

ORIGINAL RESEARCH

Short-term upper limb function following breast cancer surgery in women who underwent early rehabilitation: a pilot study

Funcionalidad a corto plazo de la extremidad superior en pacientes operadas por cáncer de mama que recibieron rehabilitación temprana: un estudio piloto

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Abstract

Introduction: The initial treatment for breast cancer is usually surgery, followed by chemotherapy and/or radiotherapy. Impaired upper limb function on the same side as the operated breast is a common complication.

Objective: To evaluate short-term upper limb function following early rehabilitation in women who underwent surgery to treat breast cancer.

Materials and methods: Observational, longitudinal, prospective pilot study of a cohort including 25 women ≥ 18 years who underwent surgery for breast cancer and began a personalized early rehabilitation plan for the affected limb at a secondary care center in Bogotá (Colombia) between July 2022 and December 2023. Upper limb function (measured using the QuickDASH questionnaire) and shoulder mobility (ranges of motion for flexion, extension, rotation, and abduction measured using a goniometer) were assessed at three time points: i) 1 week before surgery, ii) 2–3 weeks after surgery, and iii) 2–3 months after surgery. A repeated measures ANOVA with a post-hoc analysis using Student's t-test for paired samples was used to evaluate differences at the 3 time points.

Results: The mean age of the patients was 49.5 years (± 12.3) and the most common type of cancer was ductal carcinoma (80%; $n=20$). Early rehabilitation led to short-term improvement of the shoulder ranges of motion in abduction (second moment: 131.6° vs. third moment: 143°) and flexion (142.8° vs. 160.2°), although it was significant only in the latter ($p=0.007$). A clinical improvement in function was also observed between the second and third moment, but it was not significant (QuickDASH score: 21.7 ± 12.9 vs. 20.6 ± 20.8 ; $p=0.819$).

Conclusion: The early implementation of a personalized rehabilitation plan in women who underwent breast cancer surgery resulted in short-term clinical improvement in function of the affected limb and shoulder mobility in flexion and abduction, although the improvement was significant only for flexion.

Resumen

Introducción. El tratamiento inicial del cáncer de mama suele ser quirúrgico, seguido de quimioterapia y/o radioterapia. La afectación de la funcionalidad de la extremidad superior ipsilateral a la mama intervenida es una complicación frecuente.

Objetivo. Evaluar la funcionalidad de la extremidad superior a corto plazo tras rehabilitación temprana en pacientes sometidas a cirugía para tratar el cáncer de mama.

Materiales y métodos. Estudio piloto observacional, longitudinal y prospectivo de una cohorte que incluyó 25 mujeres ≥ 18 años que fueron sometidas a cirugía para tratar el cáncer de mama y en las que se inició un plan personalizado de rehabilitación temprana de la extremidad afectada en una institución de segundo nivel de atención de Bogotá (Colombia) entre julio de 2022 y diciembre de 2023. La funcionalidad de la extremidad superior afectada (medida con el cuestionario QuickDASH) y la movilidad del hombro (rangos de movimientos de flexión, extensión, rotación y abducción medidos con un goniómetro) se evaluaron en tres momentos: i) 1 semana antes de la cirugía, ii) 2a-3a semanas posoperatorias y iii) 2do-3er mes posoperatorio. Se utilizó un ANOVA de medidas repetidas con un análisis post-hoc mediante la prueba t de Student para muestras pareadas para evaluar diferencias en los 3 momentos.

Resultados. La edad promedio de las pacientes fue 49.5 años (± 12.3) y el tipo de cáncer más común fue el carcinoma ductal (80%; $n=20$). La rehabilitación temprana resultó en la mejora a corto plazo de los arcos de movilidad del hombro en abducción (segundo momento: 131.6° vs. tercer momento: 143°) y flexión (142.8° vs. 160.2°), aunque solo fue significativa en esta última ($p=0.007$). También se observó una mejora clínica, aunque no significativa, en la funcionalidad entre el segundo y el tercer momento (puntuaje QuickDASH: 21.7 ± 12.9 vs. 20.6 ± 20.8 ; $p=0.819$).

Conclusión. La implementación temprana de un plan de rehabilitación personalizado en mujeres sometidas a cirugía para tratar el cáncer de mama resultó en una mejora clínica en el corto plazo de la funcionalidad de la extremidad afectada y de la movilidad del hombro en términos de flexión y abducción, aunque la mejora solo fue significativa para la flexión.

Introduction

According to data from the Global Cancer Observatory (GCO), breast cancer was the most frequently diagnosed cancer in women in 2022 (2 296 840 new cases), as well as the leading cause of death from cancer in women worldwide (666 103 deaths).¹ This type of cancer is a major health issue, as, according to a systematic analysis by the Global Burden of Disease Study 2019, breast cancer was also the leading cause of disability-adjusted life years (DALYs), deaths, and years of life lost (YLL) related to cancer in women worldwide in 2019. Most of the global burden of this type of cancer occurred in women, with 20.3 million of total breast cancer-related DALYs in 2019 occurring in females, of which 93.3% came from YLL and 6.7% from years lived with disability (YLD).²

In the United States, according to the National Cancer Institute, the average YLL due to breast cancer for all races and both sexes was 16.8 years in 2022,³ and as per Song *et al.*,⁴ this type of cancer accounted for 4 280 128 potential years of life lost (PYLL) in 2017, with an average of 14.5 PYLL per death. In Colombia, this disease is the fourth most deadly type of cancer, with a mortality rate of 8.4%.⁵

The development of new early diagnosis strategies and treatments to fight this disease has led to increased survival rates among these patients, yet many of them suffer physical and psychological issues related to treatment.⁶ These strategies include surgery, chemotherapy, and radiation therapy, among others,⁷ which have an impact on patients' quality of life and functionality, as they can directly affect their ability to perform daily activities and their independence.^{8,9} For example, these patients may experience limited shoulder mobility, lymphedema, and numbness of the upper limb after undergoing surgical treatment, as well as depression and other mood disorders associated with the loss of a breast, a distorted body image, fear of recurrence or death,^{10,11} and changes in their relationship with their partner or family.¹⁰

Similarly, it has been reported that surgery and radiotherapy can affect the upper body in this population. According to the systematic review conducted by Lee *et al.*,¹² these patients may experience complications in the upper limb ipsilateral to the operated breast following surgery and radiotherapy, including lymphedema (0-34%), shoulder/arm pain (9-68%), restricted shoulder range of motion (1-67%), and loss of strength (9-28%).

Prehabilitation aims to improve patients' physical and emotional health before undergoing surgery or therapy. In cancer patients, significant benefits have been demonstrated, such as improving the ability to start the next cancer therapy on schedule, increased adherence rates for subsequent therapies, and better survival rates.¹³ In turn, early rehabilitation interventions implemented after surgery, such as physical exercise, lymphedema treatment, and psychosocial support, have been proven to promote functional recovery, reduce pain, and improve quality of life in breast cancer patients.¹⁴

While the evidence shows that early rehabilitation has a positive impact on cancer patient care, it remains a challenge in Colombia. According to Moreno-Capacho,¹⁵ in 2024 there were only 10 centers officially authorized to provide comprehensive health care to cancer patients in the country, including cancer rehabilitation services. However, there is insufficient information to determine whether these centers have the infrastructure, technology, and human resources required to meet the needs of this population.¹⁵

Considering the foregoing, the objective of this study was to evaluate short-term upper limb function following early rehabilitation in women who underwent surgery to treat breast cancer.

Materials and methods

Study design

Observational, longitudinal, prospective, cohort pilot study.

Sample

Consecutive sampling was used to enroll women aged ≥ 18 years who underwent surgery to treat breast cancer and began early rehabilitation of the affected upper limb at a secondary care health care center in Bogotá, Colombia, between July 2022 and December 2023. Patients with conditions that cause central sensitization, such as fibromyalgia and complex regional pain syndrome (CRPS), neurological sequelae of a central nervous system disease, rotator cuff syndrome, chronic pain in the upper limbs that is difficult to treat, deep vein thrombosis of the upper limbs, and upper limb dysfunction due to other causes, were not considered. It should be noted that patients diagnosed with fibromyalgia or CRPS are not considered eligible because these conditions are characterized by alterations in pain perception and generalized or disproportionate motor dysfunction,¹⁶⁻¹⁸ which could affect their response to physical rehabilitation and the assessment of specific upper limb functionality.

Importantly, the oncology support unit where the early rehabilitation program is carried out has a multidisciplinary team led by a physiatrist specializing in oncology rehabilitation, and breast cancer is the most common diagnosis among patients referred to this program.

Procedures and variables

Information on the following variables was obtained for all patients: age, marital status, educational attainment (secondary school, undergraduate or technical degree, post-graduate degree), occupation (housewife, employee, retired), body mass index (BMI), histological type of breast cancer, cancer stage, type of pain in the affected limb after surgery (somatic or neuropathic), non-surgical treatment of breast cancer (radiotherapy, chemotherapy), type of surgical management, side of the affected upper limb (i.e., affected breast), level of pain in the affected upper limb after surgery (assessed using the verbal numerical scale - VNS), occurrence of lymphedema (until the end of follow-up), duration of follow-up (in days), and number of physical therapy and occupational therapy sessions. Mobility of the affected shoulder (degrees of flexion, extension, internal rotation, external rotation, and abduction) was also assessed using a goniometer,¹⁹ while upper limb function was evaluated using the QuickDASH questionnaire.

QuickDASH is a self-report questionnaire consisting of 11 items that assess subjective physical function and symptom severity related to musculoskeletal disorders in the upper limbs. It is a shortened version of the 30-item DASH questionnaire. These questions are scored using a 5-point Likert scale as follows: for questions 1 through 6, the scale ranges from 1 “no difficulty” to 5 “unable to do”; for the next 2 questions, the scale goes from 1 “not at all” to 5 “very much”; and for the last 3 questions, the scale ranges from 1 “none” to 5 “extreme”. The total score on the QuickDASH questionnaire is a number between 0 and 100, with 100 indicating the most severe disability. To obtain the score, the values of the responses to each item are added, the total is then divided by the number of completed items,

1 is subtracted from the result, and then the final result is multiplied by 25. It is worth noting that the QUICKDASH score cannot be calculated if 2 or more items are not answered.²⁰

This study used the version of the QuickDASH questionnaire validated in the Colombian population with hand and shoulder disorders by García-González *et al.*²¹ (Table 1), who reported high internal consistency (Cronbach's alpha of 0.9197) and adequate test-retest reliability (Lin's coefficient of agreement of 0.8). In addition, the original version of this instrument was validated for assessing upper limb disability in breast cancer survivors by LeBlanc *et al.*,²² who also reported high internal consistency (Cronbach's alpha of 0.93) and adequate reliability (test-retest of 0.78 over 2 weeks).

Table 1. QuickDASH questionnaire items (Spanish version validated in Colombian population). The original version (English) of the QuickDASH questionnaire is available at https://dash.iwh.on.ca/sites/dash/files/downloads/quickdash_questionnaire_2010.pdf.

Por favor califique su habilidad para realizar las siguientes actividades durante la última semana, marcando con un círculo el número sobre cada línea						
		Ninguna dificultad	Dificultad leve	Dificultad moderada	Dificultad severa	Incapaz
1	Abrir un frasco nuevo o apretado	1	2	3	4	5
2	Realizar oficios caseros pesados (como lavar pisos o paredes)	1	2	3	4	5
3	Cargar una bolsa o un maletín	1	2	3	4	5
4	Lavar la espalda	1	2	3	4	5
5	Cortar comida con un cuchillo	1	2	3	4	5
6	Realizar actividades recreativas que requieren esfuerzo utilizando su brazo, hombro o mano (por ejemplo: jugar tenis, bolos, tejo, etc.)	1	2	3	4	5
		Ninguna	Leve	Moderada	Bastante	Extrema
7	¿Qué tanta dificultad ha tenido en la última semana para participar en actividades sociales normales con su familia, amigos o vecinos por el problema en su brazo, hombro o mano?	1	2	3	4	5
		Nada	Levemente	Moderadamente	Bastante	Extremadamente
8	¿Durante la última semana se vio limitado en sus actividades diarias como resultado del problema en su brazo, hombro o mano?	1	2	3	4	5
Por favor califique la severidad de los siguientes síntomas durante la última semana (marque con un círculo una respuesta en cada renglón)						
		Nada	Leve	Moderada	Bastante	Extremada
9	Dolor de brazo, hombro o mano	1	2	3	4	5
10	Hormigueo o sensación de agujas en su brazo, hombro o mano	1	2	3	4	5
		Ninguna dificultad	Dificultad leve	Dificultad moderada	Dificultad severa	La dificultad no me deja dormir
11	¿Qué tanta dificultad tuvo en la última semana para dormir por su dolor en su brazo, hombro o mano?	1	2	3	4	5

Source: Spanish version of the QuickDASH questionnaire translated and validated by García-González *et al.*²¹

Before describing how and when data were collected, we must note that following a breast cancer diagnosis at the institution where this study was conducted, the treating physician refers patients to the oncology support program before initiating cancer-specific treatment. This program includes an assessment by a specialist in oncological rehabilitation to assess

the patient's baseline function and design a personalized rehabilitation plan. Accordingly, during the initial consultation for the program, a questionnaire is administered to obtain information on the sociodemographic and clinical variables considered. Likewise, information on clinical variables is confirmed and completed based on what is reported in the patients' medical records.

The mobility and function of the affected upper limb were measured at three points in time: i) initial consultation one week before surgery (baseline assessment), ii) between two and three weeks after surgery (postoperative assessment), and iii) two to three months after surgery (final assessment). Measurements of the range of motion in the shoulder were taken by a physiatrist specializing in oncology rehabilitation, who is also part of the research team.

Early rehabilitation

As mentioned in the previous subsection, at the institution where the research was conducted, patients with a confirmed diagnosis of breast cancer are referred to the oncology support program to be evaluated by a physiatrist specializing in oncology rehabilitation. The physiatrist designs a personalized rehabilitation plan for the upper limb ipsilateral to the breast undergoing surgery, which begins before surgical oncology treatment.

Although the early rehabilitation plan is personalized and developed based on an assessment of the patient's preoperative function, its general components include patient education, physical therapy, and occupational therapy. Concerning patient education, topics such as wound care, drain management, infection prevention, postoperative ergonomics, promoting mobility of the affected shoulder, and adjustments to daily routines to conserve energy are addressed. These educational activities are conducted by nurses, physical therapists, and occupational therapists in a personalized session prior to the patient's surgery.

Postoperative physical therapy and occupational therapy interventions are tailored to each individual. Physical therapy includes interventions ranging from joint mobility to muscle strengthening, as well as exercises to improve respiratory mechanics. In addition, after ruling out or treating lymph node involvement, myolymphokinetic exercises are taught to prevent lymphedema. Occupational therapy includes interventions such as sensory re-education, safe mobility, post-operative ergonomics, adjustment of daily routines, use of breast prostheses, and even the creation of these prostheses by the patients themselves.

Patients referred to the cancer support program are expected to receive at least one physical therapy session and two occupational therapy sessions (each session lasting approximately 30 minutes) during follow-up.

Statistical analysis

Data are described using measures of central tendency and dispersion (means and standard deviations [SD], or medians and interquartile ranges [IQR]) for quantitative variables, as well as absolute and relative frequencies for qualitative variables. Data distribution was assessed using the Shapiro-Wilk test. A repeated measures ANOVA was used to evaluate changes in the function of the upper limb ipsilateral to the operated breast and in shoulder mobility (flexion, extension, internal rotation, external rotation, abduction) at the three assessment times, followed by a post-hoc analysis with Student's t-test for paired samples. A statistical significance level of $p < 0.05$ was considered.

Ethical considerations

The study was approved by the Research Ethics Committee of the Fundación Universitaria Sanitas through resolution CEIFUS 2134-22 dated August 3, 2022. It complied with the ethical principles for biomedical research involving human subjects established in the Declaration of Helsinki²³ and the scientific, technical, and administrative standards for health research set forth in Resolution 8430 of the Colombian Ministry of Health,²⁴ which classifies the study as a minimal-risk research.

Results

This study included 25 women who underwent surgery to treat breast cancer and began early rehabilitation of the affected upper limb between July 2022 and December 2023. Their mean age and BMI were 49.5 years (± 12.3) and 24.3 kg/m² (± 4.0), respectively. Regarding sociodemographic characteristics, 96% (n=24) had completed higher education, 68% (n=17) were employed, and 44% (n=11) were married (Table 2).

The following clinical characteristics were found: the most common histological type of breast cancer was ductal carcinoma (80%; n=20); the most frequent cancer stages were 0 (40%; n=10) and IIA (28%; n=7); the right side was the most commonly affected (84%; n=21); and the most frequent surgical management was quadrantectomy plus sentinel lymph node resection (32.0%; n=8). In addition, 16% (n=4) of the patients underwent radiotherapy and 24% (n=6) underwent chemotherapy (Table 2).

Meanwhile, 40% (n=10) of patients reported neuropathic or somatic pain (20% each; n=5). Moreover, the medians for postoperative pain intensity (VNS), number of physical therapy sessions, number of occupational therapy sessions, and duration of follow-up were 0 (IQR: 1), 3 sessions (IQR: 6), 4 sessions (IQR: 4), and 71 days (IQR: 118), respectively (Table 2). At the end of the follow-up period, only one patient (4%) had developed lymphedema.

Table 2. Sociodemographic and clinical characteristics of the participants (n=25).

Variable		n (%)
Age		
Mean (SD)		49.5 (12.3)
Educational attainment	Secondary school	1 (4.0)
	Undergraduate or technical degree	15 (60.0)
	Postgraduate degree	9 (36.0)
Occupation	Housewife	7 (28.0)
	Employee	17 (68.0)
	Retired	1 (4.0)
Marital status	Single	6 (24.0)
	Married	11 (44.0)
	Domestic partnership	5 (20.0)
	Separated/divorced	3 (12.0)
Body mass index kg/m²		
Mean (SD)		24.3 (4.0)
Histological type of breast cancer	Ductal carcinoma	20 (80.0)
	Lobular carcinoma	5 (20.0)

Table 2. Sociodemographic and clinical characteristics of the participants (n=25). Continued

Variable		n (%)
Cancer stage	0 (in situ)	10 (40.0)
	IA	4 (16.0)
	IB	2 (8.0)
	IIA	7 (28.0)
	IIIA	2 (8.0)
Side of the affected upper limb	Right	21 (84.0)
	Left	4 (16.0)
Type of surgical management	Quadrantectomy	5 (20.0)
	Quadrantectomy + sentinel lymph node biopsy	8 (32.0)
	Modified radical mastectomy + sentinel lymph node biopsy	2 (8.0)
	Modified radical mastectomy + axillary lymph node dissection	4 (16.0)
	Bilateral mastectomy	2 (8.0)
	Axillary lymph node dissection	1 (4.0)
	Skin-sparing mastectomy and flap	3 (12.0)
Radiotherapy		4 (16.0)
Chemotherapy		6 (24)
Pain in the affected limb	Yes	10 (40.0)
	No	15 (60.0)
Type of pain in the affected limb	Somatic	5 (20.0)
	Neuropathic	5 (20.0)
Postoperative pain intensity (VNS) Median (IQR)		0 (0-1)
Physical therapy sessions Median (IQR)		3 (0-6)
Occupational therapy sessions Median (IQR)		4 (2-6)
Duration of follow-up (days) Median (IQR)		71 (53.5-171.5)

VNS: verbal numerical scale; SD: standard deviation; IQR: interquartile range.

Regarding shoulder mobility during follow-up, the results of the repeated measures ANOVA showed statistically significant differences in the means for flexion ($F=10.18$, $df=2$; $p=0.001$), external rotation ($F=3.51$, $df=2$; $p=0.042$), and abduction ($F=5.66$, $df=2$; $p=0.007$) across the 3 measurements. Moreover, an increase in the QuickDASH score was observed between the first assessment (12.9 ± 15.7) and the second assessment (21.7 ± 12.9), which was statistically significant ($p=0.018$), indicating an increase in the perception of upper limb dysfunction, and a decrease between the second and third assessments (20.6 ± 20.8), although it was not statistically significant ($p=0.819$). As for shoulder mobility, it was observed that, with the exception of extension, ranges of motion decreased after surgery, with statistically significant decreases in flexion ($p=0.001$), external rotation ($p=0.014$), and abduction ($p=0.005$) (Table 3).

Furthermore, when comparing measurements between the second and third moments (i.e., following early rehabilitation interventions), increases were observed only in abduction (131.6° vs. 143°) and flexion (142.8° vs. 160.2°) movements, being statistically significant only in the case of flexion ($p=0.007$) (Table 3).

Table 3. Upper limb function at the three assessment points.

Variable	Assessment	Mean	SD	95%CI	Comparison	Difference in means	p-value
QuickDASH score (%)	Baseline	12.9	15.7	6.4-19.4	Postoperative vs. Baseline	8.78	0.018
	Postoperative	21.7	12.9	16.4-27.0	Final vs. Postoperative	-1.12	0.819
	Final	20.6	20.8	12.0-29.2	Final vs. Baseline	7.66	0.086
Degrees of flexion	Baseline	170.8	17.1	163.7-177.8	Postoperative vs. Baseline	-28.00	0.001
	Postoperative	142.8	27.5	131.5-154.1	Final vs. Postoperative	17.40	0.007
	Final	160.2	22.9	150.7-169.7	Final vs. Baseline	-10.60	0.066
Degrees of extension	Baseline	62.8	15.1	56.5-69.1	Postoperative vs. Baseline	2.80	0.347
	Postoperative	65.6	11.5	60.9-70.3	Final vs. Postoperative	-2.60	0.405
	Final	63.0	15.3	56.7-69.3	Final vs. Baseline	0.20	0.949
Degrees of internal rotation	Baseline	76.0	21.4	67.2-84.8	Postoperative vs. Baseline	-3.60	0.396
	Postoperative	72.4	12.8	67.1-77.7	Final vs. Postoperative	-3.20	0.273
	Final	69.2	15.5	62.8-75.6	Final vs. Baseline	-6.80	0.147
Degrees of external rotation	Baseline	84.8	11.5	80.1-89.5	Postoperative vs. Baseline	-8.20	0.014
	Postoperative	76.6	12.3	71.5-81.7	Final vs. Postoperative	-0.28	0.939
	Final	76.3	17.8	68.9-83.7	Final vs. Baseline	-8.48	0.049
Degrees of abduction	Baseline	164.0	30.5	151.4-176.7	Postoperative vs. Baseline	-32.40	0.005
	Postoperative	131.6	34.9	117.2-146.0	Final vs. Postoperative	11.40	0.235
	Final	143	40.9	126.1-159.9	Final vs. Baseline	-21.00	0.034

SD: standard deviation; 95%CI: 95% confidence interval.

Note: The baseline assessment was performed at time point 1, one week before surgery; the postoperative assessment was performed at time point 2, two to three weeks after surgery; and the final assessment was performed at time point 3, two to three months after surgery.

Discussion

The shoulder joint is key to upper limb function and to performing activities of basic self-care, work, instrumental activities, and activities of daily living. This study evaluated short-term upper limb function following early rehabilitation in a small sample ($n=25$) of women who underwent surgery to treat breast cancer at a health care center in Bogotá, showing an improvement in shoulder mobility between the second and third measurements (i.e., after early rehabilitation interventions) in terms of flexion (mean difference [MD]: 17.4; $p=0.007$) and abduction (MD: 11.4; $p=0.235$), with only flexion being statistically significant. In fact, in the case of flexion, this increase is greater than the intraobserver minimum clinically important difference (MCID) (11° - 16°) and is within the range of the interobserver MCID (14° - 24°) described by Muir *et al.*²⁵

The changes observed in the ranges of motion for flexion and abduction are consistent with what has been reported in the literature. For example, in a systematic review (24 studies; 2 132 individuals) evaluating the efficacy of exercise-based interventions for treating upper limb dysfunction due to breast cancer treatment, McNeely *et al.*,²⁶ based on the meta-analysis results, suggest doing exercises in the first weeks after surgery to restore the ranges of motion for flexion and abduction in this population. They note that, compared to usual care, more structured postoperative exercise programs improve flexion in the short term (4-6 weeks after surgery) and the long term (6 months), while the benefit in abduction is observed only the long term.²⁶ This highlights the need for long-term follow-up to assess complete functional recovery, especially considering that studies such as the one conducted by Min *et al.*²⁷ in Seoul on 70 breast cancer patients scheduled for surgery have reported that, compared to extension, the ranges of motion of

flexion and abduction of the shoulder ipsilateral to the operated breast are more affected and their recovery is slower in the short term (recovery of shoulder strength for these movements to 60% and 55% of preoperative levels at 6 months).

Furthermore, our findings are consistent with those of other studies that have compared the effect of various interventions on shoulder range of motion in patients undergoing surgery for breast cancer treatment. For example, Shen *et al.*,²⁸ in a clinical trial evaluating an optimized functional exercise model in a rehabilitation workshop versus home exercises in 52 breast cancer patients who had undergone surgery (experimental group: 26, control group: 26), reported statistically significant differences in shoulder flexion and abduction angles between the two groups at 1, 2, and 3 months, with better outcomes in the intervention group ($p < 0.05$), although the difference gradually decreased over time. Similarly, in a systematic review (20 randomized clinical trials with a total of 2 442 participants) comparing the effect of early implementation of rehabilitation exercises on upper limb function, Redemski *et al.*²⁹ reported that, compared with usual care, the use of early exercise programs resulted in a significant improvement in flexion and abduction angles in the short term (MD: 16.1° and 17.6°).

Regarding upper limb function, the present study showed a statistically significant difference between baseline and postoperative QuickDASH scores ($p = 0.08$). Moreover, the DM (8.78) is lower than the MCID reported for this instrument (12.85),³⁰ and the score remained stable during the rest of the follow-up (21.7 vs. 20.6). These findings are partially consistent with those of Chan *et al.*,³¹ who evaluated whether major breast surgery causes functional impairment of the upper limb in 41 Asian women with breast cancer, finding that the QuickDASH disability score was significantly worse at the second and sixth postoperative weeks compared to the initial value (baseline: 0, postoperative week 2: 6.82, postoperative week 6: 2.5). They are also consistent with the results of Min *et al.*,²⁷ who reported significant changes in the Quick-DASH score from the preoperative period to 6 months after surgery (baseline: 8.5, week 1: 36.6, week 2: 40.9, week 4: 32.8, month 3: 17.9, month 6: 13.5), suggesting that extended follow-up is necessary to assess functional recovery of the affected upper limb.

In our study, 40% of participants reported neuropathic or somatic pain (20% each; $n = 5$), which is within the range reported in the literature, where post-mastectomy pain syndrome, defined as chronic pain (lasting >3 months) in the anterior thorax, axilla, or upper arm that may be related to peripheral nerve damage during surgery, has been described in 25% to 60% of cases.³² However, our findings differ from those reported in a systematic review on the presence of neuropathic pain after breast-conserving surgery, which included 8 studies (1 469 patients in total) where the prevalence of this type of pain was higher (31%).³³ Aside from the difference in sample sizes, this difference may be explained by the fact that our patients received early rehabilitation and, as demonstrated by Bauman *et al.*³⁴ in a literature review, exercise therapy reduces pain intensity in women with post-mastectomy pain syndrome.

With respect to the development of lymphedema, in our study only 1 patient (4%) presented this complication in the short-term follow-up, which is lower than the figure reported by Ribeiro-Pereira *et al.*,³⁵ who, in a study of 964 women who underwent axillary lymph node resection as surgical treatment for breast cancer from August 2001 to November 2002 at an institution in Brazil, reported a cumulative incidence of lymphedema of 13.5% at 2 years, 20.2% at 5 years, and 41.1% at 10 years. It is worth noting that, according to Ribeiro-Pereira *et al.*,³⁵ the development of lymphedema associated with cancer treatment is progressive and slow-growing, with clinical manifestations that may take months or even years to identify. In this context, given the short follow-up period,

the frequency of this complication reported in our study is not reliable, and this finding should be confirmed in studies with longer follow-up periods.

The strengths of this pilot study include the objective assessment of the function of the upper limb ipsilateral to the operated breast and shoulder mobility using a validated instrument (QuickDASH) and a goniometer, respectively, obtaining reliable data on the functional evolution of patients in a real clinical setting. Moreover, the early rehabilitation approach, starting in the preoperative stage, is a strategy that has a positive impact on short-term functional recovery.

However, the study had several limitations, such as a small sample size, lack of a control group, and non-probability sampling, which constrains the generalizability of the results, the determination of the impact of early rehabilitation, and the performance of statistical analyses with sufficient statistical power and adjusted for confounding factors. It is important to bear in mind that the small sample size could be attributed to the low rate of timely referral of these patients to cancer support programs before starting cancer-specific treatment, as well as to barriers to accessing health services in the country. Another aspect to consider is the follow-up period (second and third postoperative months), which narrows the study's scope and results.

In view of the foregoing, it is recommended that future studies have larger sample sizes, include comparison groups, undertake longer follow-ups, and include measurements of quality of life, pain control, and perception of disability in order to evaluate the long-term benefits of early rehabilitation on outcomes other than function.

Conclusions

In the present study, early implementation of a personalized rehabilitation plan in women who had undergone surgery to treat breast cancer resulted in the maintenance of upper limb function and short-term improvement in shoulder mobility in terms of flexion and abduction, although that improvement was only statistically significant for flexion. Moreover, the intervention led to the maintenance of other ranges of motion, such as extension and rotation. These results stress the importance of adopting a multi-disciplinary approach to treating these patients, combining cancer-specific treatments such as surgery with the early implementation of rehabilitation programs, to improve and/or maintain physical function.

Conflicts of interest

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