital Content 2, <http://links.lww.com/MD/H419>). In the control group, the printed education brochures were provided to read and understand for an hour. In the experimental group, the printed education brochures were provided, and then direct 1:1 education was conducted for 30 minutes about the contents included in the education brochures. After thirty minutes, the researcher confirmed level of understanding by asking some information verbally and to perform exercise physically, then taught back some parts that were not fully understood, for 30 minutes. After that, no additional education was conducted for the experimental group. The researcher informed subjects of both groups to be familiar with the education brochures after breast cancer surgery.

2.4. Outcome measurements

The primary outcomes of this study were passive shoulder ROM, the degree of pain as visual analogue scale (VAS), short version of the Disability of Arm Shoulder and Hand (short DASH) scores, Shoulder Pain and Disability Index (SPADI), and arm circumferences. The secondary outcomes were odds ratios (OR) for shoulder ROM limitation, and timing of change in shoulder motion, pain, dysfunction and arm circumferences.

The baseline evaluation at zero week (before surgery) was performed including demographic variables (age, height, body weight, body mass index, dominant hand, previous medical history, occupational state, and education level) and clinical variables (location of the breast cancer, cancer stage, surgery type, results of lymphangiography, presence of lymph node dissection,

and duration of postoperative drain). Evaluation of ipsilateral shoulder function and lymphedema were performed at 1, 3, 6, and 12 months following surgery. To evaluate the impairment of shoulder function, passive shoulder ROM, the degree of pain as VAS, short DASH scores, and SPADI were measured.

The ROM (abduction, forward flexion, and external rotation) of the subject's shoulder joint was measured using a goniometer with limited scapular movement by a medical doctor. In addition, the Apley scratch test was used to evaluate internal rotation.^[14] VAS was used to represent the degree of pain, with zero being no pain to 10 being to the most severe pain imaginable.^[15] The short DASH was used instead of the 30-item DASH, which was as reliable and sensitive as 30-item DASH.^[16] The SPADI is a self-administered questionnaire that can be used to assess shoulder pain and functional limitations.^[17]

To evaluate lymphedema, the arm circumferences were measured with a tape measure. Both arms were placed on the table with the shoulder joints in a neutral state and bent 45 degrees, while the forearm was maintained in maximum supination. The circumferences of the arm at a distal and proximal distance of 5 cm from the elbow fold were measured as reference points. The circumferences differences of 2 cm or more were regarded as being significant edema.^[18] This method is known to be valid and reliable for the accurate diagnosis and measurement of secondary lymphedema.^[19] The sample size was calculated with Epidat Software (Health Situation Analysis Program, Washington D.C.), using the VAS as the primary outcome measurements of shoulder pain. Based on similar studies (numeric rating pain scale difference in means of 2.17 points; standard deviation: 1.6) with 80% power and an alpha level of 0.05, a total sample size of 30 patients in each arm was estimated to enter this study design.^[20,21]

2.5. Statistical analysis

Demographics and clinical variables were compared through Wilcoxon rank-sum test, Fisher's exact test and Chi-square test, according to the characteristics of variables. Changes of shoulder movement, pain, shoulder function and arm circumferences were compared using Mann-Whitney *U* test. Odd ratios for shoulder ROM limitation was analyzed using generalized linear mixed model with binomial distribution, and average changes in shoulder motion, pain, dysfunction and arm circumferences were analyzed using generalized linear mixed model with normal distribution.

All tests were 2-tailed and a *P* value of < .05 was considered statistically significant. All statistical analyses were performed using SAS Ver. 9.4 (SAS Institute, Cary).

3. Results

Seventy-nine patients with unilateral breast cancer were screened for the trial, 62 of whom were eligible. Of these patients, thirty-one were assigned to the experimental group, and thirty-one were assigned to control group. One patient in the control group dropped out during the follow-up because of a medical problem and its treatment. Figure 1 shows the flow of participant enrollment in the study. Finally, 61 patients were evaluated, and 31 were experimental (50.8%) and 30 were control group (49.2%). There were no differences in either the demographic and clinical variables between both groups, including age, height, body weight, body mass index, dominant hand, previous medical history, occupational state, education level, location of the breast cancer, cancer stage, surgery type, results of lymphangiography, presence of lymph node dissection, and duration of postoperative drain (Table 1).

There was no significant difference between 2 groups in external rotation, internal rotation, pain VAS, short DASH score, SPADI score and arm circumference except there was a

significant difference in abduction and forward flexion between control and experimental groups at 6 months after the surgery (Table 2). Shoulder abduction of control group was 176.0 ± 7.24 , while experimental group was 179.0 ± 3.01 , at 6 months after the surgery. Also, shoulder forward flexion of control group was 175.7 ± 7.74 , while experimental group was 179.0 ± 3.01 , at 6 months after the surgery. Therefore, the experimental group showed significantly low limitation in abduction ($P = .042$) and forward flexion ($P = .039$) of the shoulder joint than control group (Table 2).

The OR for abduction being below 180 was 1.930, with the 95% CI 0.088 to 3.772 ($P = .043$) at 1 month after surgery. It was 1.950 with the 95% CI 0.090 to 3.672 ($P = .044$) at 6 months after surgery. The OR for forward flexion being below 180 degrees was also 1.983 with the 95% CI 0.111 to 3.885 ($P = .038$) at 1 month after surgery, and it was 1.902 with the 95% CI 0.101 to 3.894 ($P = .039$) at 6 months after surgery. Therefore, OR for abduction and forward flexion being below 180 degrees were significantly higher than being 180 degrees at 1 and 6 months after the surgery. In addition, OR for external rotation being below 90 degrees was 2.304 with the 95% CI 0.552 to 4.057 ($P = .010$), 2.923 with the 95% CI 1.130 to 4.717 ($P = .001$), 3.223 with the 95% CI 1.411 to 5.035 ($P = .001$) and 1.600 with the 95% CI 0.603 to 4.248 ($P = .001$) at 1, 3, 6, and 12 months after the surgery, respectively (Table 3). Although OR for shoulder ROM limitation was not statistically different between control and experimental groups, it was always higher in control groups at all follow-ups following surgery, except for OR in the 1 month for the external rotation (similar tendency) (Fig. 2).

Changes in shoulder internal rotation, pain VAS, short DASH, SPADI score, and arm circumferences were not significantly different between 2 groups at any time (not shown).

Because there were no significant differences between 2 groups at any time, the average changes in shoulder motion, pain, dysfunction, and arm circumferences in all patients were analyzed. Internal rotation evaluated by Apley scratch test significantly increased 0.75 cm ($P = .023$), and 0.72 cm ($P = .020$), at 3 and 6 months following surgery (Table 4). The pain VAS significantly increased 1.633 scores ($P < .001$) 1 month following surgery, then significantly decreased 0.833 scores ($P = .006$) and 0.600 scores ($P = .046$), at 3 and 6 months after surgery. The short DASH significantly increased 2.167 scores ($P < .001$) 1 month following surgery, and then significantly decreased 1.267 scores ($P = .015$) 3 months following surgery. The SPADI significantly increased 4.100 scores ($P = .003$) 1 month following surgery, which then significantly decreased 1.075 scores ($P = .036$) at 12 months following surgery. Arm circumference 5 cm above elbow significantly increased 0.480 cm ($P = .014$) and 0.450 cm ($P = .021$) at 3 and 6 months following surgery. The arm circumference 5 cm below elbow also significantly increased 0.493 cm ($P = .013$) at 6 months following surgery (Table 4).

4. Discussion

In the present study, shoulder dysfunction and lymphedema following unilateral breast cancer surgery were assessed, and differences between groups according to preoperative education were compared. Among the 61 subjects with unilateral breast cancer surgery, patients who received pre-operative personal education showed less limitation in shoulder abduction and forward flexion at 6 months, compared to those patients who did not receive preoperative personal education. Therefore, preoperative personal education is helpful for prevention of shoulder ROM limitation. The OR for shoulder ROM limitation was also higher in subjects supplied with printed education brochures only as compared to subjects with preoperative personal education, although this was not of statistical significance. Therefore, the results of the present study support the hypothesis that

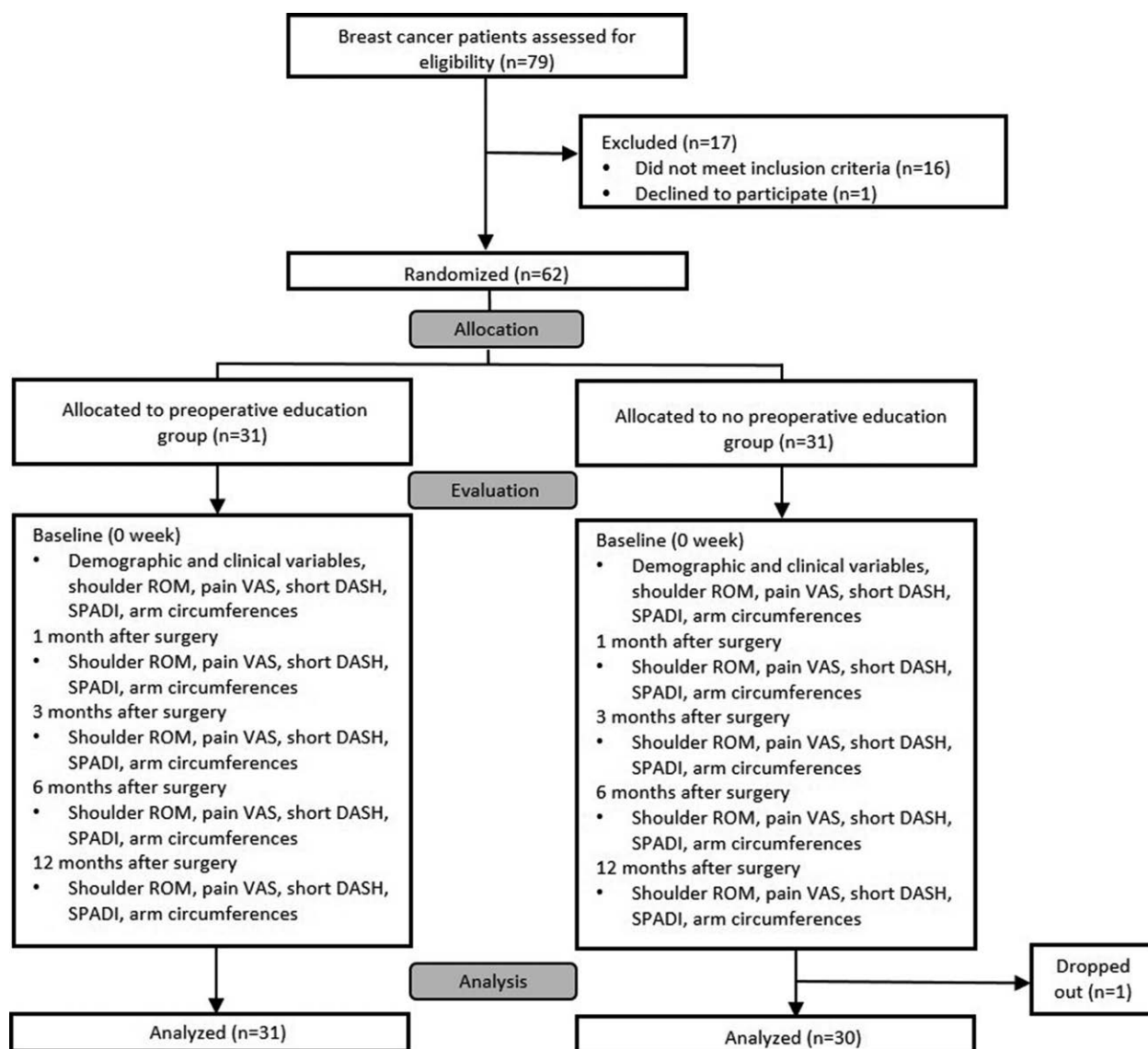


Figure 1. Flow diagram for study participants.

preoperative personal education about shoulder motion and function effectively helps to reduce postoperative complications in patients with breast cancer. On the last follow up day of the present study, patient's satisfaction about the preoperative education was investigated. In the survey questioning the level of understanding, quality, location, timing and type of education, 96.7% of patients reported over 80% satisfaction. The result indicates additional support for the role of preoperative education in patients with breast cancer surgery.

Breast and axillary surgery with radiotherapy are parts of the standard treatment for breast cancer, which can cause scar and wound formation, fibrosis, shortening of soft tissues and secondary muscle activity loss. Although less extensive surgery and possible reduction of radiotherapy have been tried, subsequent limitation in shoulder ROM with pain and disability are still observed.^[22] To prevent such complications, preoperative and postoperative exercises have been studied concerning its role and timing.

Previous studies about the role of education in other chronic diseases such as diabetes, hypertension and ankylosing spondylitis elucidated its positive effects.^[23–25] Additional studies showed that preoperative education reduced fear, anxiety, pain and the length of hospital stay, and it increased psychological

well-being and satisfaction.^[26–29] According to the systematic review by Moyer et al.^[30] preoperative education and/or exercise improved function, quadriceps strength, and length of stay in patients undergoing total knee arthroplasty, and it improved pain, function, and length of stay in patients undergoing total hip arthroplasty.

Timing of the education has been studied with diversified conditions. Preoperative education helps to conduct both preoperative and postoperative exercise by letting patients to exercise by themselves before they enter a period of potential immobility or decreased activity. The present results are in agreement with the results of a previous study carried out by Imamoğlu et al.^[31] who reported significantly better shoulder functions in patients who had been educated about lymphedema. In their study, 1 group was educated about causes and symptoms of lymphedema, as well as strategies for lymphedema care such as skin care, exercises, and changes to be made in daily life activities, while the other group was not educated. Although subjects were patients with lymphedema, shoulder function improved with education. However, their study was about education after the occurrence of lymphedema, which is different from the present study dealing with education before the surgery. There was a prospective study dealing with a perioperative educational

Table 1
Demographic and clinical variables.

Characteristics	Control group (n = 30)	Experimental group (n = 31)	P value
Age (yrs)	56.16 ± 11.05	55.60 ± 12.41	.530†
Height (cm)	157.4 ± 6.13	156.8 ± 5.05	.891†
Body weight (kg)	60.46 ± 13.50	61.59 ± 10.38	.530†
Body mass index (kg/m ²)	24.29 ± 4.35	25.05 ± 3.73	.286†
Dominant hand			1.000‡
Right (n)	29	30	
Left (n)	1	0	
Both (n)	0	1	
Previous medical history			.510§
Absent (n)	12	15	
Present (n)	18	16	
Occupational state			.717§
Unemployed (n)	19	21	
Employed (n)	11	10	
Education yr (yrs)	10.73 ± 3.60	11.58 ± 4.00	.188†
Location of breast cancer			.083‡
Right (n)	14	16	
Left (n)	16	15	
Cancer stage			.435‡
DCIS (n)	3	3	
Invasive carcinoma grade I (n)	11	13	
Invasive carcinoma grade II (n)	11	12	
Invasive carcinoma grade III (n)	4	3	
Invasive carcinoma grade IV (n)	1	0	
Surgery type			.231‡
BCS (n)	24	21	
MRM (n)	4	5	
Total mastectomy (n)	0	1	
Nipple sparing mastectomy (n)	2	3	
Wide excision (n)	0	1	
Lymphangiography result			.370‡
Not checked (n)	19	21	
Secondary lymphedema (n)	2	1	
LNs uptake (n)	8	7	
No visualized LNs (n)	1	1	
No focal uptake (n)	0	1	
Presence of lymph node dissection			.097§
SLNB alone (n)	15	18	
Partial ALND (level I–II) (n)	15	13	
Duration of postoperative drain (d)	6.97 ± 2.08	6.32 ± 2.87	.213†

ALND = axillary lymph node dissection, BCS = breast conserving surgery, DCIS = ductal carcinoma in situ, LN = lymph nodes, MRM = modified radical mastectomy, SLNB = sentinel lymph node biopsy.

†P value by Wilcoxon rank-sum test.

‡P value by Fisher's exact test.

§P value by Chi-square test.

program.^[32] That study included 37 patients in perioperative educational program, and 27 patients in control group supplied written information about shoulder exercise. The perioperative educational program given before surgery resulted in improved horizontal extension and an improved Subjective Perception of Post-Operative Functional Impairment of the Arm scores. The result was similar to the present study, but it was a nonrandomized, controlled trial. Education not only affects shoulder function, but also lymphedema. Fu et al^[33] analyzed patients with breast cancer-related lymphedema and concluded that patients who had received information about lymphedema had significantly fewer symptoms of it. The present study did not show significant differences in arm circumferences between 2 groups. The difference in results might be because of the contents of information provided before the surgery. In the study by Fu et al,^[33] they concluded that information about breast cancer related lymphedema had helped patients to stay away from the avoidable risk factors that can lead to lymphedema. The present study contained more information about exercise than about risk factor avoidance. Therefore, preoperative education that contains information directly related to lymphedema prevention would be helpful in improving arm swelling and lymphedema.

Types of the education also needs to be considered. There was a study comparing in-person instruction with video teaching for shoulder prehabilitation exercise for patients with breast cancer.^[34] In their study, in-person teaching was not significantly superior to video teaching. However, their study was different with the present study comparing education brochures supply with preoperative personal education, which showed significant advantage in shoulder ROM limitation. The difference might be due to the time cost for video teaching, which would be longer than reading the educative brochures in the present study. Time consuming would include time for explanation and confirmation of understanding about the explained information.

Lokapavani et al^[35] reported that patients with prehabilitation of the glenohumeral and scapulothoracic joint ROM exercises were more resistant to shoulder ROM limitation, disability, and pain. Postoperative shoulder ROM exercise also showed a moderate level of evidence of improved shoulder flexion, abduction, and external rotation, whereas muscle strengthening exercise exhibited less evidence for improved shoulder function.^[36] Therefore, shoulder ROM and strengthening exercise before and after the surgery would help to prevent shoulder dysfunction and restore its function. Limitation in shoulder movement,

Table 2**Changes of shoulder movement, pain, shoulder function and arm circumferences.**

Measure	Evaluation time	Control group (n = 30)	Experimental group (n = 31)	P value
Shoulder passive ROM (degrees)				
Abduction				
Before surgery		175.7 ± 15.47	178.4 ± 4.54	.902
1 mo after surgery		174.7 ± 11.06	177.7 ± 4.97	.291
3 mo after surgery		176.0 ± 8.94	178.1 ± 4.77	.429
6 mo after surgery		176.0 ± 7.24	179.0 ± 3.01	.042*
12 mo after surgery		176.8 ± 14.80	178.6 ± 3.55	.210
Forward flexion				
Before surgery		175.8 ± 15.87	178.7 ± 3.41	.883
1 mo after surgery		173.7 ± 14.50	178.4 ± 3.74	.156
3 mo after surgery		175.3 ± 11.06	178.4 ± 3.74	.393
6 mo after surgery		175.7 ± 7.74	179.0 ± 3.01	.039*
12 mo after surgery		176.5 ± 6.61	179.6 ± 3.55	.194
External rotation				
Before surgery		85.33 ± 12.79	86.45 ± 8.77	.880
1 mo after surgery		81.00 ± 13.48	83.55 ± 10.18	.628
3 mo after surgery		81.50 ± 12.26	84.19 ± 8.86	.448
6 mo after surgery		80.67 ± 13.63	83.23 ± 9.09	.629
12 mo after surgery		80.00 ± 15.06	84.14 ± 8.27	.356
Internal rotation				
Before surgery		7.73 ± 9.04	7.16 ± 8.40	.885
1 mo after surgery		8.46 ± 8.85	7.92 ± 9.00	.659
3 mo after surgery		8.48 ± 8.82	7.47 ± 8.30	.603
6 mo after surgery		8.48 ± 8.72	7.45 ± 8.51	.598
12 mo after surgery		8.42 ± 9.08	7.72 ± 8.78	.399
Pain VAS				
Before surgery		0.30 ± 1.47	0.13 ± 0.50	.973
1 mo after surgery		1.93 ± 2.39	1.55 ± 2.06	.502
3 mo after surgery		1.13 ± 1.38	1.13 ± 1.50	.872
6 mo after surgery		0.90 ± 1.30	0.61 ± 0.92	.500
12 mo after surgery		0.42 ± 0.81	0.51 ± 1.01	.698
Short DASH score				
Before surgery		2.23 ± 11.50	0.52 ± 1.69	.451
1 mo after surgery		3.00 ± 3.69	2.35 ± 2.96	.600
3 mo after surgery		2.10 ± 2.72	1.39 ± 1.86	.509
6 mo after surgery		1.70 ± 2.38	0.77 ± 1.18	.170
12 mo after surgery		0.97 ± 1.64	0.57 ± 1.01	.524
SPADI score				
Before surgery		0.83 ± 4.04	0.32 ± 1.14	.693
1 mo after surgery		6.33 ± 8.52	7.42 ± 10.54	.660
3 mo after surgery		4.53 ± 5.83	3.29 ± 3.93	.813
6 mo after surgery		3.07 ± 4.60	1.35 ± 1.99	.267
12 mo after surgery		1.19 ± 2.09	1.08 ± 2.02	.883
Arm circumferences (above elbow 5cm) (cm)				
Before surgery		24.59 ± 2.53	24.81 ± 2.42	.707
1 mo after surgery		24.86 ± 2.60	24.79 ± 2.59	.983
3 mo after surgery		25.07 ± 2.88	24.91 ± 2.39	.908
6 mo after surgery		25.04 ± 2.77	25.00 ± 2.67	.948
12 mo after surgery		24.78 ± 2.55	25.07 ± 2.60	.541
Arm circumferences (below elbow 5 cm) (cm)				
Before surgery		23.04 ± 2.09	23.09 ± 2.00	.520
1 mo after surgery		23.14 ± 2.11	23.35 ± 2.02	.588
3 mo after surgery		23.27 ± 2.45	23.33 ± 2.08	.767
6 mo after surgery		23.53 ± 2.44	23.39 ± 1.88	.994
12 mo after surgery		23.18 ± 2.45	23.68 ± 2.20	.287

C = control group, DASH = disability of arm shoulder and hand outcome measure, E = experimental group, ROM = range of movement, SPADI = shoulder pain and disability index, VAS = visual analogue scale.

* $P < .05$, P value by Mann–Whitney U test.

especially forward flexion and abduction, improved by the preoperative personal education in the present study. Although it was 3.0 to 3.3 degrees, the difference was significant. This is similar with previous randomized controlled trial showing a greater improvement in shoulder flexion and abduction in post-surgical breast cancer subjects who had training in excise program of passive stretching and progressive resistance training.^[37] Also, Box et al,^[38] showed a quicker return of abduction to

preoperative level following a Physiotherapy Management Care Plan. Although there are other studies showing shoulder ROM improvement in external rotation or internal rotation, more studies would be required to reveal the exact effect of breast cancer surgery and preoperative shoulder exercise on shoulder mobilization.^[39,40] According to the study by Shamley et al,^[41] muscle activity of trapezius evaluated by electromyogram was lower on affected side following breast cancer surgery, and the

Table 3
Odd ratios for shoulder range of motion limitation.

Shoulder ROM	Evaluation time	OR (95% CI)	P value
Abduction < 180	1 mo after surgery	1.930 (0.088-3.772)	.043*
	3 mo after surgery	1.246 (-0.605-3.097)	.192
	6 mo after surgery	1.950 (0.090-3.672)	.044*
	12 mo after surgery	2.076 (0.624-7.253)	.093
Forward flexion < 180	1 mo after surgery	1.983 (0.111-3.885)	.038*
	3 mo after surgery	1.280 (-0.598-3.158)	.183
	6 mo after surgery	1.902 (0.101-3.894)	.039*
	12 mo after surgery	2.087 (0.602-7.229)	.087
External rotation < 90	1 mo after surgery	2.304 (0.552-4.057)	.010*
	3 mo after surgery	2.923 (1.130-4.717)	.001*
	6 mo after surgery	3.223 (1.411-5.035)	.001*
	12 mo after surgery	1.600 (0.603-4.248)	.001*

CI = confidence interval, OR = odds ratio, ROM = range of motion.

* $P < .05$, P value by Generalized linear mixed model with binomial distribution.

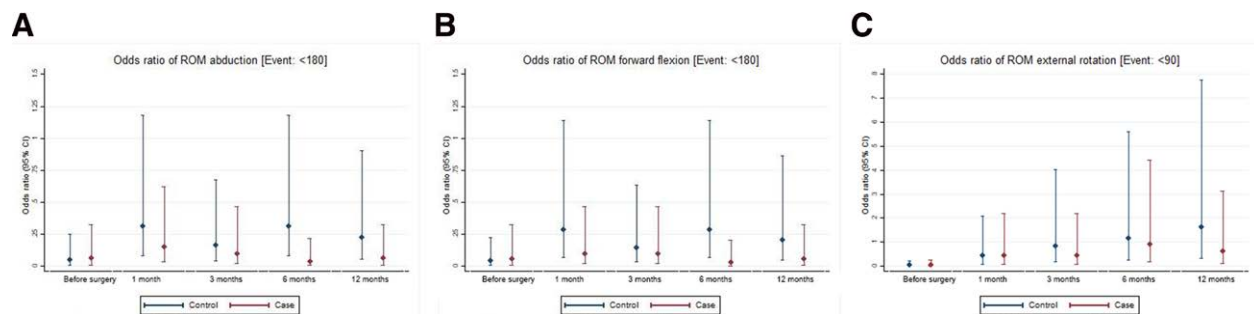


Figure 2. Odd ratios for shoulder range of motion limitation in control and experimental groups. (A) Shoulder abduction being below 180 degrees. (B) Shoulder forward flexion being below 180 degrees. (C) Shoulder external rotation being below 90 degrees.

muscle size of pectoralis major and minor were significantly smaller on the affected side. The pectoralis muscles are also in the surgical field of the breast cancer.^[42] Therefore, shoulder movement related to these muscles would require more attention for postoperative care.

Acute postoperative pain, which may arise from surgical tissue trauma and related acute inflammatory processes, tend to resolve within 2 to 10 days following surgery.^[43] Pain may last beyond the healing of injured tissue inflammation, and it may persist for several months following surgery. Around 10% to 50% of patients who undergo surgery develop persistent post-surgical pain.^[44] Following breast cancer surgery, around 40% of patients reported persistent pain until 1 year.^[45] The present study also showed a similar tendency. Pain and disability tended to increase immediately following surgery, which then decreased with time. These changes started prior to shoulder ROM and arm circumference change, which started 3 months following surgery. Therefore, the present study suggests focusing on pain and disability for the first month in postsurgical breast cancer patients, then focusing on shoulder ROM and lymphedema for next 3 months.

The main strength of the present study is the randomized control study design, since it enables direct evaluation of the role of preoperative personal education. In addition, this study followed up subjects for a year following surgery to compare and confirm any late complications. However, there are some limitations. The study was carried out at a single center and the number of patients was insufficient for subgroup analysis, such as surgery type, presence of lymph node dissection, lymphangiography result, and cancer stage. In addition, evaluation about patient's experience with education and type of education such

as format, content, and timing were not conducted, and these would help to support more about the importance of education in future studies. The ROM difference were less than 5 degrees, which need further evaluation about the role of presented ROM difference in relation to the shoulder function. Further prospective studies are required to strengthen these results.

This study demonstrates that preoperative personal education is helpful for the prevention of shoulder abduction and forward flexion limitation. Pain, short DASH, SPADI significantly increased at 1 month following surgery, while shoulder internal rotation and arm circumferences significantly increased at 3 months following surgery. Therefore, healthcare providers need to focus on pain and disability in patients immediately following breast cancer surgery and then to move on to ROM and lymphedema for better postoperative follow up.

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Table 4
Average changes in shoulder motion, pain, dysfunction, and arm circumferences.

Measure	Evaluation time		P value
Shoulder ROM Internal rotation	Change in cm		
	1 mo after surgery	0.821	.103
	3 mo after surgery	0.750	.023*
	6 mo after surgery	0.720	.020*
	12 mo after surgery	0.055	.759
Pain VAS	Change in scores		
	1 mo after surgery	1.633	<.001*
	3 mo after surgery	-0.833	.006*
	6 mo after surgery	-0.600	.046*
	12 mo after surgery	-0.478	.999
Short DASH	Change in scores		
	1 mo after surgery	2.167	<.001*
	3 mo after surgery	-1.267	.015*
	6 mo after surgery	-0.867	.094
	12 mo after surgery	-0.465	.949
SPADI	Change in scores		
	1 mo after surgery	4.100	.003*
	3 mo after surgery	-2.300	.088
	6 mo after surgery	-0.833	.536
	12 mo after surgery	-1.075	.036*
Arm circumference above elbow 5 cm	Change in cm		
	1 mo after surgery	0.270	.167
	3 mo after surgery	0.480	.014*
	6 mo after surgery	0.450	.021*
	12 mo after surgery	-0.095	.394
Arm circumference below elbow 5 cm	Change in cm		
	1 mo after surgery	0.103	.599
	3 mo after surgery	0.230	.243
	6 mo after surgery	0.493	.013*
	12 mo after surgery	-0.030	.343

DASH = disability of arm shoulder and hand outcome measure, ROM = range of motion, SPADI = shoulder pain and disability index, VAS = visual analogue scale.

* $P < .05$, P value by Generalized linear mixed model with normal distribution.

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