

Analysis of the Influencing Factors of Postoperative Lymphedema of Breast Cancer and the Influence of Axillary Reverse Mapping on Edema and Postoperative Quality of Life

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HuanLi Zeng¹, Xiu Wang¹, Yi Xiao¹, ShangYu Xie¹, ChuanRen Zhuang²

¹Department of Surgery, Cangnan County Hospital of Traditional Chinese Medicine, 325800 Wenzhou, Zhejiang, China

²Department of Laboratory, Cangnan County Hospital of Traditional Chinese Medicine, 325800 Wenzhou, Zhejiang, China

AIM: Postoperative lymphedema was a common and debilitating complication following breast cancer surgery, which significantly affects quality of life. This study analyzes the risk factors associated with lymphedema and evaluates the effectiveness of axillary reverse mapping (ARM) in reducing its incidence and improving quality of life.

METHODS: For this retrospective cohort study, 232 breast cancer patients who underwent axillary dissection between January 2022 and January 2023 were recruited. Patients were classified into the lymphedema group ($n = 54$) and the control group ($n = 178$) based on edema occurrence. Influencing factors such as body mass index, surgical techniques, and adjuvant therapies were analyzed. To assess ARM's impact on lymphedema and quality of life, patients were also divided into a mapping group ($n = 133$) and the control group ($n = 99$). Lymphedema stages were evaluated according to the International Lymphatic Society consensus, and quality of life was assessed using the Quality of Working Life Questionnaire for Cancer Survivors (QWLQ-CS), Breast Cancer Survivors Resilience Scale (BCRS), and Strategies Used by People to Promote Health (SUPPH) scale.

RESULTS: The results showed that chemotherapy (odds ratios [OR]: 4.063; $p < 0.001$) and radiotherapy (OR: 3.358; $p < 0.001$) were significant risk factors for lymphedema. ARM was associated with a reduced risk of lymphedema (OR: 0.322, $p = 0.004$). A higher proportion of patients in the mapping group were classified as having Stage 0 lymphedema (86.46%) compared to the control group (63.67%). For the mapping group, the QWLQ-CS was 71.04 ± 12.31 ($p = 0.041$), BCRS was 23.89 ± 6.32 ($p = 0.003$), and SUPPH was 85.65 ± 12.57 ($p = 0.001$), which were significantly higher than the control group.

CONCLUSIONS: Postoperative lymphedema risk in breast cancer patients is influenced by chemotherapy and radiotherapy, with ARM proving beneficial in reducing incidence and enhancing postoperative quality of life.

Keywords: postoperative lymphedema; breast cancer; axillary reverse mapping on edema; quality of life

Introduction

Postoperative lymphedema following breast cancer surgery was a significant complication affecting quality of life among survivors, manifesting primarily as a chronic and debilitating swelling of the upper limbs [1]. The condition was attributed to impaired lymphatic drainage due to axillary lymph node dissection, a standard procedure in breast cancer management for both diagnostic and therapeutic purposes [2]. Despite advancements in surgical techniques and adjuvant therapies, lymphedema remains a prevalent issue, with incidence rates ranging from 6% to 60% depending on various factors such as surgical approach, extent of node involvement, and adjuvant therapy regimens [3].

Identifying and understanding the risk factors associated with postoperative lymphedema was crucial for devising

effective preventative and management strategies [4]. The pathophysiology of lymphedema was intricate, involving a combination of mechanical insufficiency where the lymphatic system fails to transport interstitial fluid, and dynamic insufficiency where the lymph load exceeds the transport capacity [5]. Various risk factors have been implicated in the development of lymphedema, including obesity, the extent of surgical intervention, radiation therapy, and some chemotherapy regimens [6].

Recently, surgical innovation has introduced axillary reverse mapping (ARM) as a promising technique to mitigate the risk of lymphedema by conserving lymphatic vessels draining the arms during axillary dissections [7]. ARM facilitates the visualization and preservation of crucial lymphatic pathways, thereby potentially reducing the incidence and severity of lymphedema [8]. However, evaluating the impact of ARM on postoperative quality of life, beyond its physiological benefits, remains an area ripe for investigation, given its potential to influence mental health and social reintegration [9].

Understanding the repercussions of these complex interactions requires a comprehensive examination of both direct

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Correspondence to: ChuanRen Zhuang, Department of Laboratory, Cangnan County Hospital of Traditional Chinese Medicine, 325800 Wenzhou, Zhejiang, China (e-mail: 15888702114@163.com).

physiological impacts and broader psychosocial outcomes [10]. Quality of life for cancer survivors was increasingly recognized as an essential endpoint in oncological care, emphasizing functional recovery and psychosocial well-being alongside traditional survival metrics [11]. The Quality of Working Life Questionnaire for Cancer Survivors (QWLQ-CS), Breast Cancer Survivors Resilience Scale (BCRS), and Strategies Used by People to Promote Health (SUPPH) scale provide robust frameworks to assess these dimensions [12]. Notably, leveraging patient-reported outcomes can illuminate the nuanced effects of surgical and therapeutic interventions on patient-centered measures, fostering a holistic approach to cancer survivorship [13].

In this study, we aim to critically analyze the factors contributing to postoperative lymphedema in breast cancer patients, with an emphasis on the role of body mass index (BMI), adjuvant therapies, and surgical techniques. We further seek to evaluate the efficacy of ARM in reducing lymphedema incidence and improving postoperative quality of life. By characterizing the interplay between physiological outcomes and quality of life dynamics, we aspire to enhance the current understanding of lymphedema pathogenesis and identify strategies that harmonize oncologic efficacy with quality-of-life considerations.

Materials and Methods

Study Participants

This retrospective cohort study included 232 breast cancer patients who underwent axillary dissection in the Cangnan County Hospital of Traditional Chinese Medicine between January 2022 and January 2023. We collected clinical data through patient records, encompassing general information, clinical variables, adjuvant therapy, lymphoedema staging, and survey scales. Given that the study utilized only de-identified patient data, there was no risk of potential harm or impact on patient care. Consequently, according to the regulatory and ethical standards of retrospective study, written informed consent was obtained from all study participants. This study was approved by the Institutional Review Board and Ethics Committee of Cangnan County Hospital of Traditional Chinese Medicine (SY2024096) and conducted in accordance with the Declaration of Helsinki.

Inclusion and Exclusion Criteria

The inclusion criteria of this study are as follows: (1) Patients were aged between 18 and 60, and demonstrated the ability to understand and cooperate with various treatments and examinations; (2) A histopathological diagnosis of breast cancer was confirmed, which was classified into stages carcinoma *in situ* (CIS) and I–III; (3) Patients exhibited stable vital signs; (4) Patients maintained clear consciousness and were capable of accurately understanding and completing questionnaires.

The exclusion criteria of this study are as follows: (1) Patients with other severe progressive diseases; (2) Patients

suffering from neurological disorders or cognitive impairments; (3) Individuals with other malignant tumors or severe physical disorders; (4) Patients experiencing cancer recurrence or metastasis; (5) Patients unable to complete the questionnaire for any reasons during the survey.

Grouping Criteria and the ARM Method

To analyze the factors influencing postoperative lymphedema in breast cancer, the included patients were categorized based on the occurrence of edema within 12 months following axillary dissection. This resulted in two groups: the lymphedema group ($n = 54$) and the control group ($n = 178$). Lymphedema was diagnosed if the circumference of the upper limbs differed by 2 cm or more. Surveyors received professional training to familiarize themselves with the procedures of the methods used and the measurement steps. The measurement needs to be conducted three times to ensure accuracy and consistency of data.

To study the influence of ARM on edema and postoperative quality of life, the study participants were divided into two groups: the mapping group ($n = 133$) and the control group ($n = 99$), according to whether they had received ARM.

Patients in the ARM group underwent preoperative sentinel lymph node (SLN) localization using methylene blue tracer (JLC11336, 100 mL; Shanghai Jingkang Biological Engineering Co., Ltd., Shanghai, China). During the surgery, 0.1 mL of methylene blue was injected slowly into the subcutaneous tissue for graded visualization to reveal the efferent lymphatic vessels and the next-station lymph nodes. When resecting the lymph nodes, great care was taken to avoid damaging the lymphatic vessels by using sharp instruments for delicate dissection. If partial resection of lymphatic vessels was unavoidable, the cut ends of the lymphatic vessels were meticulously managed, such as through ligation or suturing, to prevent lymphatic fluid leakage.

Arm Circumference Measurement

Arm circumference was the most commonly used metric for assessing upper limb lymphedema in breast cancer patients. A soft tape measure was employed to evaluate multiple fixed locations along the upper limb, specifically by recording the circumference at the following five positions: the proximal end of the metacarpal bones, the wrist joint, 5 cm above the wrist joint, the elbow joint, and 5 cm above the elbow joint. A diagnosis of lymphedema was made if there was a discrepancy of 2 cm or more in the circumference between either side of the limbs [14].

Assessment of Lymphedema

According to the 2020 consensus of the International Lymphatic Society, lymphedema is categorized into four stages [15]. Stage 0, known as the latent or subclinical stage, is characterized by symptoms such as swelling and discomfort without any noticeable difference in arm circumference. Stage I is the early stage of edema, where elevat-

ing the affected limb can alleviate the swelling, known as pitting edema, and there is minimal fibrosis in the subcutaneous tissue. In Stage II, there is pronounced edema that cannot be relieved by limb elevation, termed non-pitting edema, and treatment can only partially reduce symptoms, as subcutaneous fibrosis has typically developed. Stage III is characterized by lymphatic elephantiasis, with symptoms including skin keratinization, verrucous hyperplasia, and frequent episodes of lymphangitis.

Quality of Working Life Questionnaire for Cancer Survivors (QWLQ-CS)

The QWLQ-CS scale, specifically designed to evaluate the work and life quality of cancer survivors, encompasses multiple aspects related to their professional and personal lives. These include job perceptions, job characteristics, social structures and environments, organizational features, as well as the impacts of illness and treatment. It addresses symptoms associated with lymphedema (such as pain, discomfort, and a sense of heaviness), the effects on daily activities (like work, household chores, and leisure activities), psychological implications for patients (such as anxiety, depression, and impaired self-esteem), and the limitations imposed by lymphedema on their social interactions and work capabilities. Higher scores on this scale indicate a better quality of life for the patients [16].

Breast Cancer Survivors Resilience Scale (BCRS)

Psychological resilience refers to an individual's capacity to comprehend and manage the stress associated with illness, as well as their beliefs and life goals. We assessed patients' psychological resilience using the BCRS, which comprises two dimensions: personal protection and social protection. The scale consists of 16 items, evaluated on a 4-point Likert scale, with responses ranging from "completely disagree" (scored as 1) to "absolutely agree" (scored as 4). Total scores range from 16 to 64, with higher scores indicating greater psychological resilience in breast cancer patients. In this study, the scale exhibited a Cronbach's alpha coefficient of 0.93, reflecting high reliability [17].

Strategies Used by People to Promote Health (SUPPH) Scale

We assessed the self-efficacy of cancer patients using the SUPPH scale, which comprises three dimensions: self-stress reduction, self-decision making, and positive attitude. The scale includes a total of 28 items, with total scores ranging from 28 to 140. Higher scores denote stronger self-efficacy and a greater level of confidence in managing their illness. In this study, the scale demonstrated a Cronbach's alpha coefficient of 0.93, indicating high reliability [18].

Statistical Methods

Data analysis was conducted using SPSS statistical software version 29.0 (SPSS Inc., Chicago, IL, USA). Categori-

cal variables are expressed as counts and percentages. Chi-square test was applied using the standard formula when the sample size was ≥ 40 and the theoretical frequency $T \geq 5$. If the sample size was ≥ 40 but the theoretical frequency was between 1 and < 5 , the corrected chi-square test was used. For sample sizes < 40 or theoretical frequencies $T < 1$, Fisher's exact test was employed for statistical analysis. The Shapiro-Wilk test was utilized to assess the normality of continuous variables. Normally distributed continuous variables are represented as mean $\pm$ standard deviation (SD). The data were analyzed using *t*-test with adjusted variance. Multiple ordered logistic regression analyses were performed with the occurrence of lymphocele as the dependent variable and other influencing factors as independent variables (predictors, explanatory variables). A two-sided *p*-value of < 0.05 was considered statistically significant.

Results

Baseline Characteristics

A significantly higher proportion of patients in the lymphedema group underwent total mastectomy compared to the control group, whereas more patients in the control group underwent breast-conserving surgeries ($\chi^2 = 19.578$, $p < 0.001$). Other characteristics such as age, BMI, education level, marital status, occupation, hypertension, dominant hand usage, diabetes, smoking status, tumor staging, number of lymph nodes removed, pathological type and operative site did not show statistically significant differences between the groups ($p > 0.05$). These findings suggest that the type of breast cancer surgery may be associated with the development of postoperative lymphedema (Table 1).

Adjuvant Therapy

The analysis of adjuvant therapy factors revealed that a significantly higher proportion of patients in the lymphedema group underwent chemotherapy and radiotherapy compared to those in the control group (Table 2). Specifically, 75.93% in the lymphedema group received chemotherapy versus 51.69% in the control group ($\chi^2 = 9.952$, $p = 0.002$), and 59.26% in the lymphedema group received radiotherapy compared to 36.52% in the control group ($\chi^2 = 8.808$, $p = 0.003$). Additionally, there was a significant difference in the rate of ARM surgeries, with 33.33% of the lymphedema group undergoing ARM compared to 64.61% of the control group ($\chi^2 = 16.564$, $p < 0.001$). Other factors, such as the number of chemotherapy cycles, the number of radiotherapy sessions, and tamoxifen usage, did not reach statistical significance in the comparison between the lymphedema group and the control group ($p > 0.05$). These findings suggest that chemotherapy, radiotherapy, and performing ARM surgeries are associated with the development of postoperative lymphedema in breast cancer patients.

Table 1. Baseline characteristics of patients.

Parameters	Lymphedema group (n = 54)	Control group (n = 178)	t/ χ^2	p
Age (years)	54.40 ± 10.90	53.10 ± 9.53	0.845	0.395
BMI (kg/m ²)	23.56 ± 6.47	23.46 ± 4.12	0.135	0.892
Education level			0.514	0.774
Primary school	9 (16.67%)	36 (20.22%)		
Secondary school	19 (35.19%)	55 (30.9%)		
College	26 (48.15%)	87 (48.88%)		
Marital status			0.539	0.764
Married	38 (70.37%)	134 (75.28%)		
Single	11 (20.37%)	31 (17.42%)		
Divorced	5 (9.26%)	13 (7.3%)		
Occupation			0.247	0.970
Homemaker	34 (62.96%)	114 (64.04%)		
Retired	13 (24.07%)	40 (22.47%)		
Office worker	5 (9.26%)	15 (8.43%)		
Others	2 (3.70%)	9 (5.06%)		
Hypertension (yes/no)	22 (40.74%)/32 (59.26%)	67 (37.64%)/111 (62.36%)	0.168	0.682
Dominant hand (right)	52 (96.30%)	168 (94.38%)	0.042	0.837
Diabetes	14 (25.93%)	28 (15.73%)	2.905	0.088
Smoker	11 (20.37%)	46 (25.84%)	0.669	0.413
Tumor staging			0.697	0.706
Stage I	14 (25.93%)	53 (29.78%)		
Stage II	32 (59.26%)	94 (52.81%)		
Stage III	8 (14.81%)	31 (17.42%)		
Number of lymph nodes removed	14.10 ± 5.30	13.50 ± 2.30	1.189	0.235
Type of breast cancer surgery			19.578	< 0.001
Breast-conserving operation	19 (35.18%)	121 (67.98%)		
Total mastectomy	21 (38.89%)	29 (16.29%)		
Concurrent breast reconstruction	14 (25.93%)	28 (15.73%)		
Pathological type			3.594	0.166
Invasive ductal carcinoma	50 (92.59%)	173 (97.19%)		
Invasive lobular carcinoma	0 (0.00%)	1 (0.56%)		
Mucinous adenocarcinoma	4 (7.41%)	4 (2.25%)		
Operative site				
Unilateral operation	44 (81.48%)	147 (82.58%)	0.034	0.852
Bilateral operation	10 (18.52%)	31 (17.42%)		

Notes: BMI <18.5 kg/m² denotes very light weight; 18.5 kg/m² ≤ BMI < 24 kg/m² denotes normal weight; 24 kg/m² ≤ BMI < 28 kg/m² denotes overweight.

Abbreviation: BMI, body mass index.

Multivariate Logistic Regression Analysis of Risk Factors

A multiple logistic regression model was established using lymphedema as the dependent variable (lymphedema = 1, no lymphedema = 0), and the type of breast cancer surgery (breast-conserving operation = reference value, total mastectomy = 1, concurrent breast reconstruction = 0), chemotherapy (yes = 1, no = 0), radiotherapy (yes = 1, no = 0), and ARM surgery (yes = 1, no = 0) as independent variables. The multivariate logistic regression analysis identified several significant risk factors for postoperative lymphedema in breast cancer patients (Table 3). Receiving chemotherapy significantly elevated the risk for postoperative lymphedema, as indicated by an odds ra-

tio (OR) of 4.063 (95% confidence interval [CI], 1.870–8.827; $p < 0.001$), similar to radiotherapy, which had an OR of 3.358 (95% CI, 1.635–6.896; $p < 0.001$). ARM surgery may decrease the risk of lymphedema, with an OR of 0.322 (95% CI, 0.149–0.694; $p = 0.004$). Compared with breast-conserving surgery, the risk of lymphedema was significantly increased in patients undergoing total mastectomy, with OR of 2.353 (95% CI, 0.922–6.007; $p = 0.074$). These results suggest that chemotherapy and radiotherapy increase the likelihood of postoperative lymphedema, while ARM surgeries may offer a protective effect.

Table 2. Adjuvant therapy.

Parameters	Lymphedema group (n = 54)	Control group (n = 178)	t/χ^2	<i>p</i>
Chemotherapy patients	41 (75.93%)	92 (51.69%)	9.952	0.002
Number of chemotherapy cycles	7.56 ± 2.84	6.81 ± 3.45	1.453	0.147
Radiotherapy patients	32 (59.26%)	65 (36.52%)	8.808	0.003
Number of radiotherapy sessions	27.45 ± 6.88	26.43 ± 5.56	1.115	0.266
Tamoxifen usage	23 (42.59%)	100 (56.18%)	3.071	0.080
ARM surgeries	18 (33.33%)	115 (64.61%)	16.564	<0.001

Abbreviation: ARM, axillary reverse mapping.

Table 3. Multivariate logistic regression analysis of risk factors.

Parameters	Coefficient	SE	WALD	OR	OR's lower CI	OR's upper CI	<i>p</i>
Constant	-0.838	0.467	3.214	0.433			0.073
Breast-conserving operation			7.750				0.021
Total mastectomy	0.856	0.478	3.202	2.353	0.922	6.007	0.074
Concurrent breast reconstruction	-0.289	0.478	0.366	0.749	0.293	1.911	0.545
Chemotherapy	1.402	0.396	12.537	4.063	1.870	8.827	<0.001
Radiotherapy	1.211	0.367	10.882	3.358	1.635	6.896	<0.001
ARM surgeries	1.113	0.392	8.367	0.322	0.149	0.694	0.004

Abbreviations: ARM, axillary reverse mapping; CI, confidence interval; OR, odds ratio; SE, standard error; WALD, Wald's test.

Table 4. Baseline characteristics of patients classified based on ARM status.

Parameters	Control group (n = 99)	Mapping group (n = 133)	t/χ^2	<i>p</i>
Age (years)	53.30 ± 10.57	53.48 ± 9.33	0.137	0.891
BMI (kg/m ²)	23.91 ± 5.63	23.17 ± 3.97	1.180	0.239
Education level			0.650	0.722
Primary school	19 (19.19%)	26 (19.55%)		
Secondary school	29 (29.29%)	45 (33.83%)		
College	51 (51.52%)	62 (46.62%)		
Marital status			2.106	0.349
Married	78 (78.79%)	94 (70.68%)		
Single	14 (14.14%)	28 (21.05%)		
Divorced	7 (7.07%)	11 (8.27%)		
Occupation			4.987	0.173
Homemaker	65 (65.66%)	83 (62.41%)		
Retired	26 (26.26%)	27 (20.30%)		
Office worker	6 (6.06%)	14 (10.53%)		
Others	2 (2.02%)	9 (6.76%)		
Hypertension (yes/no)	41 (41.41%)/58 (58.59%)	48 (36.09%)/85 (63.91%)	0.680	0.409
Dominant hand usage (right)	96 (96.97%)	124 (93.23%)	1.616	0.204
Diabetes	22 (22.22%)	20 (15.04%)	1.976	0.160
Smoker	23 (23.23%)	34 (25.56%)	0.166	0.683

Abbreviation: BMI, body mass index.

Table 5. Evaluation of ARM-related lymphedema.

Parameters	Control group (n = 99)	Mapping group (n = 133)	χ^2	<i>p</i>
Staging of lymphedema			18.153	< 0.001
Stage 0	63 (63.67%)	115 (86.46%)		
Stage I	24 (24.24%)	14 (10.53%)		
Stage II	9 (9.09%)	4 (3.01%)		
Stage III	3 (3.03%)	0 (0%)		

Abbreviation: ARM, axillary reverse mapping.

Table 6. A summary of scores measured with different scales.

Parameters	Mapping group (<i>n</i> = 133)	Control group (<i>n</i> = 99)	<i>t</i>	<i>p</i>
QWLQ-CS	71.04 ± 12.31	68.26 ± 8.37	2.051	0.041
BCRS	23.89 ± 6.32	21.56 ± 5.41	2.953	0.003
SUPPH	85.65 ± 12.57	81.21 ± 6.52	3.488	0.001

Abbreviations: BCRS, Breast Cancer Survivors Resilience Scale; QWLQ-CS, Quality of Working Life Questionnaire for Cancer Survivors; SUPPH, Strategies Used by People to Promote Health.

Baseline Characteristics of Patients Classified Based on ARM Status

To investigate the effect of ARM on edema and postoperative quality of life, patients were divided into two groups according to whether they had received ARM: mapping group (*n* = 133) and control group (*n* = 99) (Table 4). Age (*p* = 0.891) and BMI (*p* = 0.239) were similar between the mapping group and control group. Education levels were comparable, with patients across both groups similarly distributed among primary, secondary, and college education ($\chi^2 = 0.650$, *p* = 0.722). Marital status ($\chi^2 = 2.106$, *p* = 0.349) and occupation ($\chi^2 = 4.987$, *p* = 0.173) also showed no significant difference. Presence of hypertension was somewhat more frequent in the control group than in the mapping group, but this was not statistically significant ($\chi^2 = 0.680$, *p* = 0.409). Dominant hand usage, diabetes, and smoking status also showed no significant difference between the two groups (*p* > 0.05). These findings indicate that both groups are similar in terms of demographic and health-related baseline characteristics.

Evaluation of ARM-Related Lymphedema

The evaluation of ARM-related lymphedema revealed statistically significant differences in the staging of lymphedema between the mapping group and the control group ($\chi^2 = 18.153$, *p* < 0.001) (Table 5). A higher proportion of patients in the mapping group were classified as stage 0 lymphedema (84.46%) compared to the control group (63.67%). Conversely, the control group had higher percentages of patients suffering from more advanced stages of lymphedema: 24.24% were categorized as stage I compared to 10.53% in the mapping group, 9.09% were stage II versus 3.01% in the mapping group, and 3.03% were stage III, while no patients in the mapping group were classified as stage III. These findings suggest that ARM is associated with lower rates of lymphedema in the postoperative period among breast cancer patients.

Questionnaire Investigation

Patients in the mapping group had significantly higher scores on the QWLQ-CS with a mean of 71.04 ± 12.31, compared to 68.26 ± 8.37 in the control group (*t* = 2.051, *p* = 0.041) (Table 6). The mapping group also scored significantly higher in the BCRS (23.89 ± 6.32) versus the control group (21.56 ± 5.41) (*t* = 2.953, *p* = 0.003). Sim-

ilarly, the SUPPH scores were significantly higher in the mapping group (85.65 ± 12.57) compared to the control group (81.21 ± 6.52) (*t* = 3.488, *p* = 0.001). These results suggest that patients undergoing ARM experience improvements in quality of life and resilience postoperatively.

Discussion

In the present study, the type of breast cancer surgery was identified as the key factor that influences the likelihood of lymphedema in breast cancer patients. This aligns with existing literature, which considers surgery as a risk factor for lymphedema following breast cancer treatment [19]. Mechanically, breast cancer surgery, such as a mastectomy, usually involves axillary lymph node dissection or sampling, a process that removes or damages lymphatic vessels and lymph nodes [20]. The severing of lymphatic vessels results in the obstruction of lymphatic drainage pathways in the upper extremities, causing the accumulation of lymphatic fluid in the surgical area and leading to symptoms such as swelling and a heavy sensation in the arm, hand, or affected region [21]. Additionally, breast cancer surgery may inflict other forms of damage on the lymphatic system. These injuries can impair the function of the lymphatic system, further exacerbating lymphatic fluid reflux disorders and thereby inducing or aggravating lymphedema [22].

Chemotherapy and radiotherapy were both found to significantly increase the risk of lymphedema, a finding supported by previous studies [23,24]. Chemotherapy can damage lymphatic vessels either directly via neurotoxicity or indirectly through inflammatory cytokine release, contributing to compromised lymphatic drainage [25]. Radiotherapy was recognized for causing fibrosis and lymphatic obstruction in treated tissues, which could lead to chronic edema [26]. Radiogenic fibrosis modifies the extracellular matrix architecture, impeding lymphatic vessel dilation and contraction necessary for optimal fluid transport [27]. These insights underline the importance of precision in administering adjuvant therapies, potentially incorporating approaches that minimize damage to lymphatic structures while maintaining therapeutic efficacy against cancerous tissues [28].

In addition to reducing the risk of lymphedema, ARM was also associated with the improvement of postoperative quality of life, measured using QWLQ-CS, BCRS and SUPPH tools, in the mapping group as compared to the control

group ($p < 0.05$). The clinical significance of the difference in scores is that lower scores usually indicate more difficulties or discomfort in quality of life, edema, and upper limb functional activities, while higher scores indicate better functional recovery. This highlights the broader psychosocial and adaptive benefits of ARM, likely stemming from reduced physical symptom burden [29]. By preventing or lessening lymphedema, ARM contributes to greater limb functionality and aesthetic outcomes, crucial factors influencing mental well-being and social reintegration post-cancer treatment [30]. These findings underscore the profound interconnectedness between physiological and psychological health, suggesting that procedural interventions can have expansive benefits beyond mere physical recovery.

In addition to these direct factors, the role of patient education and empowerment should be taken into consideration for its indirect influences on postoperative outcomes. A heightened awareness and proactive management approach to potential lymphedema symptoms may empower patients to engage in behaviors that mitigate severity, such as manual lymph drainage, compression therapy, and regular exercise [31]. The apparent improvements in quality of life and resilience metrics among patients receiving ARM may partly reflect this empowered mindset, encouraged by surgical choices that value and incorporate patient autonomy and education [32].

Several limitations of the present study should be acknowledged. The foremost shortcoming is the retrospective study design of this investigation and the inherent biases of record-based data analysis. Additionally, while ARM has shown promise, further research to discern differences in its efficacy across different patient populations, examine inter-radiotherapy treatments, and monitor long-term follow-up outcomes is necessary for technique improvement, which is a critical factor influencing its widespread adoption in the future. Variability in technique execution and patient anatomy may also influence effectiveness, calling for standardized procedural training to maximize ARM's therapeutic benefits.

Conclusions

In summary, findings of the current study broaden our understanding of the multifactorial etiology of postoperative lymphedema in breast cancer patients and highlight the pivotal role of surgical innovation, particularly ARM, in mitigating risk and optimizing postoperative quality of life. Future research should aim for longitudinal, prospective studies to further elucidate these relationships and to establish evidence-based protocols that harmonize clinical efficacy with improved patient-centered outcomes. Expanding research to incorporate genetic, molecular, and lifestyle variables could provide additional layers of understanding, potentially unveiling new interventions for lymphedema management and prevention. Through such endeavors, we

move closer to tailoring cancer treatment paradigms that consider the holistic needs of patients, ensuring both survival and quality of life are concurrently optimized.

Availability of Data and Materials

The data used and analysed during the current study are available from the corresponding author on reasonable request.

Author Contributions

HZ and XW designed the study; HZ, XW, YX, SX and CZ conducted the study; YX and SX collected and analyzed the data. HZ and CZ participated in drafting the manuscript, and all authors contributed to critical revision of the manuscript for important intellectual content. All authors gave final approval of the version to be published. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

This study was approved by the Ethics Committee of Cangnan County Hospital of Traditional Chinese Medicine (institution review board number, SY2024096). This study was performed in accordance with the principles of the Declaration of Helsinki. Informed consent has been obtained from all participants involved in the study.

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Conflict of Interest

The authors declare no conflict of interest.

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