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Effectiveness of Water Physical Therapy on Pain, Pressure Pain Sensitivity, and Myofascial Trigger Points in Breast Cancer Survivors: A Randomized, Controlled Clinical Trial

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Abstract

Objective. To evaluate the effects of an 8-week water physical therapy program on cervical and shoulder pain, pressure sensitivity, and the presence of trigger points (TrPs) in breast cancer survivors.

Design. Randomized, controlled trial.

Setting. To date, no study has investigated effects of water therapy in breast cancer.

Patients. Sixty-six breast cancer survivors were randomly assigned into two groups: WATER group, who received a water exercise program or CONTROL group who received the usual care treatment for breast cancer.

Interventions. The WATER therapy program consisted of 24 sessions (3 times/week over 8 weeks) of low-intensity exercises in a warm pool (32°C). Each session included 10-minute warm-up period; 35 minutes of aerobic, low-intensity endurance, and core stability training; and a 15-minute cool-down period (stretching and relaxation).

Outcomes. Neck and shoulder pain (visual analog scale, 0–100 mm), pressure pain thresholds (PPTs) over C5-C6 zygapophyseal joints, deltoid muscles, second metacarpal, and tibialis anterior muscles, and the presence of TrPs in cervical-shoulder muscles were assessed at baseline and after the 8-week program by an assessor blinded to treatment allocation.

Results. The WATER group demonstrated a between-group improvement for neck pain of –31 mm (95% confidence interval [CI] –49 to –22, $P < 0.001$; effect size 1.1, 0.81–1.75) and for shoulder-axillary of –19 mm (–40 to –04, $P = 0.046$; effect size 0.70, 0.14–1.40). Improvements were also noted for PPT levels over C5-C6 joints (between-group differences, affected side: 27.7 kPa, 95% CI 3.9–50.4; unaffected: 18.1 kPa, 95% CI 6.1–52.2). No between-group differences for PPT over the remaining points were observed ($P > 0.05$). Finally, patients in the WATER program showed a greater reduction of active TrPs as compared with the CONTROL group ($P < 0.05$).

Conclusions. An 8-week water therapy program was effective for improving neck and shoulder/axillary pain, and reducing the presence of TrPs in breast cancer survivors as compared with usual care; however, no significant changes in widespread pressure pain hyperalgesia were found.

Key Words. Breast Cancer; Water; Exercise; Pressure Sensitivity; Pain

Introduction

Breast cancer is the most common form of cancer in women [1], with an estimated 2 million breast cancer survivors in the United States [2]. Excluding skin cancer, breast cancer is the most common malignancy among women, accounting for nearly one of three cancers diagnosed in women in the United States, and is considered the second leading cause of cancer death among women [3]. The costs of breast cancer are high for society. A case-control study determined that the total average costs of breast cancer was 107,456€/patient, being 89% productivity loss costs and 11% health care costs [4]. Different studies have investigated the incidence and prevalence rates of breast cancer; however, it has been recently reported that incidence rates of breast cancer have been overestimated in the last decade [5,6]. In fact, a recent report has shown that breast cancer mortality has decreased in Europe over the last 25–30 years [7].

Almost all breast cancer survivors exhibit different cancer-related symptoms that impact their quality of life [8]. Among these symptoms, persistent pain after mastectomy has a high prevalence (43%) [9–11]. Additionally, the presence of persistent pain is related to greater rates of depression, lower levels of function, higher cancer-related fatigue, and greater associated symptoms [12,13]. One associated symptom commonly associated with pain is the presence of sensory disturbances (around 50% breast cancer survivors) [14]. In fact, there is evidence suggesting that breast cancer survivors present with changes in nociceptive processing, as mastectomy may enhance the experience of pain by sensitizing the central nervous system due to the nociception originated from damaged small nerve fibers during surgery [15,16]. Recent studies had revealed that breast cancer survivors exhibit widespread pressure hyperalgesia as sign of sensitization of the central nervous system [17] regardless if they received lumpectomy or mastectomy [18]. In these studies, pressure hyperalgesia was related to the presence of active muscle trigger points (TrPs, hypersensitive spots in taut bands in a skeletal muscle that stimulation elicit referred distant pain) [19] indicating that active muscle TrPs spatially increase mechanical sensitivity in breast cancer survivors [17].

As the presence of sensory disturbances after surgery is a predictive factor for persistent pain after breast cancer treatment [20], physical therapy programs should be targeted in decreasing clinical pain and nociceptive gain. There is evidence showing that exercise improves physical function in breast cancer survivors [21]. Nevertheless, a recent meta-analysis found that most published studies have focused on cancer-related fatigue as the main outcome, and most did not include measures of pain or sensory disturbances [22]. A recent study showed that an 8-week multidimensional program including moderate-to-high-intensity strengthening exercises and massage was effective for improving neck and shoulder pain, and reducing pressure pain hyperalgesia in breast cancer survivors as compared with usual care treatment [23]. However, in clinical practice, it is seen that some breast cancer survivors are not able to practice moderate-high intensity exercises. Therefore, physical therapy practice would benefit from further studies investigating the efficacy of different exercise programs, such as those performed in water, on persistent pain and sensory disturbances in breast cancer survivors.

Water exercise utilizes the principles of hydrostatics and hydrodynamics to create challenges promoting the improvement of health through exercise in water. The unique characteristics of exercising in water may allow people to perform exercises that they would be unable to perform on land [24]. Therefore, these characteristics can help to decrease symptoms because warmth and buoyancy may reduce muscle pain [25] found in breast cancer survivors [17].

To the best of the authors' knowledge, no previous study has investigated the effects of a water physical therapy program on pain and sensory disturbances in breast cancer survivors. Therefore, the aim of this randomized clinical study was to evaluate the effectiveness of an 8-week water physical therapy program, focused on low-intensity exercises, on cervical-shoulder pain, pressure pain hypersensitivity, and the presence of active TrPs in a population of breast cancer survivors.

Methods

Participants

Participants were recruited from the Unit of Breast Oncology of the Hospital Virgen de las Nieves and Hospital Clínico San Cecilio, Granada (Spain) from June 2010 to September 2011. Participants were eligible if they: 1) had a diagnosis of breast cancer (stages I-IIIA); 2) had received a simple mastectomy or quadrantectomy with posterior breast reconstruction; 3) between 25 and 65 years; 4) finished their co-adjuvant treatment, except hormone therapy, at least 3 months before beginning the study; 5) not having an active cancer; and, 6) having neck and shoulder pain that began after the breast cancer surgery assessed with a visual analog scale (VAS) (0–100). Neck pain was defined as pain from the occipital to C7 vertebra, not including the shoulder region, whereas shoulder-axillary pain was defined as pain experienced in the shoulder and/or the axillary region, not including the cervical spine. Subjects were excluded if they: 1) were receiving chemotherapy or radiotherapy at the time of the study; 2) suffer from an orthopedic disease that limit to follow the water program; 3) had uncontrolled hypertension (diastolic pressure >95 mm Hg); 4) had presence of lymphoedema; 5) had recurrent cancer; or 6) had previous diagnosis of fibromyalgia [26].

Potential eligible participants were contacted by telephone. Those participants interested were scheduled for appointment where they received a complete explanation of the study and provided informed consent if they agreed

to participate. After inclusion, they were scheduled for a medical visit that included a clinical history, physical examination, and medical screening to determine any condition that justified medical exclusion. The ethical approval for this study was granted by the Ethics Committee of the Hospital Virgen de las Nieves (Granada, Spain).

Design, Randomization, and Allocation

A randomized, controlled clinical trial was conducted. Eligible participants who agreed to participate were randomly assigned into two groups: WATER group who received the water exercise program or CONTROL group who received the usual care treatment for breast cancer. For ethical implications, those participants allocated to the control group, who finished the period of 8 weeks for the current study, were invited to receive the water exercise program. We allocated patients to WATER or CONTROL groups into two randomization cycles using a computer-generated numbers. The sequence was entered into numbered opaque envelopes by an external member, and they were opened after completion of the baseline assessment. Outcome measures were assessed 1 week before and after the intervention by an individual blind to group assignment.

Pain Assessment

The main outcome measures were neck and shoulder/axillary pain intensities. VAS was used to determine the intensity of neck and shoulder-axillary pain. The VAS is a 100-mm line anchored with a 0 at one end representing no pain and 100 at the other end representing the worst pain imaginable [27]. VAS was selected as an outcome measure based on its ability to detect immediate changes with a minimal clinically important difference (MCID) ranging from 9 to 11 mms [28,29].

Pressure Pain Sensitivity

The secondary outcome measure of the current study was pressure pain threshold (PPT), defined as the minimal amount of pressure where a sensation of pressure first changes to pain [30]. It was assessed with an electronic algometer (Somedic AB, Farsta, Sweden). The pressure was applied at approximately a rate of 30 kPa/seconds by a 1-cm^2 probe. Participants were instructed to press the switch when the sensation first changed from pressure to pain. The mean of three trials was calculated for each point and used for the analysis (intraexaminer reliability). A 30-second resting period was allowed between each trial. The reliability of pressure algometry has been found to be high (intra-class correlation coefficient [ICC] 0.91, 95% confidence interval [CI] 0.82–0.97) [31]. PPT was bilaterally assessed over the C5-C6 zygapophyseal joints, deltoid muscles, second metacarpal, and tibialis anterior muscles by an assessor blinded to the allocation of the participants, as described previously [17,18,23].

TrP Exploration

An additional secondary outcome was the presence of active muscle TrPs. TrPs were bilaterally examined in the upper trapezius, the sternocleidomastoid, the levator scapulae, scalene, pectoralis major, and infraspinatus muscles by an assessor who had more than 6 years of experience in the assessment and management of TrPs [23]. TrP diagnosis was performed according to the criteria as described by Simons et al. [19]: 1) presence of a palpable taut band in a skeletal muscle; 2) presence of a hyperirritable spot in the taut band; 3) local twitch response elicited by snapping palpation of the taut band; and 4) presence of referred pain in response to TrP compression. These criteria, when applied by an experienced assessor, have obtained a good interexaminer reliability, with kappa values ranging from 0.84 to 0.88 [32].

TrPs were considered active when both the local and the referred pain evoked by digital compression reproduced any pain symptom, and the patient recognized the pain as familiar. TrPs were considered latent when the local and referred pain elicited did not reproduce any symptom recognized as familiar by the patient [19]. After TrP palpation on each muscle, patients were asked: "When I pressed this muscle, did you feel any pain locally and in other distant area (referred pain). Please tell me whether the pain that you felt during compression reproduces any pain symptom that you are suffering from."

Intervention Condition: WATER Exercise Program

The WATER exercise group trained in a warm pool (32°C), 3 times/week over 8 consecutive weeks (total number of sessions: 24). For this study, we used a deep water pool frequently used for swimming (water temperature: 28–31°C; depth: 1.40 m in the lowest part and 1.80 m in the deepest part). All participants were immersed in water up to the neck. Each 1-hour session included a 10-minute warm-up consisting of slow aerobic, mobility, and stretching exercise; 35 minutes of aerobic, low-intensity endurance, and core stability training; and a 15-minute cool-down period including stretching and relaxation exercises focusing on the neck/shoulder region. The intensity of the training was established following the recommendations of the American College of Sports Medicine and American Heart Association [33]. Participants used the "Borg Rating of Perceived Exertion Scale" for rating their fatigue during the exercise [34]. Progression in the aerobic training was performed throughout the 8 weeks by gradually increasing the intensity and the duration. The program was supervised by two physical therapists with clinical experience in the management of patients with different cancer conditions, and there were 10–12 participants per group. Progression was individualized by a physical therapist with a rate of 4–5 participants for one therapist. Progression of the training is presented in Table 1.

Table 1 WATER physical therapy program

		Weeks 1–4	Weeks 5–8
Material		Pool noodles and swimming belt	Pool noodles, pull buoy, swimming board
Aerobic exercise		Unspecific work during sessions	5–10 minutes of slow aerobic exercise (aqua running or swim) and unspecific work during sessions
Strength exercise	Main muscle groups	Dosage and progression	Dosage and progression
1. Bicycling in different body position	Hip and knee flexors and extensors, trunk stabilizers	Week 1: learning proposal and familiarization with the aquatic environment.	Week 5: 10–12 repetitions × 2 sets
2. Flex/extension of elbow/wrist with a correct shoulder position	Scapular stabilizers, shoulder, elbow and wrist flexors, and extensor muscles	Week 2: 10–12 repetitions × 2 sets	Week 6: 12–15 repetitions × 2 sets
3. Maintain hip and trunk with 90° and legs movements	Trunk flexors and low-back stabilizers	Week 3: 12–15 repetitions × 2 sets	Week 7: 10–12 repetitions × 3 sets
4. Hip rotation, ADD-ABD standing	Hip rotators, adductors and abductors	Week 4: 10–12 repetitions × 3 sets	Week 8: 10–12 repetitions × 3 sets
5. Flex/extension of the shoulder	Shoulder flexors and extensors	Using water resistance. Continue progression between exercises and medium velocity execution exercises	Increase resistance with materials and positions that require more body control
6. Hip extension with control of low-back position	Low-back extensors and trunk stabilizers	Increase range of joint motion	
		Pelvic floor, scapular, and low-back stabilizers unspecific work during exercises	
Stretching/relaxation exercises		Static self stretching (trapezius, splenius, triceps, deltoid, pectoralis, quadriceps, and hamstring muscles)	Static self stretching (trapezius, splenius, triceps, deltoid, pectoralis, quadriceps, and hamstring muscles)
		Self-massage (stroking, kneading, and pressure)	Couples massage (stroking, kneading, and pressure)
		Mobility exercise of the main joints (cervical and lumbar spine, shoulder, hip, knee, and interphalangeal)	Mobility exercise in pairs of main joints (cervical and lumbar spine, shoulder, hip, knee, and interphalangeal)
		Breathing exercises (deep and diaphragmatic breathing)	Breathing exercises(deep and diaphragmatic breathing)

ADD-ABD = adduction, abduction of the shoulder.

Control Condition

Participants followed usual care recommendations by an oncologist in relation to a healthy lifestyle. Breast cancer survivors received a document printable dossier from the oncologist where they found recommendations related to nutrition, lifestyle behaviors, and exercise. A follow-up of the physical activity during the control period was used to control bias detected in previous studies with exercise in cancer survivors [35,36]. For that purpose, we used the Spanish version of the Minnesota Leisure Time Physical Activity Questionnaire [37].

Sample Size Calculation

Sample size determination was performed with appropriate software (Tamaño de la Muestra1.1©, Madrid, Spain). The calculation was based on detecting between-group differences of 11 mm on a 100-mm VAS (i.e., MCID), assuming a standard deviation of 9 [28,29], a two-tailed

t-test, an alpha (α) level of 0.05, and a desired power of 90%. The estimated desired a sample size was calculated to be at least 15 participants per group. To increase the power analysis and to accommodate possible dropouts before the study completion, we duplicated the sample and included a total of 70 participants.

Statistical Analysis

Statistical analyses were performed using SPSS statistical software, version 17.0 (SPSS, Inc., Chicago, IL, USA), and were conducted according to intention-to-treat analysis principle. Chi-square tests and Student's *t*-tests were used to examine the differences in sociodemographic, medical and clinical features, and PPT levels between the WATER and CONTROL groups. A 2×2 mixed-model repeated-measure analysis of variance (ANOVA) with time (pre- and post-intervention) as the within-subject variable and intervention (WATER-CONTROL) as the between-subjects variable was used to examine the effects of the intervention on neck and shoulder/axillary pain. A 2×3 mixed-model repeated-measure ANOVA with time (pre- and post-intervention) and side (affected or unaffected) as within-subject factors and intervention (WATER-CONTROL) as between-subjects factor was used to analyze differences in PPT. Separate ANOVAs were done with each outcome as the dependent variable. The main hypothesis of interest was the group $\times$ time interaction. Intergroup effect sizes were calculated according to the Cohen's *d statistic* [38]. An effect size <0.2 reflects a negligible difference, between $\geq$0.2 and $\leq$0.5 a small difference, between $\geq$0.5 and $\leq$0.8 a moderate difference, and $\geq$0.8 a large difference. Finally, mixed chi-square tests (McNemar-Bowker test) were applied to investigate the changes in the distribution of active TrPs between both groups at baseline and after the intervention. A *P* value less than 0.05 was considered statistically significant.

Results

Participants

During the study period (June 2010 to September 2011), 95 women with cancer aged 18–65 completed the oncology treatment in a regional hospital. Seventy patients (73%) were eligible for prescreening, and 66 (94%) agreed to participate and were included in the study (Figure 1). The mean time from breast surgery was 9 $\pm$ 3 months. No differences in age, clinical features, pain, PPT levels, and the distribution of TrPs prior to the study existed between the WATER and CONTROL groups (Tables 2–5), so it can be assumed that both groups were comparable in all the outcomes at the beginning of the study.

Adherence and Adverse Events of the WATER Physical Therapy Program

A checklist of all sessions was completed by the subjects to determine adherence to the water exercise program. One participant in the WATER program dropped out due to a recurrence of breast cancer during the program. All

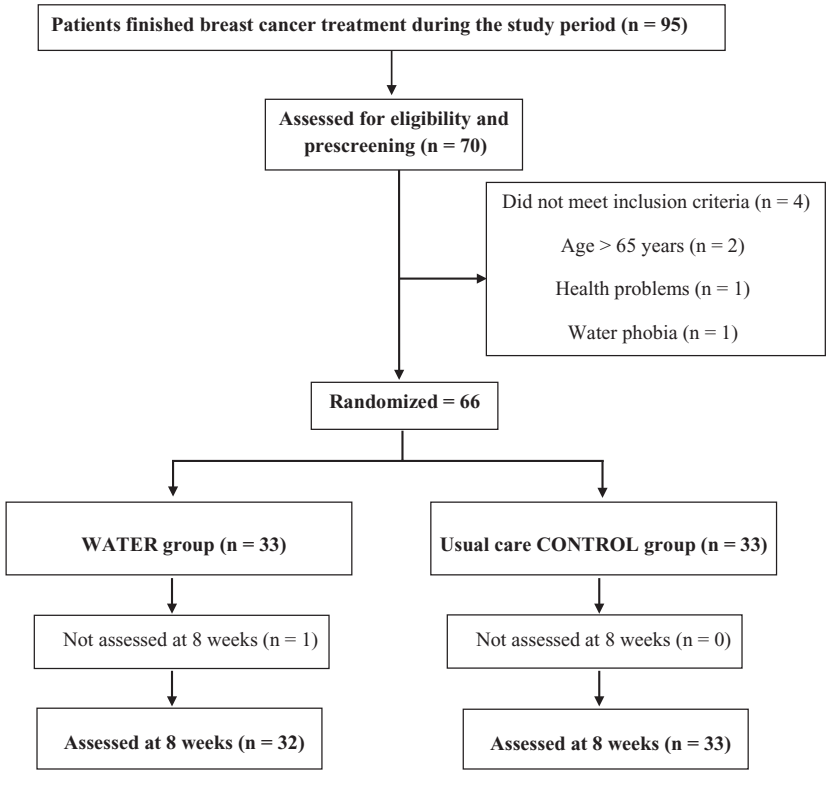

Figure 1 Flow diagram of subject recruitment and retention throughout the course of the study.

Table 2 Patient's characteristics and comparisons between both breast cancer survivor groups

Variable	Water program (N = 33)	Control group (N = 33)	*P* value
Age (years), mean (SD)	48 (8)	47 (9)	0.783
Tumor stage, N (%)			
I	16 (48)	17 (51)	0.679
II	10 (30)	10 (30)	
IIIA	7 (22)	6 (19)	
Type of surgery, N (%)			
Quadrantectomy	22 (67)	21 (64)	0.851
Mastectomy	11 (33)	12 (36)	
Side of surgery, N (%)			
Right (dominant) side	19 (57)	18 (54)	0.804
Left (nondominant) side	14 (43)	15 (46)	
Type of treatment, N (%)			
Radiation	1 (3)	1 (3)	0.861
Chemotherapy	2 (7)	1 (3)	
Radiation + chemotherapy	30 (90)	31 (94)	
Hormone therapy, N (%)			
Antagonist of estrogen receptors (tamoxifen)	2 (6)	2 (6)	0.802
Aromatase inhibitors (anastrozole)	3 (9)	2 (6)	

P-values for comparisons among group based on chi-square and analysis of variance tests.
SD, standard deviation.

participants within the WATER group completed more than 85% of the 24 water exercise sessions, showing a high adherence rate to the program. Three women reported a transient increase of edema, and four women noted an increase in fatigue immediately after the beginning of the first session, which improved in the next few days. These women did not dropout of the study. No other adverse events were recorded during the study.

Changes in Minnesota Leisure Time Physical Activity Questionnaire

At the beginning of the study, no significant differences ($P = 0.466$) were found for the Minnesota Leisure Time Physical Activity Questionnaire between groups (water group: 32.6 ± 22.8; control group: 37.1 ± 20.5). At the end of the study, the control group did not change its physical activity (score: 31.4 ± 25.3, $P = 0.641$), whereas the water exercise group exhibited a statistically significant increase (score: 63.2 ± 35.8, $P < 0.001$).

Effects of WATER Physical Therapy in Neck and Shoulder/Axillary Pain

The ANOVA found a significant group × time interaction for the main outcome of the study: neck ($F = 11.734$; $P < 0.001$) and shoulder/axillary ($F = 4.827$; $P = 0.046$) pain; the WATER group experienced a greater decrease in neck and shoulder/axillary pain than the CONTROL group (Table 3). The intergroup effect size was large for neck pain (*d* 1.1, 95% CI 0.81–1.75) and moderate for shoulder/axillary pain (*d* 0.7, 95% CI 0.14–1.40).

Table 3 Pre-intervention, post-intervention, and change scores for neck and shoulder/axillary pain

Group	Pre-intervention	Post-intervention	Within group change scores	Between-group differences
Neck pain				
WATER program	40 ± 31	12 ± 15	–28 (–42, –17)	–31 (–49, –22)*
Control	39 ± 21	42 ± 23	3 (–5, 11)	
Shoulder/axillary pain				
WATER program	27 ± 33	12 ± 13	–15 (–29, –10)	–19 (–40, –4)*
Control	38 ± 35	43 ± 33	5 (–1, 19)	

* Significant group × time interaction (repeated analysis of variance test, $P < 0.05$).
Values are expressed as mean ± standard deviation for pre- and post-intervention data and as mean (95% confidence interval) for within- and between-group change scores.

Table 4 Pre-intervention, post-intervention, and change scores for pressure pain thresholds

Group	Pre-intervention	Post-intervention	Within group change scores	Between-group differences
C5-C6 zygapophyseal joint affected				
WATER program	156.0 ± 65.8	174.0 ± 63.5	18.0 (3.1, 31.8)	27.7 (3.9, 50.4)*
Control	163.4 ± 62.7	153.7 ± 49.7	–9.7 (–29.5, 10.1)	
C5-C6 zygapophyseal joint unaffected				
WATER program	167.4 ± 66.3	167.3 ± 62.4	0.1 (–18.6, 18.8)	18.1 (6.1, 52.2)*
Control	181.9 ± 61.8	163.7 ± 54.1	–18.2 (–50.5, –4.1)	
Deltoid muscle affected				
WATER program	181.4 ± 76.8	206.9 ± 66.8	25.5 (1.4, 49.6)	6.5 (–35.7,48.9)
Control	194.6 ± 111.4	213.6 ± 69.3	19.0 (–19.9, 57.8)	
Deltoid muscle unaffected				
WATER program	191.6 ± 83.3	212.6 ± 61.1	21.0 (5.0, 46.9)	21.3 (–15.8, 58.4)
Control	223.4 ± 77.7	223.1 ± 60.4	–0.3 (–26.4, 25.7)	
Second metacarpal affected				
WATER program	210.4 ± 65.9	243.8 ± 83.8	33.4 (8.3, 58.4)	46.1 (5.8, 86.2)
Control	234.4 ± 81.1	221.7 ± 66.9	–12.7 (–46.6, 21.2)	
Second metacarpal unaffected				
WATER program	242.3 ± 66.3	255.2 ± 72.6	12.9 (–16.8, 42.7)	–2.8 (–45.3, 39.6)
Control	233.1 ± 80.9	248.8 ± 57.7	15.7 (–13.7, 45.2)	
Tibialis anterior muscle affected				
WATER program	261.2 ± 108.6	259.4 ± 82.1	–1.8 (–41.9, 38.4)	–20.7 (–75.7, 34.5)
Control	293.3 ± 83.8	312.2 ± 88.5	18.9 (–15.9, 53.5)	
Tibialis anterior muscle unaffected				
WATER program	275.4 ± 112.5	268.5 ± 101.7	–6.9 (–49.7, 35.9)	–21.1 (–78.5, 36.4)
Control	302.9 ± 92.1	317.1 ± 75.4	14.2 (–19.7, 48.1)	

* Significant group × time interaction (repeated analysis of variance test, $P < 0.05$).
Values are expressed as mean ± standard deviation for pre- and post- intervention data and as mean (95% confidence interval) for within- and between-group change scores.

Effects of WATER Physical Therapy in Pressure Pain Sensitivity

The intraexaminer repeatability of PPT readings for the points included in the current study ranged from 0.9 to 0.93 for the affected side and from 0.92 to 0.94 for the unaffected side. The standard error of measurement ranged from 6.2 to 7.1 kPa for the affected side and from 5.9 to 6.5 kPa for the unaffected side.

The ANOVA revealed significant group × time interactions for PPT levels over the C5-C6 zygapophyseal joint ($F = 4.835$; $P = 0.030$) but not over the deltoid muscle ($F = 0.984$; $P = 0.323$), second metacarpal ($F = 3.328$; $P = 0.071$), and tibialis anterior muscle ($F = 1.104$; $P = 0.296$). No significant group × time × side interactions for PPT levels over the C5-C6 zygapophyseal joints ($F = 0.196$; $P = 0.659$), deltoid muscle ($F = 0.275$; $P = 0.601$), second metacarpal ($F = 0.425$; $P = 0.516$), and tibialis anterior muscle ($F = 0.061$; $P = 0.805$) were observed. The WATER group experienced bilateral increases in PPT over the cervical spine compared with the CONTROL group (Table 4). The intergroup effect size was large for C5-C6 zygapophyseal joints (d 1.5, 95% CI 0.21–2.77) but small for the remaining PPT levels ($–0.5 < d < 0.11$).

Effects of WATER Physical Therapy in Active TrPs

The nonparametric McNemar–Bowker test revealed significant changes in the distribution of active TrPs after the intervention for both upper trapezius (affected: $P = 0.011$; unaffected: $P = 0.042$), levator scapulae (affected: $P = 0.039$; unaffected: $P = 0.048$), scalene (affected: $P = 0.014$; unaffected: $P = 0.001$), pectoralis major (affected: $P = 0.017$; unaffected: $P = 0.021$), and infraspinatus (affected: $P = 0.041$; unaffected: $P = 0.034$) but not for the sternocleidomastoid (affected: $P = 0.737$; unaffected: $P = 0.787$) muscles; patients in the WATER exercise program showed a greater reduction of active TrPs as compared with the CONTROL group (Tables 5 and 6). No change in the presence of TrPs was observed in the CONTROL group.

Discussion

The current randomized, controlled trial found that an 8-week supervised water physical therapy program focused on low-intensity exercise was effective for improving neck and shoulder/axillary pain and reducing the presence of TrPs in breast cancer survivors as compared with usual care. However, no significant changes in widespread pressure pain hyperalgesia were found.

Table 5 Distribution of muscle trigger points (TrPs) in breast cancer survivors at baseline

	WATER group (N = 33)					
	Upper trapezius muscle		Sternocleidomastoid muscle		Levator scapulae muscle	
	Affected side	Nonaffected side	Affected side	Nonaffected side	Affected side	Nonaffected side
Active TrPs, N (%)	15 (45)	19 (58)	6 (19)	6 (19)	9 (27.5)	9 (27.5)
Latent TrPs, N (%)	3 (10)	0 (0)	3 (10)	3 (10)	1 (3)	1 (3)
No TrPs, N (%)	15 (45)	14 (42)	24 (71)	24 (71)	23 (69.5)	23 (69.5)
	Scalene muscle		Pectoralis major muscle		Infraspinatus muscle	
Active TrPs, N (%)	15 (45)	8 (24)	23 (69.5)	3 (10)	10 (30)	7 (22)
Latent TrPs, N (%)	9 (27.5)	6 (19)	2 (6.5)	1 (3)	2 (6.5)	1 (3)
No TrPs, N (%)	9 (27.5)	19 (57)	8 (24)	29 (87)	21 (63.5)	25 (75)
	CONTROL group (N = 33)					
	Upper trapezius muscle		Sternocleidomastoid muscle		Levator scapulae muscle	
	Affected side	Nonaffected side	Affected side	Nonaffected side	Affected side	Nonaffected side
Active TrPs, N (%)	16 (49)	12 (36)	7 (21)	4 (12)	15 (45)	11 (33)
Latent TrPs, N (%)	2 (6)	2 (6)	3 (9)	2 (6)	1 (3)	1 (3)
No TrPs, N (%)	15 (45)	19 (58)	23 (70)	27 (82)	17 (51)	21 (54)
	Scalene muscle		Pectoralis major muscle		Infraspinatus muscle	
Active TrPs, N (%)	18 (55)	6 (18)	21 (63.5)	6 (18)	12 (36.5)	5 (15)
Latent TrPs, N (%)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
No TrPs, N (%)	15 (45)	27 (72)	12 (36.5)	27 (72)	21 (63.5)	28 (85)

In the current study, the effect size for improvement in neck pain (1.1) was large, whereas the improvement in shoulder/axillary pain (0.70) was moderate suggesting a clinically important change. In addition, between-group mean with its 95% CI for difference change score for neck pain surpassed the MCID of 9 and 11 mm [28,29], providing assurance when making clinical decisions regarding the treatment effect of water physical therapy program on this outcome. Similarly, between-group difference change score for shoulder/axillary pain also surpassed the MCID; however, the lower bound of the 95% CI falls within this score, potentially limiting the clinical effect on this outcome. Our results are similar to those previously found by Fernández-Lao et al. [23] who reported that a multimodal physical therapy program including moderate-intensity aerobic and strengthening exercises also decreased neck and shoulder/axillary pain in breast cancer survivors. Nevertheless, the effect of this exercise protocol demonstrated a greater decrease in pain than the current randomized trial. A possible explanation is that the exercise protocol applied by Fernández-Lao et al. [23] included moderate-intensity strengthening [39] exercises and post-session recovery massage, whereas the current study was focused on low-intensity exercises conducted in water without any recovery post-session intervention. Nevertheless, previous and current evidence suggests that physical therapy is effective for reducing neck and shoulder pain in breast cancer survivors that is highly relevant as 20% of breast cancer survivors usually contact a physician for pain complaints [40].

We also found a small increase in PPT levels, that is, a decrease in pressure pain hypersensitivity over the cervical spine after the water exercise program; however, no changes in the remaining PPT levels were found. This finding would suggest a localized hypoalgesic effect of the program in breast cancer survivors; however, PPT changes over the cervical spine were small. Our results differ from those previously reported by Fernández-Lao et al. who found a generalized hypoalgesic effect as widespread changes in pressure pain sensitivity were observed [23]. It has been postulated that the cause of the exercise-induced hypoalgesia is related to the activation of central inhibitory pain mechanisms. In fact, it seems that exercise-induced hypoalgesia is dependent on the intensity of the exercise [41]. Hoffman et al. determined that an intensity >50% Vo^2 max and a duration >10 minutes are minimum thresholds required for eliciting this exercise-induced anal-

Table 6 Distribution of muscle trigger points (TrPs) in breast cancer survivors after the intervention

	WATER group (N = 33)					
	Upper trapezius muscle		Sternocleidomastoid muscle		Levator scapulae muscle	
	Affected side	Nonaffected side	Affected side	Nonaffected side	Affected side	Nonaffected side
Active TrPs, N (%)	5 (15)	4 (12)	1 (3)	0 (0)	3 (9)	1 (3)
Latent TrPs, N (%)	0 (0)	1 (3)	0 (0)	3 (9)	0 (0)	1 (3)
No TrPs, N (%)	28 (85)	28 (85)	32 (97)	30 (91)	30 (91)	31 (94)
	Scalene muscle		Pectoralis major muscle		Infraspinatus muscle	
Active TrPs, N (%)	1 (3)	1 (3)	7 (21)	1 (3)	2 (6)	0 (0)
Latent TrPs, N (%)	5 (15)	3 (9)	3 (3)	0 (0)	0 (0)	0 (0)
No TrPs, N (%)	27 (82)	29 (88)	23 (66)	32 (97)	31 (94)	33 (100)
	Control group (N = 33)					
	Upper trapezius muscle		Sternocleidomastoid muscle		Levator scapulae muscle	
	Affected side	Nonaffected side	Affected side	Nonaffected side	Affected side	Nonaffected side
Active TrPs, N (%)	19 (58)	12 (35)	11 (33)	7 (21)	16 (51)	11 (33)
Latent TrPs, N (%)	0 (0)	2 (7)	5 (16)	4 (12)	0 (0)	2 (7)
No TrPs, N (%)	14 (42)	19 (58)	17 (51)	22 (67)	17 (49)	20 (60)
	Scalene muscle		Pectoralis major muscle		Infraspinatus muscle	
Active TrPs, N (%)	15 (45)	1 (3)	27 (82)	2 (6)	16 (49)	11 (33)
Latent TrPs, N (%)	2 (6)	0 (0)	0 (0)	0 (0)	2 (6)	0 (0)
No TrPs, N (%)	16 (49)	32 (97)	6 (18)	31 (94)	15 (45)	22 (67)

gesia [42]. It is possible that breast cancer survivors included in the water group did not reach this intensity level as the water physical therapy program was focused on low-intensity aerobic exercises. Future studies should investigate the dose–response relationship for different physical therapy programs in breast cancer survivors. Nevertheless, it should be noted that the current study is the first one investigating changes in pressure pain hypersensitivity after the application of water physical therapy in breast cancer survivors.

It has been previously suggested that pain and central sensitization in breast cancer survivors may be related to the presence of active TrPs [17,43]. In the current study, the decrease in neck and shoulder/axillary pain was also accompanied by a reduction in the presence of active TrPs in neck-shoulder muscles in those breast cancer survivors who received the water physical therapy program. In addition, no changes in the presence of active TrPs were found within the control group, supporting that active TrPs is a stable phenomenon in breast cancer survivors if not appropriately treated, as previously suggested [17,23,43]. It should be noted that in the current study, the decrease in the presence of active TrPs was not related to changes in pressure pain sensitivity, which may be related to the hypothesis that active muscle TrPs can be more involved in the genesis of pain rather than in changes in sensory process in breast cancer survivors.

Finally, we should recognize the potential strengths and limitation of the current randomized, controlled clinical trial. Strengths of the current trial include a structured water physical therapy program supervised by skilled physical therapist, objective outcomes, intention-to-treat analyses, and group therapy; however, we should recognize its limitations. The first limitation is that the entire sample was recruited from one oncology center perhaps limiting the extrapolation of the results. The second weakness of this study was that the control group was allowed to freely practice physical activity. The possible bias associated with this was controlled as our control group did not show significant increases in physical activity during the study as identified by the Minnesota Leisure Time Physical Activity Questionnaire [35,36]. Additionally, we did not control factors such as time spent with a therapist and patient expectations for improvement in the control condition. A third possible weakness is that we only assessed short-term effects of water exercise program. Future studies should investigate long-term effect of physical therapy programs in

sensory disturbances and pain observed in breast cancer survivors.

Conclusions

An 8-week water physical therapy program using low-intensity exercise and stretching exercises was effective for improving neck and shoulder/axillary pain and reducing the presence of TrPs in breast cancer survivors as compared with usual care. No significant changes in widespread pressure pain hyperalgesia were found. Our results support that physical therapy interventions may be clinically useful for avoiding persistent pain and sensory disturbances in breast cancer survivors Futures studies are needed to determine the long-term effects of physical therapy in sensory disturbances in patients with breast cancer.

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