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REVIEW ARTICLE

Effectiveness of therapeutic inflatable ball self-exercises for improving shoulder function and quality of life in breast cancer survivors after sentinel lymph node dissection

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Abstract

Background The survival rate of breast cancer survivors (BCSs) is > 90%. Particular issues are upper arm dysfunction caused by surgery and treatments. Physical activity has been recommended to improve shoulder function and quality of life (QoL) in BCSs. However, rehabilitation programs tend not to be continuous.

Purpose To explore the effectiveness of therapeutic inflatable ball self-exercise for improving shoulder function and QoL in breast cancer survivors (BCSs) following breast cancer surgery.

Patients and methods Seventy-two BCSs were allocated to two groups, conventional self-exercise (CSE; $n = 34$; age, 48.9 ± 7.2 years) and therapeutic inflatable ball self-exercise (IBE; $n = 38$; age, 47.7 ± 8.9 years); 22 in the CSE and 23 in the IBE group completed the interventions. Both groups performed intervention for 12 weeks, three times per week and 15 min a day at least. Measurement was performed three times for shoulder range of motion (ROM), handgrip strength, Shoulder Pain and Disability Index (SPADI), and Functional Assessment of Cancer Therapy-Breast (FACT-B).

Result Flexion and extension of shoulder ROM showed significant differences between the two groups at 12 weeks. Flexion and extension of shoulder ROM showed significant differences for t1-t2 ($p = 0.02$) and t0-t1 ($p = 0.04$). Abduction showed a significant difference for t0-t1 ($p = 0.03$), t1-t2 ($p = 0.02$), and t0-t2 ($p = 0.01$). CSE (7 points) and IBE (20 points) satisfied the MDC in FACT-B total score. The MDC of the SPADI total score was 13 points in the CSE group and 9 points in the IBE group.

Conclusion IBE would be more appropriate to start the rehabilitation for BCSs and CSE would be effective after the pain has improved.

Keywords Breast cancer · Rehabilitation · Shoulder pain and function · Self-exercise · Inflatable ball

The survival rate of breast cancer survivors (BCSs) is > 90%, the highest of all cancer survivors due to early detection and advanced surgical methods and treatments. The treatment of side effects is important to improve quality of life (QoL) because of the increased survival rate of BCSs. Particular issues are upper arm dysfunction caused by hand muscle weakness, scar tissue, pectoralis muscle shortness, wound formation, and fibrosis [1]. In BCSs, secondary diseases including adhesive capsulitis, myofascial dysfunction, and nerve dysfunction can occur beyond 3 months after breast cancer surgery, leading to shoulder dysfunction, pain, weakness, or decreased shoulder range of motion (ROM). Moreover, shoulder dysfunction in BCSs can occur regardless of whether immediately after surgery or 6 months after surgery, axillary lymph node dissection, or sentinel lymph node dissection (SLND) is used. Although SLND is a newer, less invasive procedure, > 45% of patients experience shoulder limitations immediately after mastectomy [2]. After mastectomy or quadrantectomy, anterior chest or

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axillary tissue alterations may cause shoulder dysfunction [3]. In addition, decreased tissue healing caused by radiation therapy or chemotherapy can increase tissue fibrosis and stiffness [3]. Shoulder dysfunction can affect QoL because it limits overhead reaching, sleep, and leisure activities [4].

BCSs experience restricted shoulder ROM due to tissue alterations in the scapular muscles [5]. The scapular muscles are dynamic stabilizers during shoulder and upper arm movements [6]. Tissue changes hinder normal movement of the scapulothoracic, glenohumeral acromioclavicular, and sternoclavicular joints [7]. For normal three-dimensional shoulder movement, these joints should work together. When the balance between scapulothoracic and glenohumeral motion is disrupted, BCSs may experience microtearing of muscle fibers, the sheath around the muscle and the connective tissue and/or chronic pain [8].

Although early post-operative exercise is desirable for facilitating shoulder ROM [9], the authors have noted that BCSs have difficulty actively attending the rehabilitation for shoulder function after undergoing breast cancer surgery. Due to acute post-operative pain and passive rehabilitation methods, BCSs can experience thoracic flexion and scapular protraction to protect the surgical sight, leading to muscle shortening [5]. Thus, many women delay the commencement of rehabilitation for up to 6 months resulting in reduced functional progression. In addition, although BCSs start rehabilitation for shoulder function 6 months after surgery, normal shoulder movement is difficult due to altered proprioception and muscle tissue and abnormal scapular positioning, which can change the length-tension relationship of the scapular muscles. These adaptations and changes cause length-tension relationship issues and myofascial pathology and strain.

Recently, physical activities such as walking, jogging, ergometers, resistance training, Yoga, and Taichi have been recommended to improve shoulder flexibility, muscle strength, cardiorespiratory capacity, and QoL of BCSs. However, because the rehabilitation programs tend to less take BCSs' healthy condition into account, it is not easy for BCSs to continue to participate in rehabilitation. Moreover, oncologists generally do not recommend physical activity during chemotherapy and radiation therapy to minimize energy, preferring patients to focus on cancer cell treatment [7]. Furthermore, most BCSs are sedentary because of physical fatigue caused by chemotherapy or radiation therapy, depression, social phobia, or surgical pain [10]. Since > 50% of BCSs experience acute post-operative pain after breast cancer surgery (visual analogue scale [VAS] > 5) [11–13] affecting QoL, they struggle to participate in rehabilitation programs to improve shoulder function. Consequently, in South Korea, it is difficult to treat BCSs early and regularly, therefore, a continuous, self-exercise rehabilitation program is necessary for normal shoulder function in BCSs.

Self-exercise is a realistically recommended rehabilitation method which patients can easily access with low burden for economic, temporal and spatial constraints compared with hospital rehabilitation exercise. Self-exercises can be performed with low costs using implements such as foam rollers and tennis balls [7]. However, foam rollers, tennis balls, golf balls, and massage balls can cause pain or discomfort due to their hardness. A soft, therapeutic inflatable ball is available for muscle release [14, 15]. Pressure is concentrated at specific regions and is easily adjusted to individual needs, making these balls suitable for self-exercise.

This study aimed to demonstrate the effectiveness of therapeutic inflatable balls to improve shoulder function and QoL in BCSs. Self-stretching exercises were included as a control because this is a common and useful clinical rehabilitation method. The hypothesis was that inflatable ball exercise (IBE) improves shoulder function, pain, and QoL in BCSs. To test this hypothesis, BCSs who underwent SLND at least 6 months previously performed CSE and IBE for 12 consecutive weeks. We assessed shoulder ROM, hand grip strength, and QoL.

Methods

Experimental design

We used a pragmatic, quasi-experimental design to demonstrate the effect of therapeutic inflatable ball exercise for shoulder pain and function of BCSs in a community-based setting. The participants were screened for eligibility by a trained physical therapist. Ethical approval was provided by the Institutional Review Board (1040548-KU-IRB-17-51-A-4).

Participants

For 12 weeks in 2017, 97 participants were recruited using announcements on a website (http://cafe.naver.com/uvacenter). Inclusion and exclusion criteria are shown in Table 1. All participants were aware of the objectives of the study and signed informed consent forms. This study included two groups (control [$n = 34$] and experimental [$n = 38$] (Fig. 1).

Pre-intervention education

At the first attendance after baseline, one physical therapist with 5 years of clinical experience educated the CSE and IBE groups using video presentation respectively. The physical therapist then demonstrated CSE and IBE to the respective groups separately in each other space. During the instruction session, two other physical therapists helped to guide the participants and checked that movements were performed correctly. The participants were allowed to practice until they could consistently perform the movements (Table 2).

Table 1 Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
Women between 20 and 70 years of age	Cervical herniated nucleus patient
Voluntary applicants lining in the metropolitan area and underwent SLND ≥ 6 months and ≤ 3 years	Rotator cuff tear, shoulder dislocation, shoulder impingement, cardiovascular disease, renal disease
Those who received chemotherapy and radiotherapy after mastectomy	Regular exercise, concurrent unstable cardiac, hypertensive, respiratory disease, cognitive dysfunction
Those with shoulder pain and function limitations and discomfort	Smoker, pregnant, cognitive impaired

Outcome measures

For inter-rater reliability/repeatability, three physiotherapists with more than 5 years of clinical experience were trained to perform the outcome measures performed at baseline, 6 weeks, and 12 weeks (Fig. 1). At the first and second attendances, three physical therapists checked and re-trained the participant's posture and questioned them about the intervention.

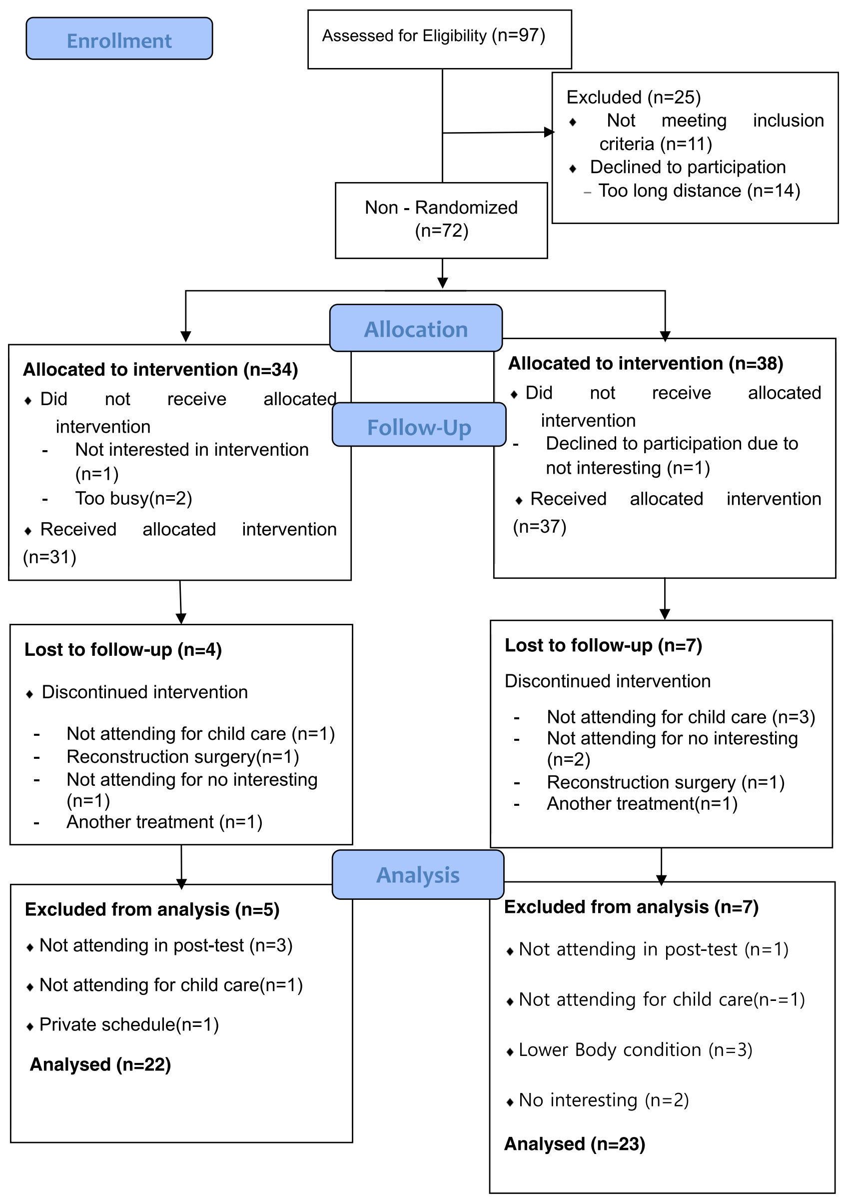

Fig. 1 Flow chart

Table 2 The detailed postures of the intervention

Common contents	
Both groups performed the intervention at least 15 min, 3 times per week for 12 weeks at home	
Both groups warmed up neck and shoulder 5 min. The main intervention session consisted of 10 min with 60 s of holding posture and 30 s of resting time	
Both groups performed the intervention in supine, prone, standing or sitting position	
Conservative stretching exercise	
Warming up	Flexion, extension, rotation with or without diagonal direction in neck by hands, slowly
CSEI	Slow active stretching(abduction, adduction, flexion, extension)
CSEII	Slow active stretching on the mat for shoulder girdle
CSEIII	Slow active stretching using the towel and wall
Therapeutic inflatable ball exercise	
Simple weight bearing	Place the ball on the trapezius, rhomboids, pectoralis, serratus anterior, deltoids or latissimus dorsi with the natural pressure in supine, prone or side lying position If the pain is sensitive, TIB group softly rub the ball in pectoralis and serratus anterior using hand
Static pressure	Place the ball on the trapezius, rhomboids, pectoralis, serratus anterior, deltoids or latissimus dorsi with the natural pressure Push the ball with body weight
Dynamic pressure	Place the ball on the trapezius, rhomboids, pectoralis, serratus anterior, deltoids or latissimus dorsi with the natural pressure Push and rub the ball with body weight

CSE, conservative stretching exercise

Shoulder function and QoL were evaluated using questionnaires. Two physical therapists individually explained the contents of the questionnaires and provided advice as needed. FACT-B is a 36-item questionnaire to measure QoL in BCSs and has been previously validated. FACT-B is subdivided into four primary sections: QoL, physical well-being, social/family well-being, and emotional well-being over the prior 7 days [16]. We calculated the FACT-B Trial Outcome Index (TOI), which is the sum of the physical function and breast cancer subscales. Higher scores indicated better QoL. Each item of the FACT-B has response choices ranging from 0 ("not at all") to 4 ("very much a problem"). The TOI is the sum of the physical well-being, functional well-being, and breast cancer subscales of the FACT-B questionnaire. A total of 23 items contribute to the TOI, resulting in a maximum possible score of 92. For all FACT-B summary scores, including TOI, a higher score indicates good health-related QoL. SPADI is a valuable and reliable questionnaire for pain and disability of the shoulder [17]. The SPADI comprises 13 visual analogue scales ranging from 0 to 100, with higher scores indicating greater impairment. The total SPADI score is calculated by averaging the Pain and Disability subscale score.

After the participants completed the questionnaires, two physical therapists measured shoulder ROM. An Acumar™ single digital inclinometer (Fabricatio Enterprises Incorporated, USA) was used to measure shoulder flexion, extension, and abduction in sequence [18, 19]. For shoulder extension, measurements were taken with participants in the standing position to avoid pain and discomfort at the surgical site. Three trials were performed on the affected side in sequence and the mean of the three measurements was used for analysis.

Hand grip strength was measured using a digital hand grip dynamometer (DW-781, Daewoo Sport Industry, Korea). The result (maximum grip strength during the measurement) was automatically calculated and displayed on the LCD monitor in kilograms. Participants adducted their arm with elbow extension. Participants were instructed to grip the dynamometer with maximum effort by a verbal command before returning to a neutral condition. Three trials were performed on the affected side in sequence. Participants had a rest time at least 60 s between trials and the mean of the three measures was used for analysis.

Intervention

Figs. 2, 3 and 4 describe the interventions in detail. The intervention was dependent on the physical conditions, such as fatigue, lymphedema, discomfort, or pain. For safety, if participants felt pain or discomfort, they were encouraged to contact the physical therapist by phone to discuss the need to stop or suspend the intervention. In order to prevent participants from being confused with intervention method, the

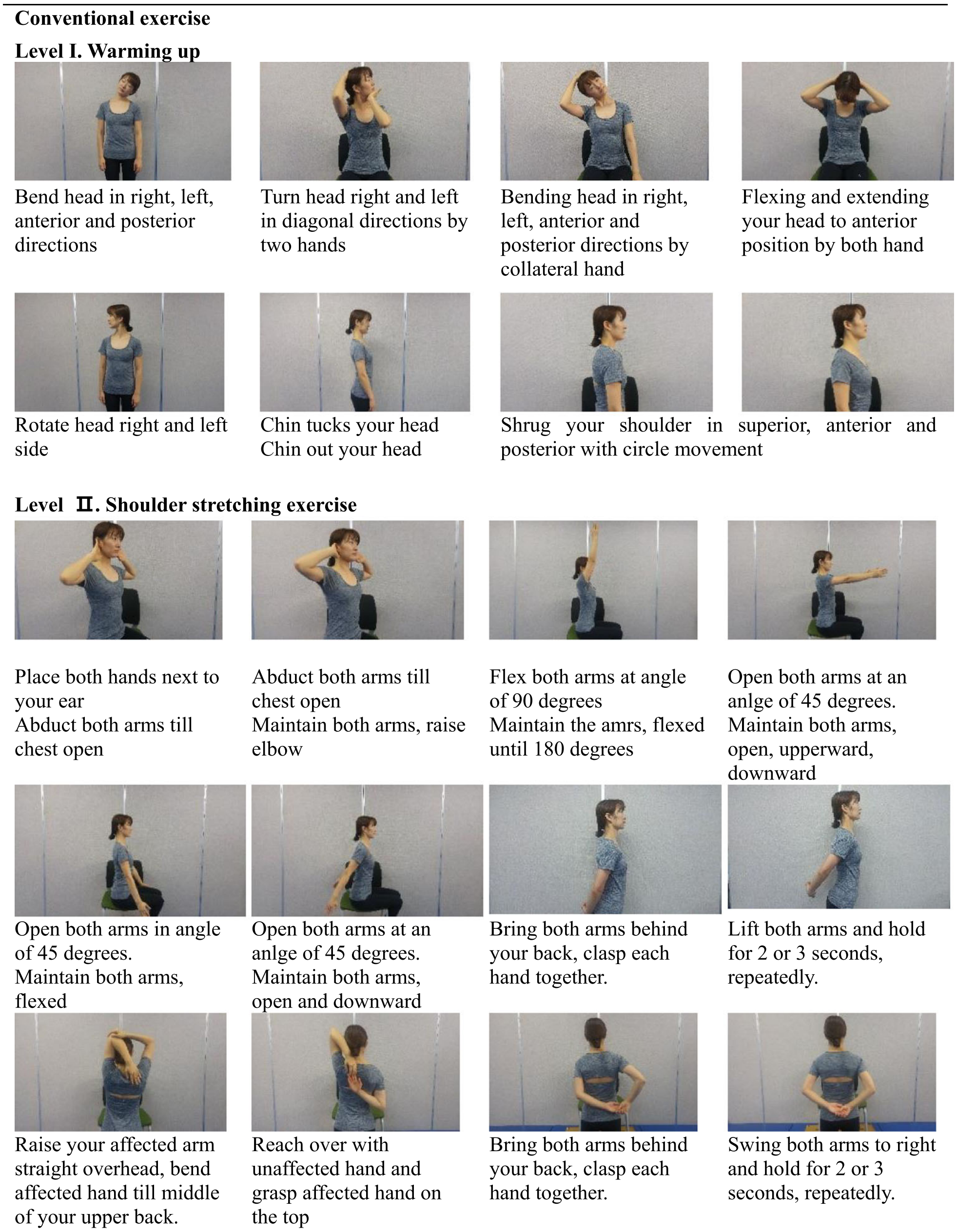

Fig. 2 Intervention description of CSE

participants were instructed on how when they visited for the pre and mid measurements to be safe, described in detail and participant-centered [19].

The IBE group used a therapeutic inflatable ball which was 6.5 cm in diameter, had a smooth surface, and was made of elastic silicone. The firmness of the therapeutic inflatable ball can be controlled according to individual needs by shifting the body weight depending on individual sensitivity to pain [15]. The participants were instructed that the pressure should be as tolerable as possible to increase soft tissue flexibility [20]. IBE is designed to release the target muscles, which are key muscles for shoulder movement (Fig. 2) [3]. The intervention postures were devised by physiotherapists with > 5 years of clinical experience. Figure 3 describes the postures in detail.

Statistics

All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS 21.0 [IBM SPSS Inc., Chicago, USA]). Baseline comparability was assessed using Student's t test. Two-way (group x time) repeated-measures analysis of covariance (ANCOVA) was used to determine changes in shoulder ROM, hand grip strength, SPADI, and FACT-B as mean and standard deviation values averaged over three measurements (baseline, 6 weeks,

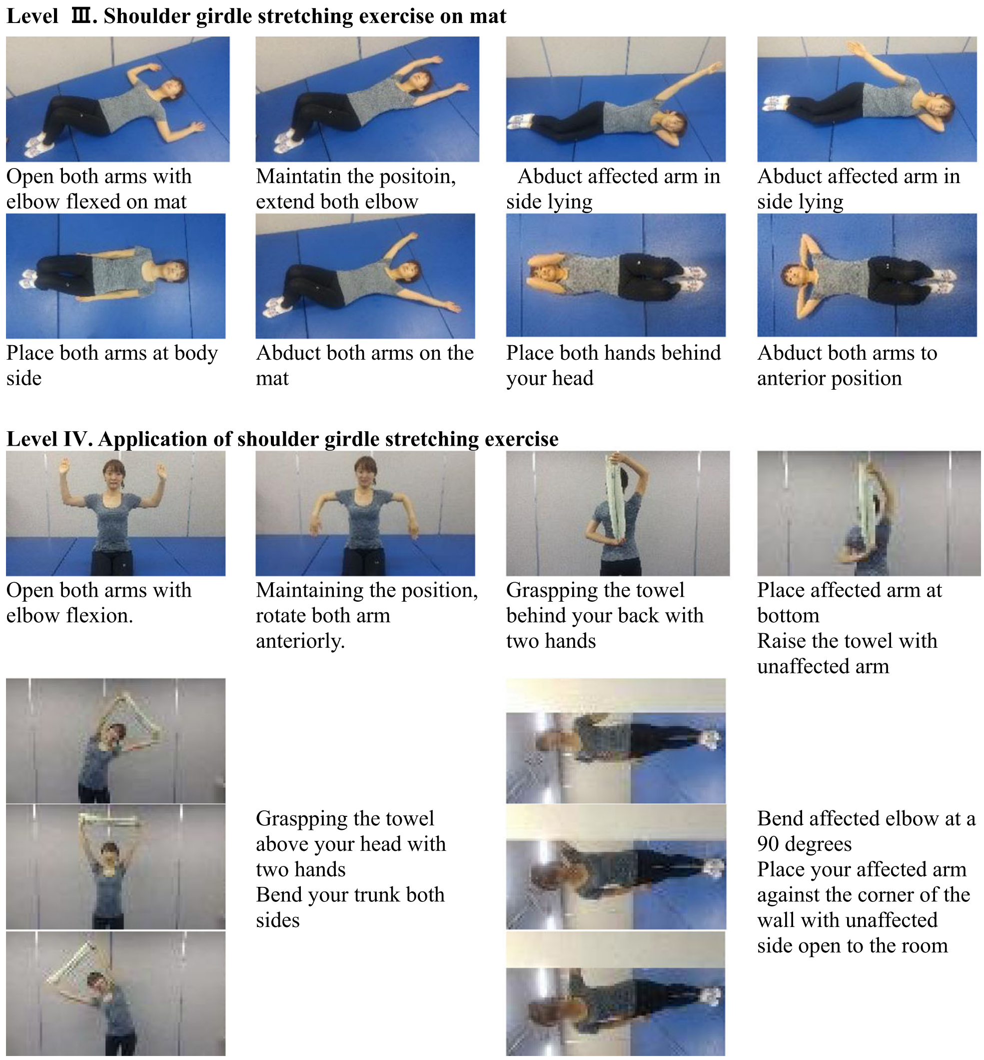

Fig. 2 (continued)

12 weeks), where the baseline (pre-intervention) score served as the covariate. The alpha level was set at 0.05. The normal distribution was estimated with the Shapiro-Wilk test. Independent *t* tests were conducted to assess the homogeneity of the demographic characteristics. We conducted a primary per-protocol analysis excluding 12 participants in both groups who missed one or more assessment session and did not participate in mid (t1) or post-test (t2). Diagnostic data included sphericity determined via Mauchly's test of sphericity. Greenhouse-Geisser adjusted testing was performed in the presence of variance heterogeneity. When ANCOVA resulted in a significant overall F-statistic, post-hoc tests were conducted using Bonferroni correction. The significance level was set at $p < 0.05$. Partial eta squared effect size estimates were also determined at each time point. Effect sizes in both groups were displayed using estimated marginal means adjusted for fixed baseline covariate values across the 6 and 12 weeks post-baseline data collection time points. The effect sizes were small (0.01), medium (0.06), and large (0.14) (Table. 3).

Results

Participants

Of the 97 participates recruited, 72 were allocated to the two groups and 25 were excluded. The number of participants in the CSE and IBE groups was 34 and 38, respectively. In the CSE group, 22 participants completed the 12-week intervention, while 23 did so in the IBE group (Fig. 1).

Shoulder ROM

Flexion and extension of shoulder ROM also showed significant difference between the groups after 12 weeks. Flexion and extension showed significant differences for t1-t2 (Figs. 5 and 6) ($F = 6.19$, $p = 0.02$) and t0-t1 ($F = 4.30$, $p = 0.04$) between the groups. Abduction showed a significant difference for t0-t1 ($F = 5.0$, $p = 0.03$), t1-t2 ($F = 5.7$, $p = 0.02$), and t0-t2 ($F = 4.97$, $p = 0.01$) between the groups according to time x

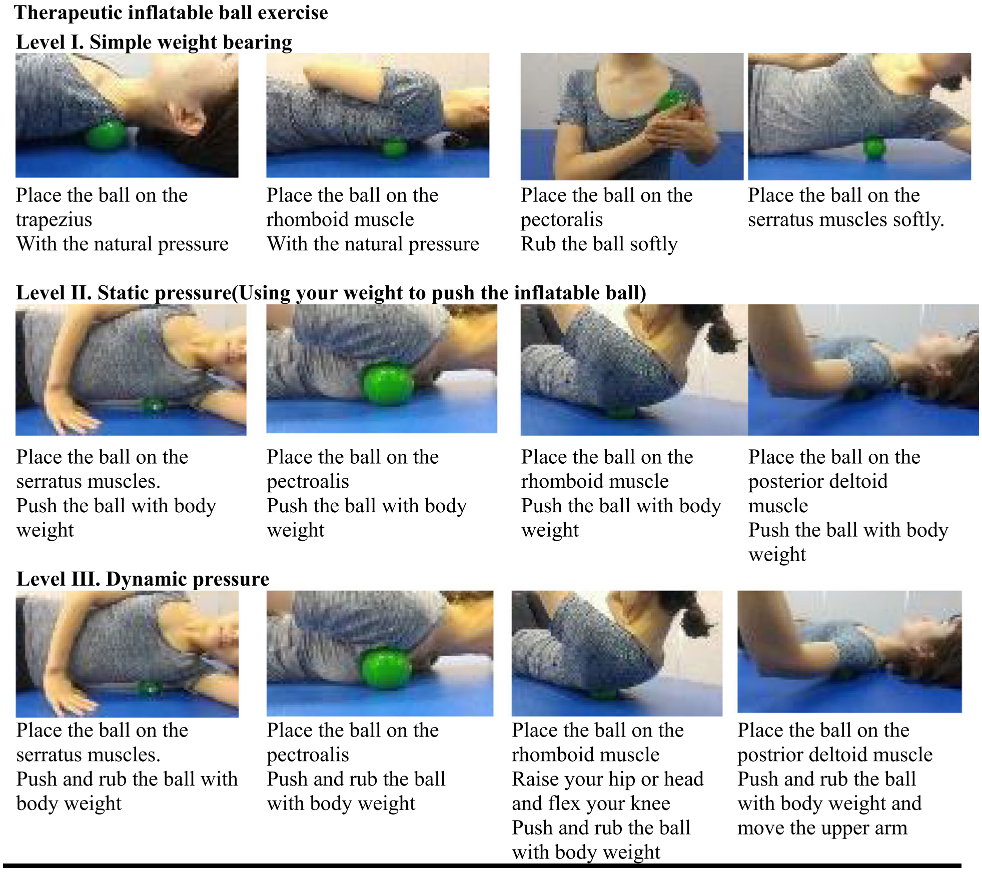

Fig. 3 Intervention description of IBE

groups. For t0-t1, shoulder ROM increased more in the IBE group. In contrast, for t1-t2, the increase was greater in the CSE group (Fig. 7). The partial eta square (effect size) was 0.14 for flexion, 0.12 for extension, and 0.11 for abduction (Fig. 4).

Handgrip strength

Handgrip strength in the affected arm showed no significant difference in t0-t1 ($F = 0.79$, $p = 0.38$), t1-t2 ($F = 0.56$, $p = 0.81$), or t0-t2 ($F = 0.59$, $p = 0.52$) between the groups. The partial eta square was 0.014.

FACT-B

Total scores of TOI, FACT-G, and FACT-B are presented. TOI showed no significant difference for t0-t1, t0-t2, and t0-t2. TOI (approximately 1 point) did not satisfy the MDC (5~6 points) in either group. FACT-G satisfied the MDC (5~6 points) in the CSE group (about 8 points) and IBE group (about 22 points), although there were no significant differences for t0-t1, t0-t2, and t0-t2. Moreover, although FACT-B total score showed no significant difference, CSE (about 7 points) and IBE (about 20 points) satisfied the MDC (7~8 points).

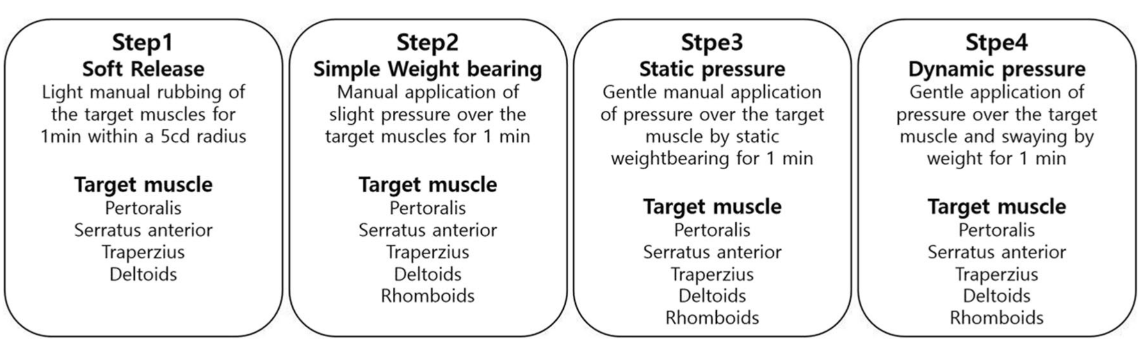

Fig. 4 Process of therapeutic inflatable ball exercises

Table 3 Changes in primary and secondary outcomes at t0, t1, and t2

		Adjusted mean changes (±SD)				
		CSE group	IBE group	M.D (95% CI)	F, *p* (partial η^2)	F, *p** (partial η^2)
Shoulder ROM						
Flexion	t0	151.23 (0.0)	151.23 (0.0)			
	t1	162.67 (3.60)	174.59 (3.14)	12.00 (12.17 to 11.88)	2.11, 0.15 (0.05)	
	t2	176.10 (2.90)	176.45 (2.83)	0.35 (0.48 to 0.22)	6.19, 0.02 (0.13)	6.65, 0.01 (0.14)
Extension	t0	47.85 (0.0)	47.85 (0.0)			
	t1	53.07 (1.98)	58.87 (1.94)	2.80(2.89 to 2.71)	4.30, 0.04 (0.09)	
	t2	61.23 (1.98)	60.34 (1.92)	− 2.00 (− 1.24 to − 1.42)	2.38, 0.13 (0.05)	2.87, 0.68 (0.12)
Abduction	t0	140.74 (0.0)	140.74 (46)			
	t1	150.64 (5.34)	167.61 (5.24)	16.97 (17.21 to 16.73)	5.0, 0.03 (0.11)	
	t2	170.04 (7.21)	153.37 (7.21)	− 16.67 (− 16.34 to − 17.01)	5.7, 0.02 (0.12)	4.97, 0.01 (0.11)
HGS						
Affected arm	t0	17.27 (0.0)	17.27 (0.0)			
	t1	17.71 (0.9)	16.62 (0.9)	− 1.25 (− 1.20 to − 1.29)	0.79, 0.38 (0.02)	
	t2	18.10 (0.8)	17.34 (0.7)	− 0.14 (− 0.11 to − 0.18)	0.56, 0.81 (0.00)	0.59, 0.52 (0.01)
FACT-B						
Physical well-being	t0	8.07 (0.0)	8.07 (0.0)			
	t1	8.31 (1.07)	6.83 (4.72)	− 1.48 (− 1.44 to − 1.53)	0.98, 0.33 (0.023)	
	t2	7.26 (0.62)	6.19 (0.66)	− 1.07 (− 1.04 to − 1.10)	0.62, 0.43 (0.015)	0.65,0.42 (0.02)
Social/Family well-being	t0	17.43 (0.0)	17.43 (0.0)			
	t1	16.98 (1.02)	16.92 (1.00)	− 0.05 (− 0.01 to − 0.01)	0.00, 0.97(0.00)	
	t2	16.99 ± (1.28)	17.86 (1.25)	0.87 (0.926 to 0.81)	0.00, 0.95 (0.00)	0.16, 0.85 (0.01)
Emotional well-being	t0	7.64 (0.0)	7.6 (0.0)			
	t1	7.79 (0.77)	6.85 (0.75)	− 0.95 (− 0.92 to − 0.98)	0.79, 0.38 (0.02)	
	t2	7.99 (0.71)	5.01 (0.63)	− 2.08 (− 2.04 to − 2.11)	3.29, 0.08 (0.73)	1.61, 0.21 (0.04)
Functional well-being	t0	15.98 (0.0)	15.98 (0.0)			
	t1	16.14 (0.92)	17.13 (0.90)	0.99(1.028 to 0.95)	0.59, 0.45 (0.01)	
	t2	17.73 (0.97)	19.30 (0.95)	1.61 (1.62 to 7.53)	1.34, 0.25 (0.03)	0.75, 0.48 (0.04)
Breast cancer subscale	t0	17.27 (0.0)	17.27 (0.0)			
	t1	16.42 (1.21)	17.34 (1.18)	0.92 (− 97 to- 0.86)	0.29, 0.59 (0.01)	
	t2	16.03 (1.13)	14.71 (1.10)	− 1.32 (− 1.27 to − 1.37)	0.69, 0.41 (0.02)	0.75, 0.48 (0.04)
TOI	t0	38.60 (0.0)	38.60 (0.0)			
	t1	40.73 (1.78)	37.09 (1.74)	− 3.55 (− 3.55 to − 3.72)	2.04, 0.16 (0.05)	
	t2	39.89 (1.61)	38.15 (1.61)	− 1.747 (− 1.67 to − 1.82)	1.09, 0.30 (0.03)	1.07, 0.89 (0.01)
FACT-G total score	t0	34.68 (0.0)	34.68 (0.0)			
	t1	46.84 (3.43)	50.00 (3.31)	3.16 (4.22 to 2.91)	0.26, 0.61 (0.01)	
	t2	42.7 (3.74)	56.18 (3.53)	13.74 (13.73 to 13.19)	0.82, 0.78 (0.00)	2.07, 0.14 (0.09)
FACT-B total score	t0	51.94 (0.0)	51.94(0.0)			
	t1	64.48 (3.76)	66.18 (3.64)	1.71 (2.00 to 1.46)	0.07, 0.79 (0.00)	
	t2	58.64 (3.64)	71.03 (3.59)	12.39 (12.64 to 12.14)	0.40, 0.53(0.01)	2.08, 0.14 (0.09)
SPADI						
Pain	t0	43.29 (0.0)	43.29 (0.0)			
	t1	37.68 (3.98)	36.35 (3.89)	− 1.33 (− 1.15 to − 1.51)	0.06, 0.81(0.00)	
	t2	28.44 (3.89)	30.67 (3.63)	2.23 (2.39 to 2.06)	0.39, 0.59(0.01)	0.22, 0.80 (0.01)
Disability	t0	27.06 (0.0)	27.06 (0.0)			
	t1	25.04 (3.54)	25.83 (3.46)	0.79 (0.95 to 0.72)	0.02, 0.88 (0.00)	
	t2	15.88 (3.17)	17.88 (3.09)	2.0(2.15 to 1.85)	3.74, 0.54 (0.01)	0.11, 0.87 (0.00)
Total score	t0	33.30 (0.0)	33.3 (0.0)			
	t1	30.66 (3.3)	29.93 (3.23)	− 0.73 (− 0.58 to − 0.88)	0.03, 0.88 (0.00)	
	t2	20.80 (3.3)	24.46 (3.20)	3.65 (3.8 to 3.51)	1.51, 0.23 (0.04)	0.68, 0.51 (0.03)

CSE, conservative self-exercise; *IBE*, inflatable ball exercise; *ROM*, range of motion; *HGS*, hand grip strength; *FACT-B*, Functional Assessment of Cancer Therapy-Breast Cancer; *FACT-G*, Functional Assessment of Cancer Therapy-Breast Cancer-General; *TOI*, trial outcome index

SPADI

SPADI showed no significant difference in pain, disability, and total scores. Score changes occurred in the CSE (about 15 points) and IBE groups (about 13 points) for pain. Score changes for disability occurred in the CSE group (about 12 points) and IBE group (about 19 points). The MDC of the total score was 13 points in the CSE group and 9 points in the IBE group.

Number of participation in interventions

The total number of practice in interventions was 36.18 and 39.65 in the CSE and IBE groups, respectively (Table 4).

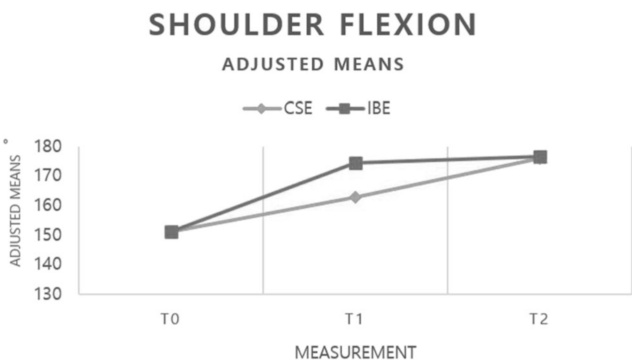

Fig. 5 Shoulder flexion

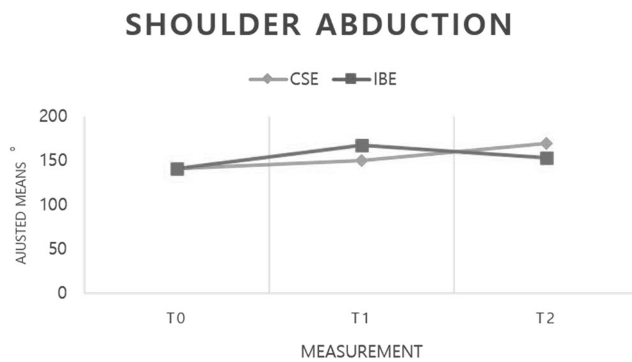

Fig. 7 Shoulder abduction

Discussion

Shoulder ROM

The effects of CSE and IBE on shoulder ROM were similar over the 12 weeks. However, IBE seemed to be more effective for the first 6 weeks of intervention, whereas CSE seemed to be more effective after 6 weeks. IBE may have been more effective during the first half of the program as the intervention is more easily modifiable in the presence of pain. More than 50% of the patients with breast cancer complained of pain with a VAS score of ≥ 5, which may interfere with shoulder movement just after breast surgery [11–13]. Conversely, CSE appeared to be more effective after 6 weeks because the decreased pain and active and slow stretching [5, 20, 21].

IBE may gradually release key muscles, such as the rhomboid, trapezius, and serratus anterior through simple weight bearing, static pressure, and dynamic pressure [8]. CSE was more effective than IBE for increasing shoulder ROM during t1-t2. We propose that due to reductions in pain gained during t0-t1, movement gains became greater during t1-t2 period. This result agrees with previous studies showing that active and slow stretching improves muscle tightness and shortening [5].

Normal scapulae muscles activate simultaneously during flexion, extension, and abduction [22]. BCSs experience difficulty with scapular retraction due to shortness and deformity of the pectoralis, serratus anterior, and latissimus dorsi and altered proprioception, muscle tissue, and weakness [23–25]. Although CSE increased shoulder ROM, altered the compensation of the large and small muscles could lead to overuse, fatigue, and spasm, since CSE activates the four key muscles using recruitment pattern movements [3].

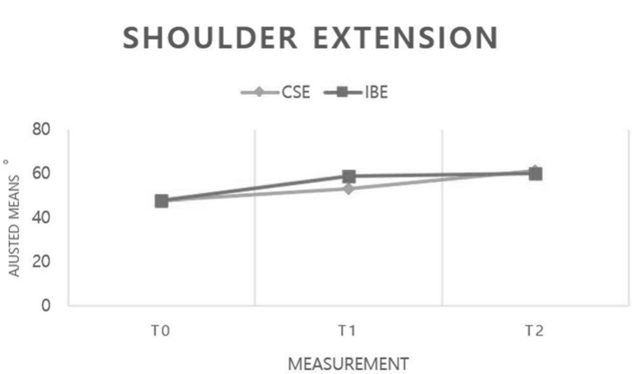

Fig. 6 Shoulder extension

The effect sizes were 0.14 (large) for flexion, 0.12 (relatively large) for extension, and 0.11 (relatively large) for abduction. For recommendable rehabilitation of shoulder ROM, BCSs appear to perform IBE initially to relieve pain and discomfort. CSE can then be used to improve shoulder ROM and function.

Hand grip strength

BCSs may experience decreased hand grip strength is related to QoL even after 6 months after breast surgery [26–28]. In the present study, hand grip strength showed no significant change and the effect size was small in both groups. In a previous study, although hand grip strength was a good rehabilitation target for shoulder motor function, the number of participants was small ($N = 10$) [29]. It was not possible to compare our results with previous studies as the target muscles such as upper and lower trapezius, supraspinatus, and serratus anterior were different to current study's muscles. The result of the present study was similar to that of a previous study showing no significant difference after 6 months of resistance exercise for handgrip strength in 114 participants following hospital treatment [30]. Consequently, improvement of shoulder function and ROM is insufficient to enhance hand grip strength at 12 weeks.

SPADI

Neither group showed significant changes in SPADI, although the subscales for pain, disability, and total score tended to increase during 12 weeks. Although the results did not reveal a MCID for the pain and disability subscales, the score of pain and disability tended to increase. The result reached the MCID

Table 4 Socio-demographics

	Control G ($n = 34$)	Experimental G ($n = 38$)	p
Age, years			
Mean(SD)	48.9(7.2)	47.69(8.9)	0.54
Range	37–60	26–60	–
Height, cm	160(0.1)	159(0.06)	0.95
Weight, kg	55.7(6.3)	58.5(6.42)	0.06
BMI	21.7(21.5)	22.9(22.9)	0.02
Education			
≥ High school	11	10	
University	20	22	
≤ Graduate school	3	4	
Marital status			
Married	25	22	
Unmarried	2	7	
Divorced	4	5	
Widowed	3	2	
Employment			
Houses Life	21	21	
Employed	5	6	
Medical Leave	6	3	
Unemployed	2	6	
Smoking			
No	30	32	
Yes	4	4	
Reconstructive surgery			
Yes	8	6	
No	25	30	
The number of Intervention participation	36.18(12.27)	39.65(11.06)	0.32
Family history of cancer (%)	13(%)	12(%)	
Cancer stage			
I	19	21	
II	15	9	
III	0	8	
Post-operative therapy			
Radiotherapy	34	38	
Hormonal blockage	19	22	
Chemotherapy	15	26	
Radiotherapy+ Chemotherapy	6	8	
Menopause			
Menopause	17	27	
Premenopause	10	18	
Postmenopause	7	9	
Surgery			
Mastectomy	5	20	
Quadrantectomy	22	18	
Number of extirpated lymph nodes			
0	3	7	
1–10 nodes	24	24	
11–20 nodes	3	4	
≥ 21 nodes	4	3	
Term between diagnosis and surgery			
≤ 2 weeks	8	9	
≤ 1 month	15	10	
≤ 3 months	7	5	
≥ 6 months	4	14	
Lymphedema			
Yes	3	1	
No	31	37	

for CSE (about 15 points) and IBE (about 12 points) in the pain subscale during t0-t1, although the result could not be compared to the MCID of the pain scale such as VAS (MCID 1,1 point) and numeric rating scale (2 points) [30]. Considering the MCID (8~13.2 points) of SPADI, CSE (approximately 13 points) and IBE (approximately 9) may have reached the MCID [31]. Although no significant changes in disability were seen, both exercises may be realistically effective for improving shoulder function and pain in BCSs in terms of the MCID over 12 weeks. Considering the MCID, the result could apply MCID to treatment planning and in guiding BCSs' expectations of treatment change [32].

FACT-B

Both groups showed significant changes in the MCID of FACT-B, although FACT-B subscale and total scores showed no significant differences during 12 weeks. PWB, SWB, FWB, and BCSs were not significantly different between the groups. The FACT-B total score increased by approximately 6 points and 20 points in the CSE and IBE groups, respectively. Moreover, FACT-B total score also increased by 51 to 58 points and 52 to 71 in the CSE and IBE groups. TOI (2~3 points), FACT-G (5~6 points), and FACT-B total scores (7~8 points) satisfied the MDC.

We can explain FACT-B score, which is a tool for evaluating the quality of life, based on the previous study [33] that the stress on the breast cancer patients was reduced by the relaxation effect of the fascia. The higher FACT-B score of the IBE group than the CSE group indicates that the inflatable ball exercise with fascia release decreased the stress of BCS by increasing secretion of natural killer cell, serotonin, dopamine and decreasing cortisol secretion through fascia release of BCS [32, 33]. In clinical view, the result can help decision making to guide treatment recommendation.

Study limitations

This study had some key limitations related to its quasi-experimental design and community-based rehabilitation setting. It was difficult to standardize the physical conditions of BCSs because of their pathological features as well as time course since surgery and other potential variables. In addition, although we recommended at least 3 sessions per week, there were deviations depending on individual satisfaction levels. To improve compliance, we provided sufficient training during the intervention period and provided a motion picture booklet for better understanding of the intervention. However, these results do provide evidence for the efficacy of CSE and IBE. Future studies should aim to clarify these findings and establish the generalizability and applicability of CSE and IBE in a larger cohort with a longer follow-up period.

Conclusion

The results of this study suggest that CSE and IBE can be clinically recommended to enhance the shoulder function and QoL of BCSs. However, physicians should choose the rehabilitation exercise protocol on the basis of the physical condition of individual patients. In the early period, IBE seemed to be effective to improve pain, discomfort, and QoL. When pain and discomfort have been reduced by IBE, CSE may be appropriate to increase the shoulder function of BCSs.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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