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Original Article

Application analysis of an internet platform tracking management mode combined with progressive resistance training in the rehabilitation of patients with breast cancer-related lymphedema

Xiaofei Wu[1*], Dongyang Zeng[2*], Chuangyang Lin[3], Xiangwen Wang[4], Hongmei Xin[3]

[1]Department of Nursing, Hainan Health Vocational College, Haikou 570311, Hainan, China; [2]International Nursing School, Hainan Medical University, Haikou 571199, Hainan, China; [3]Department of Breast Surgery, Hainan General Hospital, Haikou 570311, Hainan, China; [4]Department of Radiation Oncology, Hainan Cancer Hospital, Haikou 570311, Hainan, China. [*]Equal contributors and co-first authors.

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Abstract: Objective: To observe the influence of internet platform tracking management mode combined with progressive resistance training (PRT) on the rehabilitation of patients with breast cancer-related lymphedema (BCRL). Methods: A total of 100 patients with BCRL admitted to Hainan general hospital from January 2023 to March 2024 were selected. After the shedding cases were excluded, they were divided into group A (n=47) where PRT + out-of-hospital follow-up were given, and group B (n=48) where PRT + Internet platform tracking management mode was given. The two groups were compared in peripheral diameter difference, volume difference, lymphatic flow, edema degree, grip strength, shoulder joint activity of the upper limbs, daily living function and quality of life. Results: The peripheral diameter difference, volume difference, proportion of severe edema and Disabilities of the Arm, Shoulder and Hand (DASH) scores of upper limbs in the two groups were decreased after 4 weeks and 12 weeks of intervention, while those in the group B were even lower (P<0.05). The lymphatic flow, grip strength, abduction, rear extension level and proportion of mild edema in the upper limbs were increased after 4 weeks and 12 weeks of intervention, while those in the group B were even greater (P<0.05). There was no statistically significant difference in anterior flexion level and quality of life score between the two groups before intervention, 4 and 12 weeks after intervention (P>0.05). Conclusion: The application of the internet platform tracking management mode combined with PRT in patients with BCRL can reduce the degree of edema, improve the grip strength, enhance the shoulder joint activity, and improve the function of daily living.

Keywords: Internet platform tracking management mode, progressive resistance training, breast cancer-related lymphedema, activity

Introduction

Breast cancer is a solid tumor caused by factors such as estrogen replacement therapy, short lactation time, and late menopause age [1]. Surgery is the main treatment method, and axillary lymph node dissection and sentinel lymph node biopsy are often performed during the surgery to prevent cancer cell metastasis [2, 3]. However, the above operations may cause different degrees of damage to the lymphatic system, resulting in hindered lymphatic return and increased risk of postoperative lymphedema [4]. Patients with lymphedema may present with upper limb dysfunction, pain, fatigue, swelling, which is a progressive and chronic process. Over time, severe edema can be induced, which has adverse effects on the prognosis of patients. In the past, exercise and intervention measures adopted clinically were relatively weak in pertinence, poor in patient compliance, and unsatisfactory in overall effect [5, 6]. Progressive resistance training (PRT) stimulates the muscles through multiple groups of rhythmic weight-bearing and resistance training, in order to improve the metabolic ability of the body, accelerate lymphatic drainage, and finally improve lymphedema [7]. The inter-

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Table 1. Comparison of baseline information

Baseline information		Group A (n=47)	Group B (n=48)	t/x^2	*P*
Age (years)		50.36±6.27	50.40±6.31	0.031	0.975
Site n (%)	Left side	25 (53.19)	26 (54.17)	0.009	0.924
	Right side	22 (46.81)	22 (45.83)		
Clinical staging n (%)	Stage i	18 (38.30)	20 (41.67)	0.112	0.738
	Stage ii	23 (48.94)	18 (37.50)		
	Stage iii	6 (12.77)	10 (20.83)		
Surgical approach n (%)	Radical resection	16 (34.04)	18 (37.50)	0.124	0.725
	Modified radical resection	23 (48.94)	21 (43.75)		
	Breast conservation	8 (17.02)	9 (18.75)		

net platform tracking management mode can break the social, spatial, economic, and time constraints of patients, and is conducive to the development of sports training programs. Therefore, this study observed the rehabilitation effects of BCRL patients after applying the internet platform tracking management model combined with PRT.

Materials and methods

Included subjects

This study was approved by the Ethics Committee of Hainan general hospital. A total of 100 patients with BCRL admitted to Hainan general hospital from January 2023 to March 2024 were selected. Patients were divided into group A (n=50) and group B (n=50). After the shedding cases were excluded, 47 cases were included in the group A and 48 cases were included in the group B. The balance of the two groups in baseline information is ideal (*P*>0.05) (**Table 1**).

Inclusion criteria: All patients met the diagnostic criteria in the references [8]; All cases were unilateral; The difference in circumferential diameter between the affected side and the healthy side was not less than 2 cm.

Exclusion criteria: Patients with bilateral breast cancer; Infected limb; Patients with venous thrombosis; Combined with kidney and heart failure; Patients with tumor metastasis from other organs; Patients with operation history of upper limb; Patients with combined hearing and language dysfunction; Patients with recurrent breast cancer; Preoperative upper limb edema; Patients combined with infectious diseases.

Shedding criteria: Patients lost to follow-up; or Unable to continue resistance movement.

Methods

Group A: PRT + out-of-hospital follow-up: The content of exercise was the same as that in the group B. As for the patients who had no limb pain or extreme fatigue, the out-of-hospital follow-up was conducted once a week in the forms of telephone call and outpatient re-examination.

Patients in group B were given PRT + Internet platform tracking management mode: (1) Protocol formulation: The lymphedema therapist, attending physician, and rehabilitation therapist jointly formulated the exercise protocol, pre-exercise evaluation, and test indicators. (2) Pre-exercise evaluation: ① Cardiopulmonary endurance training was performed from 2 minutes of standing still, and the heart rate and the height reached by one-sided knee ups during stepping were recorded by the manual loop; ② The grip strength of the patient was evaluated using a grip strength meter; ③ The maximum weight overcome by a muscle contraction within a certain range was evaluated; ④ The activities of the patient such as anteflexion, abduction, and rear extension were detected and recorded. (3) PRT: ① The detachable dumbbells were equipped, and the dumbbells were distributed according to the maximum load of the patient's single repetition; ② Training content: First, the marking time, flexion and extension movements of each joint were performed, and the heart rate and 10 min pace were recorded. After that, resistance movements were performed (upper limb weight loss training for dumbbell bending, front horizontal lifting, side horizontal lifting and lifting (without dumbbells), and lower limb weight loss training for dumbbell

bending, front horizontal lifting, side horizontal lifting and lifting). Finally, the marking time in situ, flexion and extension movements of each joint were adjusted to restore the respiration, heart rate and blood pressure to normal levels; ③ Exercise intensity, time and frequency: The intensity of upper limb weight loss and lower limb weight training was determined according to the single repetition maximum load and reserve heart rate method; the heart rate in the inactive and awake state was the quiet heart rate, (207-0.7) × age was the maximum heart rate, (maximum-quiet) heart rate × percent of expected intensity + quiet heart rate = target heart rate. Finally, a sport scheme was established, sports were carried out according to the single repeated maximum load of 40 to 55 percent in the first month aft surgery, where the lifting is increased by 5 to 10 percent every 1 to 2 weeks, the range of the lifting is changed to 55 to 75 percent after one month, the range of the lifting is 75 to 85 percent after three months, the maximum weight is less than 2.5 kg, the initial sport activity time is 2 times/week, 15 to 20 min/times, each action is carried out 8 to 12 times, and is prolonged by 5 minutes every 1 to 2 weeks, and the action is increased 1 to 2 more times. It was finally increased to 20-30 min/time, with 10-15 times for each action, and the rest time was determined according to the individual situation. (4) Internet platform tracking management mode: The WeChat platform is used to establish a file including the patient's communication address, identity information, and affected limb pictures, patient were informed to strictly wear a sports bracelet during each training, staff used the sports bracelet to obtain the patient's training information, with the training data automatically uploaded to the mobile APP, and the data is shared with the lymphedema therapist, attending physician, and rehabilitation therapist. Care staff can browse the training data synchronously through the mobile APP (Zepp Life). Secondly, we monitored the patient's training through WeChat video, twice a week, and uploaded the training data to Baidu netdisk for the reference of a subsequent training plan formulation. The lymphedema therapist, attending physician, and rehabilitation therapist adjust the PRT target exercise frequency, exercise amplitude and exercise intensity in real time according to the training data to ensure the training effect of patients. In addition, patients were invited to join the WeChat group. The main members of the group are patients with the same disease in the same hospital, attending physicians and rehabilitation therapists. The group owners regularly push the relevant popular science knowledge of BCRL and PRT every month, and the content comes from the cutting-edge information of BCRL globally. The cured patients are also invited to share their training experience and experience to enhance their confidence in training.

Outcome indicators

Primary indicators: (1) Upper limb circumference difference, volume difference, and lymphatic flow detection: The peripheral diameter difference, volume difference and lymphatic flow level of upper limbs of patients were statistically recorded. (2) Edema degree [9]: The patients were assessed for edema severity, and they were divided into mild (upper limb circumference difference <3 cm), moderate (upper limb circumference difference 3-5 cm) and severe (upper limb circumference difference >5 cm). (3) Grip strength test: The electric grip strength meter (Suzhou Haobro Medical Device Co., Ltd., model: HB-WLJ-2) was used to test the grip strength levels of patients. Before measurement, the patients were asked to sit with both feet close to the ground, and with the forearm in the neutral position. The count value was pointed outward, and the fingers were aligned with the grooves. Patients concentrated on grip strength and grasped with full force. Two measurements were conducted in total, with an interval of 30 s, and the average value was recorded. (4) Shoulder joint range of motion: A medical protractor (Shanghai Yimu Medical Device Co., Ltd., model: CJ-GN-001) was used to test the level of anteflexion, abduction and rear extension of the patients. The patients had a vertical sitting position, and their upper limbs and shoulders were at the same level. Adduction and rear extension were performed.

Secondary indicators: (1) Daily living function: The Disabilities of the Arm, Shoulder and Hand (DASH) scale [10] was used to assess the daily living function of patients. The scale included 30 items, with the total score = (score/number of items -1) × 25, and the full mark was 0-100. The score was inversely proportional to the daily living function. (2) Quality of life: The upper limb lymphedema quality of life (ULLQoL) scale [11] was used to assess the quality of life of

Table 2. Peripheral diameter difference, volume difference and lymphatic flow of upper limb ($\bar{x}\pm s$)

Group	Circumference difference (cm)			Volume difference (mL)			Lymphoid flow (count/s)		
	Before	4 weeks	12 weeks	Before	4 weeks	12 weeks	Before	4 weeks	12 weeks
Group A (n=47)	7.63±0.72	5.72±0.25	3.42±0.47	493.63±50.27	330.58±35.76	294.42±30.42	6.23±0.61	8.10±0.90	11.34±1.59
Group B (n=48)	7.65±0.76	4.41±0.52	2.73±0.31	491.52±50.38	301.42±28.63	252.60±20.03	6.25±0.61	9.14±1.05	14.88±2.36
t	0.189	7.477	11.385	0.201	4.392	7.930	0.245	5.178	8.556
P	0.852	<0.001	<0.001	0.823	<0.001	<0.001	0.771	<0.001	<0.001

Table 3. Edema degrees n (%)

Group	Mild			Moderate			Severe		
	Before	4 weeks	12 weeks	Before	4 weeks	12 weeks	Before	4 weeks	12 weeks
Group A (n=47)	10 (21.28)	16 (34.04)	20 (42.55)	25 (53.19)	20 (42.55)	11 (23.40)	12 (25.53)	11 (23.40)	6 (12.77)
Group B (n=48)	9 (18.75)	30 (62.50)	42 (87.50)	27 (56.25)	16 (33.33)	6 (12.50)	12 (12.50)	2 (4.17)	0 (0.00)
x^2	0.095	7.700	21.162	0.090	0.858	1.922	0.004	7.441	6.541
P	0.758	0.006	<0.001	0.765	0.354	0.166	0.952	0.006	0.011

Table 4. Grip strength levels ($\bar{x}\pm s$)

Group	Grip strength (kg)		
	Before	4 weeks	12 weeks
Group A (n=47)	20.13±3.01	21.96±2.45	23.52±3.69
Group B (n=48)	20.21±2.99	25.01±3.02	27.77±4.12
t	0.133	5.399	5.293
P	0.893	<0.001	<0.001

patients. The scale included psychological and physical dimensions, and there were 14 items in total, with the item score of 1-5 points, and the score was negatively correlated with quality of life.

Statistical methods

SPSS 19.0 software was selected to process the data. Measurement data were described as ($\bar{x}\pm s$), the sample *t* test was used, with the paired *t*-test being used for the comparison within groups, and the analysis of variance was used for the measurement data at different time points. The count data were expressed as percentages using the χ^2 test, and the test level was α=0.05.

Results

Comparison of upper limb circumference difference, volume difference and lymphatic flow

There was no significant difference between the two groups in upper limb circumference difference (*P*>0.05). The circumference difference and volume difference of upper limbs in the two groups decreased after 4 and 12 weeks of intervention, and they were lower in group B, while the lymphatic flow of upper limb increased after 4 and 12 weeks of intervention, and it was higher in group B (*P*< 0.05) (see in **Table 2**).

Comparison of edema degree

There was no significant difference between the two groups in the degree of edema (*P*> 0.05). The proportion of mild illnesses increased in the two groups after 4 and 12 weeks of intervention, and was higher in group B, while the proportion of severe illnesses decreased after 4 and 12 weeks of intervention, and was lower in group B (*P*<0.05) (see in **Table 3**).

Comparison of grip strength levels

There was no significant difference between the two groups in the grip strength (*P*>0.05). The grip strength of patients in the two groups increased after 4 and 12 weeks of intervention, and the grip strength of patients in group B was higher (*P*<0.05) (see in **Table 4**).

Comparison of shoulder joint mobility

There was no significant difference between the two groups in shoulder joint range of motion (*P*>0.05). The abduction and extension level in the two groups increased after 4 and 12 weeks of intervention, and the level in group B was higher (*P*<0.05), but there was no statistical difference in the levels of anterior flexion between the two groups (*P*>0.05) (see in **Table 5**).

Table 5. Shoulder joint range of motion ($\bar{x}$±s)

Group	Anterior flexion (°)			Abduction (°)			Rear extension (°)		
	Before	4 weeks	12 weeks	Before	4 weeks	12 weeks	Before	4 weeks	12 weeks
Group A (n=47)	102.58±11.88	106.89±12.58	115.72±16.34	90.56±8.23	96.11±9.37	105.86±12.63	30.23±3.91	34.62±4.37	40.88±6.02
Group B (n=48)	103.01±11.76	107.42±12.62	116.69±16.56	91.01±8.23	100.42±12.25	120.42±14.69	30.25±3.88	38.89±5.72	45.66±6.17
t	0.059	0.101	0.233	0.017	1.923	5.175	1.063	4.082	3.821
P	0.951	0.823	0.723	0.983	0.039	<0.001	0.283	<0.001	<0.001

Table 6. Daily living functions ($\bar{x}\pm s$)

Group	DASH (Points)		
	Before	4 weeks	12 weeks
Group A (n=47)	56.89±6.12	50.62±5.23	36.57±4.01
Group B (n=48)	57.04±6.11	42.35±4.53	30.13±3.66
t	0.052	8.244	8.179
P	0.952	<0.001	<0.001

DASH: The Disabilities of the Arm, Shoulder and Hand scale.

Table 7. Quality of life ($\bar{x}\pm s$)

Group	Psychological (Points)			Physical (Points)		
	Before	4 weeks	12 weeks	Before	4 weeks	12 weeks
Group A (n=47)	23.57±2.54	17.09±1.21	13.81±0.92	30.68±4.61	20.40±2.60	17.02±1.24
Group B (n=48)	23.60±2.53	16.81±1.23	13.44±0.94	30.71±4.58	20.50±2.52	16.96±1.22
t	0.058	1.118	1.938	0.032	0.190	0.238
P	0.954	0.266	0.056	0.975	0.849	0.813

Comparison of daily living functions

There was no significant difference between the two groups in daily living function scores ($P>0.05$). The DASH score of patients in the two groups decreased after 4 and 12 weeks of intervention, and the score in group B was lower ($P<0.05$) (see in **Table 6**).

Comparison of quality of life

There was no significant difference between the two groups in quality of life scores before intervention, after 4 and 12 weeks of intervention ($P>0.05$) (see in **Table 7**).

Discussion

The incidence of breast cancer increases annually, with the change of lifestyle, accounting for about 10% of all malignant tumors; this not only causes economic and physical and mental loss in patients, but also increases the family and socio-economic burden [12-14]. Surgery is a common treatment for breast cancer, but most patients require axillary lymph node dissection after surgery, so the risk of lymphedema high. Relevant studies have shown that the causes of lymphedema include the following: (1) Surgical operation of breast cancer may cause damage to axillary and thoracic lymph nodes and pipelines, leading to the retention of lymph fluid after poor reflux, eventually forming edema; (2) Postoperative radiotherapy may cause hyperplasia and fibrosis of connective tissues and hinder lymph backflow; (3) Postoperative wound infection and flap necrosis can prolong the time of negative pressure drainage, thus destroying the lymphatic drainage pathway, causing edema; (4) The incidence of malnutrition and infection increases with age, and the risk of lymphedema increases with the decrease of compensatory ability of lymphatic return; (5) Without effective intervention, standardized training, overwork or premature weight bearing after operation [15-17].

Related studies [18-20] have shown that the incidence of function of daily living and quality of life of patients after surgery [21, 22]. At present, there is no effective and scientific method to restore the shoulder joint range of motion, so finding a solution that can effectively improve the lymphedema degree, enhance the grip strength level, and improve the function of daily living and quality of life has become the focus of clinical research at this stage [23].

Most patients with BCRL have different degrees of obstruction of lymph and tissue fluid reflux. In addition, the healing of the surgical incision can cause tissue spasms and compression on the local venous system, which further aggravates the reflux obstruction. Therefore, the peripheral diameter difference and volume difference of the upper limbs of patients are large, the proportion of severe edema is high, and the lymphatic flow is low. In this study, group B's

pre-exercise assessment, PRT, and internet platform tracking management were implemented. After the intervention, the peripheral diameter difference and volume difference of upper limbs were reduced, and the lymphatic flow was improved. The improvement of edema degree was superior to that of group A, indicating that the application effect of internet platform tracking management mode combined with PRT was better. PRT belongs to anaerobic exercise, and can continuously stimulate the formation of Annexin Kinase, thereby accelerating the production of muscle protein of the body and inhibiting muscle atrophy. At the same time, it can increase the lymphatic flow rate and improve edema, which has achieved good results in the treatment of limb edema in recent years [24-26]. In addition, PRT can stimulate skeletal muscle contraction, thereby stimulating lymphatic vessel contraction and increasing venous and lymphatic reflux. At the same time, the flexion and extension movement of the joint can also stimulate the lymph nodes, enhance the function of lymph nodes, and promote the operation of lymphatic vessels. Both of the above can promote lymphatic transport, reduce the accumulation of protein fluid in the tissue, thus reducing the load of lymphatic vessels, reducing the secondary injury of veins and lymphatic obstruction, thus reducing the severity of edema. The internet platform tracking management mode can remotely guide patients to conduct rehabilitation training, which is conducive to the long-term adherence of patients and ultimately improves the treatment effect [27].

In patients with lymphedema, the increase of interstitial pressure leads to the larger circumferential diameter difference of the upper limb, although having no impact on the life safety of the patients, can cause swelling and pain of the affected limb, reduction of shoulder joint range of motion and other signs [28]. Grip strength refers to the force generated by the hand muscles when grasping objects, which can reflect the upper limb function of patients, while the grip strength of patients with lymphedema is small due to the related symptoms of upper limb weakness and numbness [29]. In addition, limb discomfort and treatment uncertainty in patients with BCRL, as well as the side effects of postoperative chemotherapy, have resulted in the reduction of daily living function and quality of life [30]. In this study, the grip strength, abduction and extension levels of group B were higher after the intervention, and the DASH score was lower, indicating that the internet platform tracking management mode combined with PRT can improve the grip strength level of patients, improve daily living function, and improve joint mobility. PRT can accelerate the lymph backflow and reduce edema by promoting the active contraction of lymphatic vessels and enhancing the pumping ability of skeletal muscle. Internet platform tracking management mode can grasp the movement of patients and the changes of various indicators through WeChat platform and sports bracelet in a timely manner. The rehabilitation team members can dynamically and pertinently adjust the exercise plan according to the changes of patient indicators, and can also guide and correct the non-standard process details, so as to formulate the most suitable exercise plan for patients, and then promote the recovery of patients [31, 32]. The results of this study also indicated that there was no difference in the level of flexion and quality of life scores between the two groups before the intervention, 4 and 12 weeks after the intervention. The possible reason is that the research cycle of this study is short, and the sample size is limited, resulting in a bias. Therefore, in the future, it is necessary to extend the research cycle and increase the sample size to obtain more accurate and scientific results. Ammitzb ø ll [33] et al.'s study applied PRT to patients with breast cancer after surgery, and observed its preventive effect on lymphedema in the patients' arms. The results showed that there was no significant difference in the incidence of lymphedema between the 158 patients, but also verified the importance of PRT for women at high risk of lymphedema. The conclusion of this study is different from that study, which may be due to the fact that this study uses the internet platform tracking management mode based on PRT, which leads to the contradiction between the two conclusions, and also confirms the effectiveness of the internet platform tracking management mode in the rehabilitation of patients with BCRL.

In summary, this study found that the edema was alleviated, the grip strength was improved, the shoulder joint activity and daily living function were improved in patients with BCRL after

implementation of the internet platform tracking management mode combined with PRT, which had certain clinical promotion value.

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Disclosure of conflict of interest

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Address correspondence to: Hongmei Xin, Department of Breast Surgery, Hainan General Hospital, No. 19 Xiuhua Road, Xiuying District, Haikou 570311, Hainan, China. Tel: +86-0898-68622048; E-mail: xinhongmei.com@163.com

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