

Effect of a certain designed progressive shoulder exercise after breast cancer surgery on shoulder movement, seroma, pain, and satisfaction: a randomized controlled trial

Suchada Sanguanphak¹, Vimonwan Hiengkaew^{2*}, Noosreena Wanchitnai¹, Angkhana Tippayasi¹, Suebwong Chuthapisith³

¹Nurse Division, Siriraj Hospital, Faculty of Siriraj Medicine, Mahidol University, Bangkok, Thailand.

²Faculty of Physical Therapy, Mahidol University, Nakhon Pathom, Thailand.

³Department of Surgery, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand.

KEYWORDS

Breast cancer;
Arm function;
Satisfaction;
Seroma;
Shoulder exercise.

ABSTRACT

A free shoulder exercise for individuals after breast cancer surgery has been used in a hospital. The exercise has no warm-up and cool-down and research evidence. The exercise should be adjusted to a certain designed progressive shoulder exercise that was expected to use instead of the previous one. The study aimed to compare the effect of the certain designed progressive with the free shoulder exercise on shoulder range of motion, shoulder and arm function, net amount of seroma, pain, and overall satisfaction. Sixty (n = 60) individuals after breast cancer surgery were randomized to the free (n = 30) and certain designed progressive shoulder exercise group (n = 30). Both groups exercised by themselves using booklet and video. The free shoulder exercise group chose and did exercise as they preferred, whereas the certain designed progressive shoulder exercise group followed the exercise as described. Both groups were assessed for active and passive shoulder range of motion in all directions, shoulder and arm function, total seroma excretion, pain, and overall satisfaction. The certain designed progressive shoulder exercise showed similar outcomes to the free shoulder exercise, except less active (p -value = 0.014) and passive (p -value = 0.012) shoulder flexion range on day 3 after surgery. The certain designed progressive shoulder exercise was inferior to the free shoulder exercise on shoulder flexion range on day 3 after surgery. However, its final effect was comparable to the free shoulder exercise. The certain designed progressive shoulder exercise is suggested to be a shoulder exercise after breast cancer surgery since it demonstrates a particular exercise poses and frequency and no pain after exercise.

*Corresponding author: Vimonwan Hiengkaew, PT, PhD. Faculty of Physical Therapy, Mahidol University, 999 Phutthamonthon 4 Rd., Phuttamonthon, Salaya, Nakhon Pathom 73170, Thailand. Email address: vimonwan.hie@mahidol.ac.th

Received: 19 November 2022/ Revised: 27 February 2023/ Accepted: 5 March 2023

Introduction

Breast cancer is the most worldwide common cancer found in females⁽¹⁾. Generally, treatment is surgery probably with lymph nodes dissection⁽²⁾ that may be associated with short- and long-term unexpected effects in several patients⁽³⁾. The complications include hematoma, wound infection, seromas, pain, numbness, shoulder range of motion limitation, and lymphedema⁽⁴⁾. Shoulder exercise can reduce pain, increase shoulder range of motion, decrease activity of daily living impairments, avoid seroma formation, and increase volume of wound drainage^(5,6). There are several shoulder exercise programs; however, the suitable technique and content of programs still need further investigation⁽⁶⁾.

Shoulder exercise program can be active or passive exercise⁽⁶⁾, or free or restricted amplitude active exercise^(7,8). The free and restricted shoulder range of motion exercise demonstrate similar shoulder range of motion, pain, and upper limb function⁽⁸⁾, and prevalence of seroma^(7,8). In 2012 at a university hospital in Thailand a free amplitude active shoulder exercise was designed for individuals after breast cancer surgery and has been continuously used for the patients without supporting evidence by any research. The disadvantage of the exercise is no warm-up and cool-down that can reduce vicious resistance of muscles and joints⁽⁹⁾, lactic acid accumulation, pain and muscle soreness⁽¹⁰⁾. Additionally, subjectively observed individuals with complication after breast cancer surgery such as hematoma and wound pain did less and avoided exercise, and did not use arm (Private Patient Division, Siriraj Hospital, unpublished data, February 2015). Therefore, the program needs improvement. By collaboration between a nurse and a physical therapist, a certain designed progressive active shoulder exercise consisting of warm-up and cool-down, and a main active shoulder exercise was raised and expected to be a choice for individuals after breast cancer surgery. Moreover, individuals after breast cancer surgery still need certain shoulder exercise at home after discharge from hospital to reduce pain

and promote shoulder range of motion⁽¹¹⁾. Therefore, the objective of the study was to compare a certain designed progressive shoulder exercise with a free active shoulder exercise in individuals after breast cancer surgery on shoulder range of motion, shoulder and arm function, seroma drainage, pain, and satisfaction of the exercise and health professions.

Materials and methods

The study was approved by the faculty ethic committee (COA No. Si 437/2017) and registered for clinical trial (TCTR20210427001). Participants were informed about the study and signed written informed consent prior to participation.

Participants

The sample size calculation was based on two independent means formula on shoulder abduction at day 3 after breast cancer surgery⁽¹²⁾ that the mean difference was 14.4 with a ratio of the two sample sizes = 1, a type II error probability = 0.200, and level of significance = 0.05. A sample size with dropout 15% was 54. Therefore, 27 subjects were in each group. The faculty ethic committee approved to collect 30 subjects in each group, totally 60 participants in the study.

Sixty individuals with breast cancer (n = 60) receiving breast surgery including armpit lymph node removal participated in the study. They were recruited from a Private Patient Division of a university hospital and randomly assigned to the free shoulder exercise (n = 30) and certain designed progressive shoulder exercise group (n = 30). The inclusion criteria were 1) receiving mastectomy or wide excision of breast surgery, 2) removing lymph nodes in the armpit including sentinel lymph node biopsy or axillary lymph node on the same side of breast surgery, 3) able to communicate in Thai, 4) able to move shoulder in all directions before surgery, 5) normal shoulder range of motion before surgery⁽¹³⁾, 6) no history of frozen shoulder, and 7) no history of shoulder surgery. The exclusion criteria were 1) diagnosed diabetes mellitus, 2) diagnosed arteriosclerosis, 3) receiving both breast surgery or breast augmentation surgery, 4) receiving radiation after breast surgery, 5) having wound infection after

surgery, and 6) retaining Redovac drain until follow-up.

Procedures

The study was single-blind randomized controlled trial using the sealed envelope method. A researcher drew lots for participants that the number 1 was the free shoulder exercise group and the 2 was the certain designed progressive exercise group. On the day of admission, participants received a booklet to read and a compact disc to watch the video that contained the same information of breast cancer and surgery methods and the free or the certain designed progressive shoulder exercise. Nurses on the duty explained surgery methods and its consequences, and the exercises, and also asked participants to perform the exercises to ensure that they did correctly. Participants used the booklet and the compact disc to do exercise by themselves.

Research assistances who were nurses working in the ward were blinded to the data collection. They extracted age, weight, side of breast surgery, dominant hand and the side of breast surgery, surgical method and amount of lymph node dissection, tumor size, and length of hospitalization from medical files. The length of stay in hospital was usually about five days after surgery. Participants could be discharged from hospital if they no longer needed inpatient care and could go home. Therefore, research assistances assessed the following outcomes during participants staying in the hospital and at follow-up (day 14 after surgery). Active and passive shoulder range of motion in flexion, extension, abduction, adduction, and internal and external rotation were examined on day 0 (before surgery), and day 3 and 5, and 14 after surgery by using goniometer⁽¹³⁾. Shoulder and arm function⁽¹⁴⁾ was evaluated before surgery and at follow-up. Total seroma excretion was assessed at 6.00 am every day after surgery during staying in the hospital and at follow-up.

Additionally, participants assessed pain on every session before and after shoulder exercise using numerical rating scale⁽¹⁵⁾ and evaluated

satisfaction of exercise program and advice of health professions at follow-up using a developed questionnaire.

Interventions

Free shoulder exercise

The free shoulder exercise (Figure 1) was a routinely exercise in real situation in a hospital composing of seven shoulder exercises; 1) arm forward lifting, 2) shoulder abduction, 3) wall shoulder side lift, 4) wall shoulder flexion, 5) shoulder extension, 6) shoulder circles, and 7) elbow push back. Participants were free to choose exercise poses and frequency of exercise. The period of exercise was from day 1-14 after surgery. Each exercise was performed 5-10 times, 3-4 sessions/day and done limited by pain. During staying in the hospital and at follow-up nurses asked participants whether they did exercise and how often.

Progressive shoulder exercise

The progressive shoulder exercise (Figure 2) consisted of 2 warm-up and cool-down and main exercises. The warm-up and cool-down exercises were shoulder shrugs and shoulder circles. The three main exercises on day 1-3 after surgery were 1) shoulder flexion and abduction with elbow flexion, 2) elbow pushback, and 3) body twist with shoulder abduction. On the first day after surgery the flexion and abduction of the shoulder were limited at maximum 90 degrees⁽⁸⁾. On day 2 and 3 after surgery the range of motion were gradually increased and limited by pain. From day 4 after surgery until follow-up, participants still performed those three exercises together with the other three main exercises limited by pain that were 1) wall shoulder flexion, 2) wall shoulder abduction, and 3) towel shoulder internal rotation. Participants started the exercises on day 1 after surgery until follow-up, 5 times/exercise, 3 sessions/day. They could contact physical therapist if they requested. Participants received a logbook to record exercise and submitted to nurses on the follow-up day.

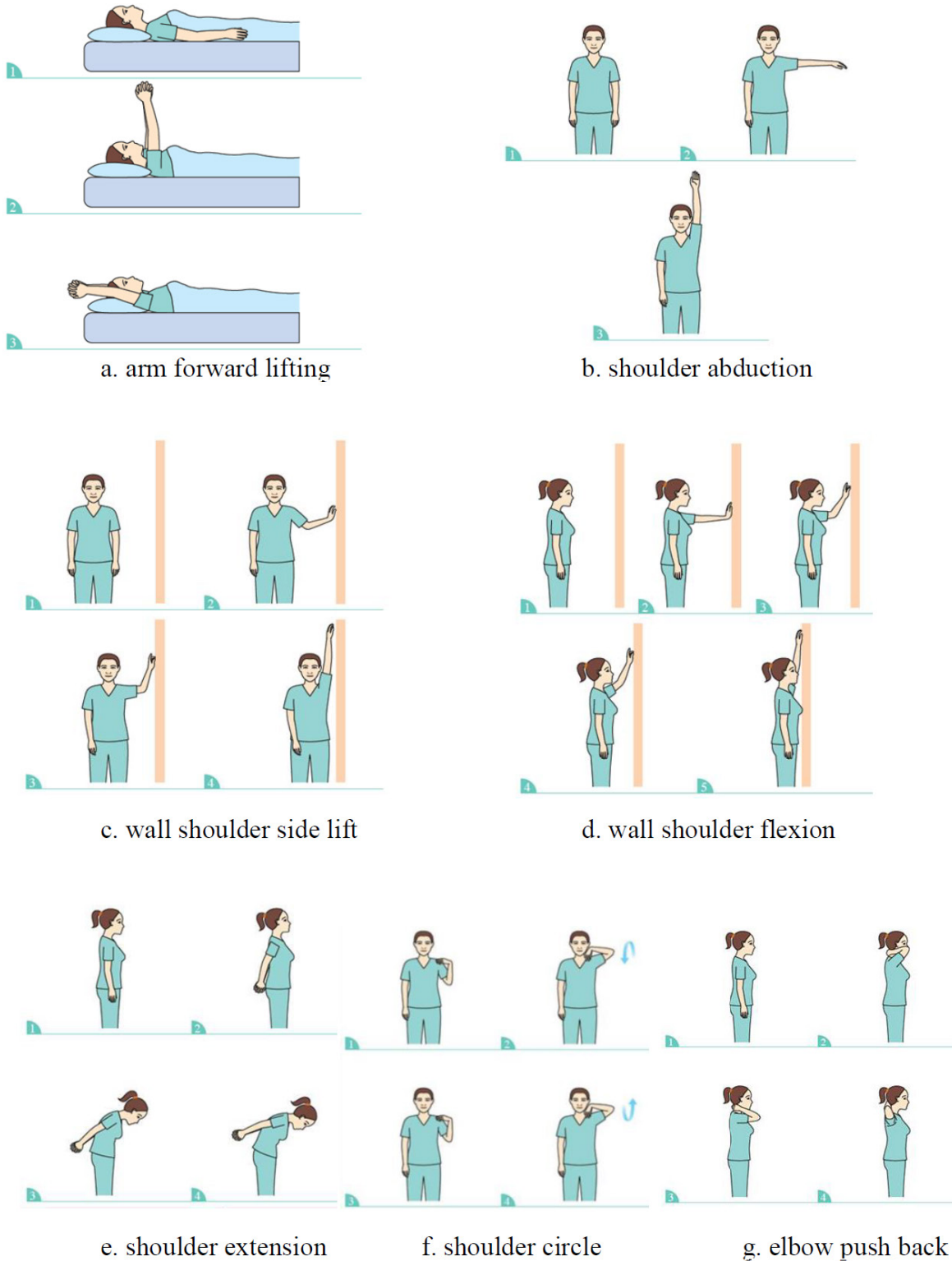


Figure 1 Free shoulder exercise: a. arm forward lifting, b. shoulder abduction, c. wall shoulder side lift, d. wall shoulder flexion, e. shoulder extension, f. shoulder circle, g. elbow push back



Figure 2 A certain designed progressive shoulder exercise. Please scan QR code: a. booklet, b. video

Outcome measures

Shoulder range of motion

Active and passive shoulder range of motion in flexion, extension, abduction, adduction, and internal and external rotation was assessed by a universal goniometer⁽¹³⁾. A physical therapist trained research assistances to use universal goniometer. The inter-and intra-rater reliability were good and excellent⁽¹⁶⁾. The inter-rater reliability was 0.721 (95%CI = -0.379 - 1.000), 0.700 (95%CI = -0.647 - 1.000), 0.816 (95%CI = 0.005 - 1.000) 0.833 (95%CI = 0.151 - 1.000), 0.764 (95%CI = -0.378 - 1.000), 0.866 (95%CI = 0.383 - 1.000) for shoulder flexion, extension, abduction, adduction, and internal and external rotation, respectively. The intra-rater reliability was 0.989 (95%CI = -0.949 - 0.997), 0.857 (95%CI = -0.366 - 0.968), 0.919 (95%CI = 0.640 - 0.982), 0.865 (95%CI=0.399 - 0.969), 0.981 (95%CI = -0.914 - 0.996), 0.977 (95%CI = 0.896 - 0.995) for shoulder flexion, extension, abduction, adduction, and internal and external rotation, respectively.

Shoulder and arm function

Shoulder and arm function⁽¹⁴⁾ was rated on 5-point scale; 0 = unable to perform, 1 = severe difficulty, 2 = moderate difficulty, 3 = mild difficulty, and 4 = no difficulty. The activities were

1) brush and comb hair on the same side of the breast operation, 2) pull a T-shirt/blouse that does not unbutton or tight necked sweater over your head, 3) put on a pair of pants or pantyhose and pull them up, 4) close a back-fastening bra, 5) completely zip up a dress with a back-fastening zipper, 6) wash the upper part of your back on the same side of the breast surgery, 7) wash the upper part of your back on the opposite side of the breast surgery, 8) reach into a cupboard over your head on the same side of the operation, 9) make a double bed, 10) carry an approximately 2-kg grocery bag on the same side of the operation. Each item score was summed to the total score.

Total seroma excretion

During staying in the hospital, the seroma excretion in milliliter (ml) was read and recorded from a vacuum drain bottle every morning at 6.00am. At follow-up a needle with syringe was used to draw the seroma. The amount of liquid was read from the syringe and recorded in ml. The total seroma was the summation of the seroma excretion during in the hospital and at the follow-up.

Pain

Numerical rating scale⁽¹⁵⁾ ranged from 0 (no pain) to 10 (the worst pain) was rated by

participants before and after exercise session. The score of before as well as after exercise session was averaged. The pain score difference was calculated by the score at before minus after the exercise.

Satisfaction of exercise program, nurses, and physical therapists

A questionnaire of satisfaction was developed by a researcher using 5-point scale; 1 = very dissatisfied, 2 = dissatisfied, 3 = neither satisfied nor dissatisfied, 4 = satisfied, and 5 = very satisfied. The questions were 1) easy program to recognize, understand and can follow immediately, 2) clear pictures and contents, 3) able to ask questions and interact with nurses, 4) able to ask questions and interact with physical therapists, 5) good advice and information from nurses, 6) good advice and information from physical therapists, 7) friendly and supportive nurses, 8) friendly and supportive physical therapists, and 9) overall, satisfaction with the exercise program.

Statistical analysis

The SPSS version 23 was used for statistical analyses. Kolmogorov-Smirnov test determined data normal distribution. Two-way mixed model ANOVA adjusted with day 0, dominant hand on the side of breast surgery, surgical methods, and lymph node dissection was conducted to analyze shoulder range of motion on day 0, and day 3, 5, and 14 after surgery between groups. Independent t-test or Mann-Whitney U test, as appropriately, was conducted to compare demographic data, shoulder and arm function, total seroma excretion, pain, and satisfaction between groups. No intention-to-treat was done in statistical analysis. The significance value was set at less than 0.05.

Results

Participants

Sixty participants (n = 60) were recruited and randomized to the free (n = 30) and certain designed progressive shoulder exercise groups (n = 30). On day 4 after surgery 17 participants in the free shoulder exercise group and 20 in the certain designed progressive group were discharged from the hospital. Thus, on day 5 after surgery there were 13 in the free and 10 in the certain designed progressive group. All participants came to follow-up (Figure 3). The characteristics of participants are shown in table 1.

Shoulder range of motion

There was no difference in active or passive shoulder range of motion in flexion, extension, abduction, adduction, and internal and external rotation before, day 3, 5, and 14 after surgery between groups, except active and passive shoulder flexion on day 3 after surgery (Table 2). No difference between before, day 3, 5, and 14 after surgery within groups was observed in all shoulder directions.

Shoulder and arm function

There was no difference in shoulder and arm function between groups before surgery and follow-up (Table 3).

Total seroma excretion

No difference in the total seroma [median (Q1, Q3) (min-max)] between the free [220 (143, 428) (0-710)] and certain designed progressive [220 (143, 428) (0-3800)] shoulder exercise group was observed (p -value = 0.734). A participant in the certain designed progressive shoulder exercise group drained the highest amount of seroma that was 3,800 ml.

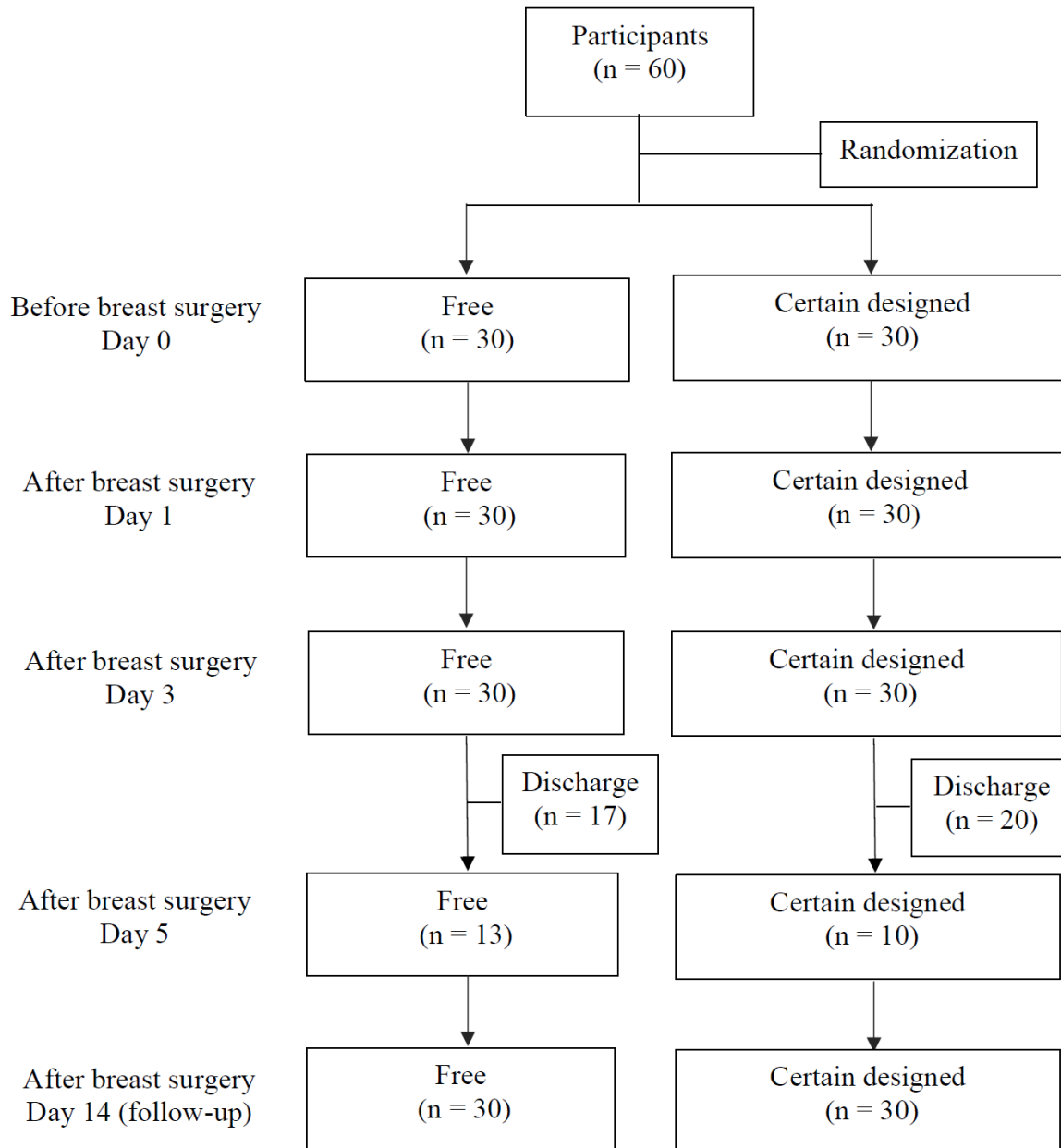


Figure 3 Number of participants in the free and certain designed progressive shoulder exercise groups.

Table 1 Characteristics of participants in the free and certain designed progressive shoulder exercise groups

	Shoulder exercise		p-value
	Free (n = 30)	Certain designed (n = 30)	
Age (years) [mean ± SD (min - max)]	54.3 ± 10.5 (34 - 75)	54.9 ± 9.1 (37 - 69)	0.803
Body mass index (kg/m²) [mean ± SD (min - max)]	23.7 ± 4.3 (17.0 - 34.2)	23.2 ± 3.7 (18.1 - 31.3)	0.614
Side of breast surgery [n, (%)]			
Left	18 (60.0)	16 (53.3)	0.602
Right	12 (40.0)	14 (46.7)	
Dominant hand on the side of breast surgery [n, (%)]			
Same side	10 (33.3)	16 (53.3)	0.118
Opposite side	20 (66.7)	14 (46.7)	
Surgical method [n, (%)]			
Total mastectomy	24 (80.0)	22 (73.3)	0.076
Modified radical mastectomy	3 (10.0)	8 (26.7)	
Wide excision	3 (10.0)	0 (0.0)	
Lymph node dissection [n, (%)]			
Sentinel lymph node biopsy	17 (56.7)	17 (56.7)	0.953
Axillary lymph node dissection	6 (20.0)	7 (23.3)	
Both	7 (23.3)	6 (20.0)	
Total lymph node dissection (lymph nodes) [median (Q1, Q3)] (min - max)	4 (2, 12) (0 - 23)	4 (2, 12) (1 - 30)	0.893
Tumor size (cm) [median (Q1, Q3)] (min - max)	2.3 (1.7, 3.1) (0.5 - 6.0)	2.1 (1.2, 4.0) (0.5 - 9.5)	0.807
Length hospitalization (day) [median (Q1, Q3)] (min - max)	5.0 (4.0, 6.0) (2 - 9)	5.0 (3.8, 5.3) (3 - 7)	0.677

Table 2 Active and passive shoulder range of motion in flexion, extension, abduction, adduction, and internal and external rotation in the free and certain designed progressive shoulder exercise groups before surgery (both groups; n = 30) and on day 3 (both groups; n = 30), 5 (free shoulder exercise; n = 30, certain designed progressive shoulder exercise; n = 10) and 14 after surgery (both groups; n = 30).

	Active range of motion (degree, mean ± SD)		p-value	Estimate ± SE	Passive range of motion (degree, mean ± SD)		p-value	Estimate ± SE
	Free	Certain designed			Free	Certain designed		
Flexion (degree)								
Before surgery	177.3 ± 3.9	179.3 ± 2.5	0.080	0.003 ± 0.45	180.0 ± 0.0	180.0 ± 0.0	1.000	NA
Day 3	159.2 ± 12.1	146.0 ± 26.2*	0.014	13.7 ± 5.10	166.3 ± 11.1	153.5 ± 26.1*	0.012	13.5 ± 4.90
Day 5	165.8 ± 10.8	163.5 ± 17.3	0.505	4.32 ± 6.36	171.5 ± 9.4	170.5 ± 11.7	0.590	3.27 ± 5.98
Day 14	167.3 ± 9.7	164.8 ± 15.8	0.422	3.02 ± 3.69	174.0 ± 8.0	170.3 ± 15.1	0.206	4.30 ± 3.30
Extension (degree)								
Before surgery	50.0 ± 0.0	50.0 ± 0.0	1.000	NA	50.0 ± 0.0	50.0 ± 0.0	1.000	NA
Day 3	49.7 ± 1.8	48.8 ± 3.1	0.322	0.70 ± 0.70	50.0 ± 0.0	49.2 ± 2.7	0.050	0.85 ± 0.43
Day 5	50.0 ± 0.0	49.7 ± 1.8	0.829	0.21 ± 0.95	50.0 ± 0.0	49.4 ± 2.5	0.245	0.63 ± 0.54
Day 14	50.0 ± 0.0	48.8 ± 4.1	0.145	1.04 ± 0.70	50.0 ± 0.0	49.5 ± 2.0	0.231	0.52 ± 0.43
Abduction (degree)								
Before surgery	175.5 ± 11.1	179.2 ± 2.7	0.087	0.37 ± 0.40	178.0 ± 8.1	180.0 ± 0.0	1.154	0.33 ± 0.51
Day 3	137.1 ± 28.0	126.6 ± 31.5	0.187	11.1 ± 8.15	145.9 ± 27.1	134.3 ± 30.7	0.136	12.1 ± 7.83
Day 5	142.3 ± 32.2	154.0 ± 39.5	0.661	-5.26 ± 11.8	148.1 ± 29.0	158.5 ± 34.2	0.675	-4.75 ± 11.2
Day 14	158.2 ± 25.6	156.3 ± 27.5	0.752	2.50 ± 7.79	164.8 ± 23.5	163.5 ± 24.1	0.786	1.91 ± 6.93
Adduction (degree)								
Before surgery	39.7 ± 1.8	39.7 ± 1.3	0.584	0.41 ± 0.18	40.0 ± 0.0	40.0 ± 0.0	1.000	NA
Day 3	37.7 ± 6.8	37.0 ± 6.9	0.670	0.72 ± 1.85	38.0 ± 6.6	37.8 ± 6.1	0.865	0.28 ± 1.61
Day 5	37.7 ± 8.3	38.0 ± 6.3	0.472	1.62 ± 2.21	38.1 ± 6.9	39.5 ± 1.6	0.731	0.53 ± 1.83
Day 14	39.2 ± 3.2	39.7 ± 1.8	0.548	-0.44 ± 0.72	39.8 ± 1.7	39.7 ± 1.8	0.829	0.11 ± 0.51
Internal rotation (degree)								
Before surgery	88.5 ± 7.3	88.5 ± 4.5	1.000	0.72 ± 0.02	89.0 ± 5.5	89.0 ± 5.5	1.000	0.90 ± 0.05
Day 3	87.7 ± 6.3	87.2 ± 6.9	0.617	0.66 ± 1.31	88.3 ± 5.9	88.2 ± 4.6	0.757	0.28 ± 0.90
Day 5	89.6 ± 1.4	89.0 ± 3.2	0.776	-0.47 ± 1.63	89.8 ± 1.2	90.0 ± 0.0	0.282	-1.38 ± 1.27
Day 14	89.0 ± 5.5	89.3 ± 2.5	0.769	-0.17 ± 0.57	89.0 ± 5.5	90.0 ± 0.0	0.324	-0.90 ± 0.90
External rotation (degree)								
Before surgery	89.5 ± 2.0	87.7 ± 6.8	0.349	0.33 ± 0.30	90.0 ± 0.0	88.3 ± 5.9	0.078	-0.09 ± 0.29
Day 3	79.5 ± 15.3	80.3 ± 15.4	0.947	0.27 ± 4.05	81.8 ± 13.9	83.2 ± 13.6	0.963	0.17 ± 3.59
Day 5	82.7 ± 12.4	83.0 ± 18.9	0.923	-0.45 ± 4.54	86.5 ± 6.9	85.0 ± 15.8	0.885	0.64 ± 4.39
Day 14	83.8 ± 14.5	82.8 ± 12.8	0.769	1.10 ± 3.71	85.3 ± 12.2	83.9 ± 9.6	0.622	1.50 ± 2.94

Note: *Significantly (p-value < 0.05) lower than the free shoulder exercise; NA, not applicable.

Table 3 Shoulder and arm function before surgery and follow-up in the free and certain designed progressive shoulder exercise groups

Shoulder and arm function	Before surgery		p-value	Follow-up		p-value
	Median (Q1, Q3)			Median (Q1, Q3)		
	(min - max)			(min - max)		
	(n)			(n)		
	Free	Certain designed		Free	Certain designed	
Brush and comb your hair on the same side of the operation						
	4 (4,4)	4 (4,4)	0.129	4 (4,4)	4 (4,4)	0.220
	(3 - 4)	(4 - 4)		(3 - 4)	(3 - 4)	
	(n = 30)	(n = 30)		(n = 30)	(n = 30)	
Pull a T-shirt, blouse that does not unbutton or tight necked sweater over your head						
	4 (4,4)	4 (4,4)	0.129	4 (4,4)	4 (4,4)	0.384
	(3 - 4)	(4 - 4)		(2 - 4)	(3 - 4)	
	(n = 30)	(n = 30)		(n = 27)	(n = 29)	
Put on a pair of pants or pantyhose and pull them up						
	4 (4,4)	4 (4,4)	0.129	4 (4,4)	4 (4,4)	0.181
	(3 - 4)	(4 - 4)		(3 - 4)	(4 - 4)	
	(n = 30)	(n = 30)		(n = 30)	(n = 30)	
Close a back-fastening bra						
	4 (4,4)	4 (4,4)	0.544	4 (4,4)	4 (4,4)	0.832
	(0 - 4)	(4 - 4)		(0 - 4)	(3 - 4)	
	(n = 27)	(n = 30)		(n = 22)	(n = 25)	
Completely zip up a dress with a back-fastening zipper						
	4 (4,4)	4 (4,4)	0.181	4 (4,4)	4 (4,4)	0.654
	(3 - 4)	(4 - 4)		(0 - 4)	(3 - 4)	
	(n = 30)	(n = 30)		(n = 30)	(n = 23)	
Wash the upper part of your back, i.e., shoulder-blade area on the same side of the operation (ipsilateral scapula)						
	4 (4,4)	4 (4,4)	0.181	4 (4,4)	4 (4,4)	0.467
	(3 - 4)	(3 - 4)		(1 - 4)	(3 - 4)	
	(n = 30)	(n = 30)		(n = 28)	(n = 25)	
Wash the upper part of your back, i.e., shoulder-blade area, on the opposite side of the operation (contralateral scapula)						
	4 (4,4)	4 (4,4)	0.490	4 (4,4)	4 (4,4)	0.738
	(1 - 4)	(4 - 4)		(1 - 4)	(3 - 4)	
	(n = 30)	(n = 30)		(n = 28)	(n = 28)	
Reach into a cupboard over your head, on the same side of the operation						
	4 (4,4)	4 (4,4)	0.181	4 (4,4)	4 (4,4)	0.589
	(3 - 4)	(3 - 4)		(3 - 4)	(1 - 4)	
	(n = 30)	(n = 30)		(n = 29)	(n = 30)	

Table 3 Shoulder and arm function before surgery and follow-up in the free and certain designed progressive shoulder exercise groups (cont.)

Shoulder and arm function	Before surgery		p-value	Follow-up		p-value
	Median (Q1, Q3) (min - max) (n)			Median (Q1, Q3) (min - max) (n)		
	Free	Certain designed		Free	Certain designed	
Make a double bed	4 (4,4) (3 - 4) (n = 30)	4 (4,4) (4 - 4) (n = 30)	0.129	4 (4,4) (3 - 4) (n = 25)	4 (4,4) (1 - 4) (n = 27)	0.404
Carry a grocery bag that weighs approximately 2 kg, on the same side of the operation	4 (4,4) (3 - 4) (n = 30)	4 (4,4) (3 - 4) (n = 30)	0.181	4 (4,4) (3 - 4) (n = 24)	4 (4,4) (2 - 4) (n = 28)	0.538

Note: The number (n) was less than 30 since participants did not do that function.

Pain

There was no difference in pain score before and after exercise between the free and certain designed progressive shoulder exercise groups.

The difference in pain score between before and after exercise was not different between groups (Table 4).

Table 4 Pain score before and after exercise session and its difference between the free and certain designed progressive shoulder exercise group

Exercise session	Pain score [median (Q1, Q3) (min - max)]		p-value
	Shoulder exercise group		
	Free (n = 30)	Certain designed (n = 30)	
Before	0 (0, 0) (0, 0)	0 (0, 0) (0, 0)	0.214
After	0 (0, 0) (0, 1)	0 (0, 0) (0, 1)	0.215
Difference between before and after	0 (0, 0) (0, 0)	0 (0, 0) (0, 1)	0.091

Satisfaction of exercise program, nurses, and physical therapists

No difference was shown in satisfaction of the exercise program, nurses, and physical

therapists between groups (Table 5). In the certain designed progressive shoulder exercise participants did not request physical therapists to advice the exercises.

Table 5 Satisfaction of exercise program, nurses, and physical therapists in the free and certain designed progressive shoulder exercise groups

Questions	Satisfaction scores		p-value
	Median (Q1, Q3) (min-max)		
	Free (n = 30)	Certain designed (n = 30)	
Program is easy to recognize, understand and can be followed immediately.	5 (4,5) (3 - 5)	5 (4,5) (3 - 5)	0.555
Pictures and contents are clear and corresponded.	5 (4,5) (3 - 5)	5 (4,5) (3 - 5)	0.551
You can ask questions and interact with nurses.	5 (4,5) (3 - 5)	5 (4,5) (4 - 5)	0.497
You can ask questions and interact with physical therapists.	NA	-	-
Nurses give good advice and information.	5 (4,5) (4 - 5)	5 (4,5) (4 - 5)	0.403
Physical therapists give good advice and information.	NA	-	-
Nurses are friendly and supportive.	5 (4,5) (4 - 5)	5 (4,5) (4 - 5)	0.376
Physical therapists are friendly and supportive.	NA	-	-
Overall, you are satisfied with the exercise program.	5 (4,5) (4 - 5)	5 (4,5) (4 - 5)	0.439

Note: NA; not applicable, -; no data for analysis.

Discussion

The study compared a certain designed progressive shoulder exercise with a free active shoulder exercise for individuals after breast cancer surgery on shoulder range of motion, shoulder and arm function, seroma drainage, pain, and satisfaction of the exercise and health professions in individuals after breast cancer surgery. The certain designed progressive shoulder exercise showed similar outcomes to the free shoulder exercise, except less active and passive shoulder flexion on day 3 after surgery than the free exercise.

The active and passive shoulder flexion range of motion in the certain designed progressive shoulder exercise group was less than the free shoulder exercise group. It may be due to the restriction at 90° of shoulder flexion and abduction in the first day after surgery and gradually increased the range of motion, limited by pain, in the consecutive day. Both groups had no pain before each exercise session. Thus, participants in the certain designed progressive shoulder exercise may perform less shoulder range of motion than those in the free shoulder exercise

group because of instruction. Additionally, the certain designed progressive shoulder program designed a particular number of exercises, 5 times/exercise, 3 sessions/day, whereas the free shoulder exercise was suggested in a range, 5-10 times/exercise, 3-4 sessions/day. By communication with nurses on duty, participants in the free shoulder exercise groups did 3 exercises, 10 times/exercise, and 3 sessions/day. Therefore, participants in the free shoulder exercise group seemed to do a greater number of exercise than those in the certain designed progressive shoulder exercise group. Those in the free shoulder exercise did 90 times/day, whereas those in the certain designed progressive shoulder exercise did 45 times/day. However, the active and passive shoulder flexion on days 5 and 14 after surgery was similar in both groups. It may be that the 3 main exercises on the first 3 days together with the other 3 exercises increased the number of exercises in the certain designed progressive shoulder exercise group. Furthermore, the 3 main exercise on the first 3 days was a combination of shoulder external rotation with the movement of flexion and abduction. Shoulder external

rotation is a component of shoulder flexion and abduction^(17,18) and is an important factor for the effectiveness of shoulder range of motion exercise^(19,20). It also stretches anterior upper trunk tightness and upper limb dysfunction after breast surgery⁽²¹⁾. Therefore, finally, the certain designed progressive shoulder exercise produced the similar shoulder flexion range of motion to the free shoulder exercise.

The shoulder and arm function, total seroma, and pain of the certain designed progressive shoulder exercise was similar to the free shoulder exercise. It may be due to shoulder exercises starting on the first day after surgery and similar shoulder range of motion in all directions in both groups. After breast cancer surgery, the pain decreases as the shoulder range of motion increases⁽²²⁾. In the present study, participants had no pain before and after shoulder exercise in each session. Hence, shoulder range of motion was improved, then promoted shoulder and arm function⁽¹²⁾ and seroma excretion in individuals with breast surgery⁽⁵⁾.

Good satisfaction in the program, nurses, and physical therapists was demonstrated in both the free and certain designed progressive shoulder exercise. No participants in the certain designed progressive shoulder exercise requested to consult physical therapists for exercise. It may be because of clear instruction and ease to follow the exercises from the booklet and video. Moreover, they did not make decision on pose and frequency of exercise, or were worried about pain if they did a lot. Furthermore, they did not have any complications after surgery. Therefore, the exercise booklet and video may be useful for shoulder exercise in individuals after breast cancer surgery who did not have any complication.

There were few limitations in the study. Since the free shoulder exercise group was done routinely in a real situation, the amount, poses, and frequency of exercise in individuals was not recorded. The effect of the free and the certain designed progressive shoulder exercise after surgery was observed in a short duration. The long-term effect of both exercises is suggested in future study.

Conclusion

The certain designed progressive shoulder exercise may be inferior to the free shoulder exercise on shoulder flexion range of motion on day 3 after surgery, but finally produced similar effects.

Take home messages

The certain designed progressive shoulder exercise consisting of warm-up, cool-down, and a particular poses and frequency that is easy to perform could be a shoulder exercise for individuals after breast cancer surgery to increase shoulder range of motion and function without pain after exercise.

Conflicts of interest

The authors declare no conflict of interest.

Acknowledgement

We thank all participants for their participation, and nurses for data collection and taking care of participants. We are appreciated Dr. Kullathorn Thephamongkol and Dr. Orawan Supapueng in statistical analysis. Siriraj Research Development Fund (Managed by Routine to Research: R2R) Grant Number (IO) R016135018, Faculty of Medicine Siriraj Hospital, Mahidol University is hereby acknowledged.

References

1. Ferlay J, Soerjomataram I, Dikshit R, Eser S, Mathers C, Rebelo M, et al. Cancer incidence and mortality worldwide: sources, methods and major patterns in GLOBOCAN 2012. *Int J Cancer* 2015; 136(5): E359-86.
2. Fowble BL, Solin LJ, Schultz DJ, Goodman RL. Ten year results of conservative surgery and irradiation for stage I and II breast cancer. *Int J Radiat Oncol Biol Phys* 1991; 21(2): 269-77.

3. Lucci A, McCall LM, Beitsch PD, Whitworth PW, Reintgen DS, Blumencranz PW, et al. Surgical complications associated with sentinel lymph node dissection (SLND) plus axillary lymph node dissection compared with SLND alone in the American College of Surgeons Oncology Group Trial Z0011. *J Clin Oncol* 2007; 25(24): 3657-63.
4. Al-Hilli Z, Wilkerson A. Breast Surgery: Management of postoperative complications Following operations for breast cancer. *Surg Clin North Am* 2021; 101(5): 845-63.
5. Das S, Sureshkumar SCV, Kate V, Srinivasan K. Effect of exercise on shoulder function and morbidity following mastectomy with axillary dissection in patients with breast cancer: a prospective randomized clinical study. *Int Surg J* 2018; 5(10): 3217-25.
6. De Groef A, Van Kampen M, Dieltjens E, Christiaens MR, Neven P, Geraerts I, et al. Effectiveness of postoperative physical therapy for upper-limb impairments after breast cancer treatment: a systematic review. *Arch Phys Med Rehabil* 2015; 96(6): 1140-53.
7. Teodózio CGC, Marchito LO, Fabro EAN, Macedo FO, de Aguiar SS, Thuler LCS, et al. Shoulder amplitude movement does not influence postoperative wound complications after breast cancer surgery: a randomized clinical trial. *Breast Cancer Res Treat* 2020; 184(1): 97-105.
8. Rizzi SKLA, Haddad CAS, Giron PS, Figueira PVG, Estevão A, Elias S, et al. Exercise protocol with limited shoulder range of motion for 15 or 30 days after conservative surgery for breast cancer with oncoplastic technique: a randomized clinical trial. *Am J Clin Oncol* 2021; 44(6): 283-90.
9. Wright V. Stiffness: a review of its measurement and physiological importance. *Physiotherapy* 1973; 59(4): 107-11.
10. Van Hooren B, Peake JM. Do we need a cool-down after exercise? A narrative review of the psychophysiological effects and the effects on performance, injuries and the long-term adaptive response. *Sports Med* 2018; 48(7): 1575-95.
11. Kanokpran T, Srimoragot P, Sindhu S, Chuthapisith S. Effect of a self-regulation home-based shoulder exercise program on range of motion and function of shoulder joints in patients post breast cancer surgery. *J Nurs Sci* 2014; 32(3): 74-84.
12. Na YM, Lee JS, Park JS, Kang SW, Lee HD, Koo JY. Early rehabilitation program in postmastectomy patients: a prospective clinical trial. *Yonsei Med J* 1999; 40(1): 1-8.
13. Norkin CC, White DJ. Measurement of joint motion: a guide to goniometry. 5th ed. Philadelphia (PA): FA Davis; 2016.
14. Wingate L. Efficacy of physical therapy for patients who have undergone mastectomies. *Phys Ther* 1985; 65(6): 896-900.
15. Williamson A, Hoggart B. Pain: a review of three commonly used pain rating scales. *J Clin Nurs* 2005; 14(7): 798-804.
16. Portney LG, Watkins MP. Foundations of clinical research: applications to practice. 3rd ed. New Jersey: Pearson Education Inc.; 2009.
17. Culham E, Peat M. Functional anatomy of the shoulder complex. *J Orthop Sports Phys Ther* 1993; 18(1): 342-50.
18. Ludewig PM, Phadke V, Braman JP, Hassett DR, Cieminski CJ, LaPrade RF. Motion of the shoulder complex during multiplanar humeral elevation. *J Bone Joint Surg Am* 2009; 91(2): 378-89.
19. Box RC, Reul-Hirche HM, Bullock-Saxton JE, Furnival CM. Shoulder movement after breast cancer surgery: results of a randomised controlled study of postoperative physiotherapy. *Breast Cancer Res Treat* 2002; 75(1): 35-50.
20. Testa A, Iannace C, Di Libero L. Strengths of early physical rehabilitation programs in surgical breast cancer patients: results of a randomized controlled study. *Eur J Phys Rehabil Med* 2014; 50(3): 275-84.
21. Lee CH, Chung SY, Kim WY, Yang SN. Effect of breast cancer surgery on chest tightness and upper limb dysfunction. *Medicine (Baltimore)* 2019; 98(19): e15524.
22. Akbas A, Dagmura H, Daldal E, Dasiran FM, Deveci H, Okan I. Association between shoulder range of motion and pain catastrophizing scale in breast cancer patients after surgery. *Breast Care (Basel)* 2021; 16(1): 66-71.