

The Association of Hand Dominance With the Development of Breast Cancer–related Lymphedema After Mastectomy: A Retrospective Analysis

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Background: Risk factors for developing breast cancer–related lymphedema (BCRL) are well studied, but little is known about the effect of hand dominance (HD). This study aimed to investigate the relationship between HD and postmastectomy BCRL for unilateral breast cancer (BC). Because BCRL treatment involves movement of the affected limb, we postulated that the inherently increased use of a dominant upper extremity may be protective against BCRL.

Methods: A retrospective cohort study of female patients with unilateral BC who underwent mastectomy at a single institution between 2012 and 2022 was performed. BCRL was confirmed by a certified lymphedema therapist. The laterality of HD and BC was categorized as ipsilateral or contralateral.

Results: Of the 266 patients included in the analysis, 70 (26.3%) developed BCRL. A greater proportion of patients with HD contralateral BC developed BCRL (30.3% versus 22.4%; $P = 0.129$) compared with those with HD ipsilateral BC. No statistically significant difference in BCRL development based on BC and HD laterality was demonstrated regardless of lymph node management type. Multivariable analysis showed significant associations between the development of BCRL, and the number of lymph nodes removed ($P < 0.001$) and adjuvant radiation therapy ($P < 0.001$).

Conclusions: Although a greater proportion of patients with contralateral HD and BC developed BCRL, our results demonstrated no statistically significant relationship. Known risk factors such as increased number of lymph nodes removed and adjuvant radiation therapy were significantly associated with BCRL. Further studies including larger and multicenter populations are required to comprehensively elucidate the relationship between HD and BCRL. (*Plast Reconstr Surg Glob Open* 2025;13:e7251; doi: [10.1097/GOX.00000000000007251](https://doi.org/10.1097/GOX.00000000000007251); Published online 10 November 2025.)

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INTRODUCTION

Breast cancer (BC) is the most common cancer affecting women in the United States, with estimates finding that 1 in 8 women will be diagnosed in their lifetime.^{1–3} Given the prevalence of BC and its 5-year survival rates of 91%, an emphasis is placed on mitigating potential complications of treatment and increasing quality of life following therapy for BC survivors.^{2–4} One such complication is breast cancer–related lymphedema (BCRL), which is characterized by uncomfortable or painful edema of the upper extremity and can affect patient function, appearance, and psychosocial well-being.

Disclosure statements are at the end of this article, following the correspondence information.

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Currently, there is no cure for lymphedema, and treatment approaches aim to prevent progression, control edema, alleviate symptoms, and reduce risk for infection.^{5,6} New advances in prophylactic and therapeutic surgical management strategies continue to emerge and evolve, such as liposuction for debulking, lymphovenous anastomosis, and vascularized lymph node transfer.^{6–9} Yet, complete decongestive therapy (CDT), involving techniques such as manual lymphatic drainage, exercises, and compression therapy performed by specially trained physical therapists, remains the standard in BCRL care.^{10–13} These approaches, along with strength training and other exercising protocols, have also been shown to act as preventative measures for BCRL due to contraction of extrinsic skeletal muscles, which is known to mobilize lymph.^{12,14–16} Several studies have demonstrated that intentional exercise before and after BC treatment is safe and may decrease the risk of developing BCRL.^{12,17–26}

When considering the upper extremities, individuals tend to exhibit a strong preference for using 1 “dominant” limb. This is the right limb in approximately 90% of the population, and is more often used for activities such as writing, eating, or playing sports.^{27–30} Previous studies have shown that not only is the dominant limb used more often for daily activities but also that the dominant limb tends to have an increased baseline strength when compared with the nondominant side.^{29–31} When considered in the context of BCRL, the dominant limb may therefore be better equipped to support lymphatic drainage following BC treatment, thereby potentially lowering the risk of BCRL. This study aimed to explore the role of handedness as a protective factor against BCRL, as there are currently no studies on the relationship between hand dominance (HD) and BCRL development. The authors hypothesized that women with unilateral BC undergoing mastectomy on their hand dominant side would be less likely to develop BCRL.

PATIENTS AND METHODS

Study Design

A retrospective chart review of 364 patients with BC at a single institution was performed. This cohort study was approved by the University of Tennessee Graduate School of Medicine in Knoxville (institutional review board no. 5205). Inclusion criteria were (1) female patients with BC, (2) those who underwent mastectomy with or without lymphadenectomy between January 2012 and June 2022, and (3) those with minimum follow-up of 1.5 years. Confirmation of BCRL by a certified lymphedema therapist was required for patient inclusion in the lymphedema cohort. Exclusion criteria included (1) individuals younger than 18 years of age at the time of mastectomy, (2) patients with bilateral BC, (3) those with incomplete records, (4) individuals deceased at the time of data collection, or (5) those unable to be contacted. A total of 98 patients were excluded for 1 or more of these reasons.

Study data were collected and managed using Research Electronic Data Capture tools hosted at the

Takeaways

Question: Does breast cancer–related lymphedema (BCRL) develop less often after mastectomy when a patient’s breast cancer is on the same side as their dominant hand?

Findings: Of 266 women with unilateral breast cancer who underwent mastectomy, 70 (26.3%) developed BCRL. Fewer patients with hand dominance on the same side as their breast cancer developed BCRL (22.4% versus 30.3%, $P = 0.129$), but this was not statistically significant. No significant difference was found when evaluated by lymph node management type.

Meaning: Hand dominance was not significantly associated with BCRL development after mastectomy for unilateral breast cancer.

University of Tennessee Graduate School of Medicine in Knoxville.^{32,33} Research Electronic Data Capture is a secure, web-based software platform designed to support data capture for research studies, providing (1) an intuitive interface for validated data capture, (2) audit trails for tracking data manipulation and export procedures, (3) automated export procedures for seamless data downloads to common statistical packages, and (4) procedures for data integration and interoperability with external sources.

Collected information included demographics (age at BC diagnosis, race/ethnicity, HD); comorbidities (body mass index [BMI], diagnosis of diabetes mellitus, tobacco use); treatment types (neoadjuvant or adjuvant chemotherapy, radiation therapy [RT], or hormonal therapy); oncological characteristics (BC laterality); perioperative information (final operative lymph node management (sentinel lymph node biopsy [SLNB], axillary lymph node dissection [ALND], or none), total number of lymph nodes removed, breast reconstruction); and outcomes of interest (BCRL, laterality of lymphedema).

Patients were divided into 2 cohorts, including those with BCRL and those without (non-BCRL). Confirmation of BCRL by a certified lymphedema therapist was required for patient inclusion in the lymphedema cohort. HD was obtained in 1 of 2 ways: (1) through medical records or (2) self-reported via telephone calls. Patients were contacted via telephone, and consent was obtained. Involvement was voluntary and able to be withdrawn at any time. Patients were contacted up to 3 times, after which they were designated as “unable to contact” and were therefore excluded from analysis. “Ipsilateral” patients were defined as those with HD and BC on the same side (ipsilateral BC/HD), and “contralateral” patients were defined as those with HD on the opposite side of their BC (contralateral BC/HD). As there are no current standardized criteria for determination of handedness, for those who reported some level of ambidexterity (ie, writing with 1 hand and throwing with the other), handedness was classified based on their preferred writing hand, as penmanship requires finer motor control compared with other tasks.^{27–30}

Statistical Analysis

Chi-squared or Fisher exact tests, when appropriate, and *t* tests were used to assess differences in categorical and continuous variables across the 2 cohorts, respectively. For continuous variables, Shapiro–Wilk tests were performed to assure normality. Once normality was confirmed, 2-tailed independent sample *t* tests were used to quantitatively compare differences between groups. Multivariable logistic regressions were performed to calculate adjusted odds ratios (ORs) for developing BCRL. Variable selection for multivariable models was based on clinical relevance, significance in univariate logistic regression analysis ($P < 0.25$), and avoidance of multicollinearity and overfitting. Through this process, covariates included age at BC diagnosis, BMI at diagnosis, number of lymph nodes removed, neoadjuvant chemotherapy, adjuvant chemotherapy, adjuvant hormonal therapy, adjuvant RT, BC and HD laterality, and breast reconstruction. Goodness of fit was assessed using the Hosmer–Lemeshow test. As this was a retrospective study, our sample size was determined by available records. In response, we performed a post hoc power analysis to quantify this limitation. Due to the available records, our study had approximately 32% power to detect the observed effect size at a significance level of 0.05. Continuous variables were shown as mean $\pm$ SD. *P* values less than 0.05 were considered statistically significant. All analyses were performed using Statistical Package for the Social Sciences software, version 29 (IBM, Armonk, NY).

RESULTS

A total of 266 patients met criteria for inclusion in the analysis. The mean overall patient age was 54.8 years with an average BMI of 28.5 kg/m². The majority of patients were identified as White (96.6%) and never smokers (66.9%). The average follow-up time of data collection was 42.77 months after mastectomy. Demographic and comorbidity data are presented in Table 1. Patients in the BCRL cohort were found to be younger than those in the non-BCRL group (52.1 versus 55.7 y, $P = 0.026$), but there were no other significant differences in demographic characteristics and comorbidities between cohorts.

Treatment types, oncological characteristics, and perioperative information between the 2 cohorts are presented in Table 2. The majority of patients underwent SLNB at the time of mastectomy (68.8%), followed by ALND (30.1%) and no lymph node management (1.1%). On average, 8.5 lymph nodes were removed across all patients. Overall, more than half of patients (63.2%) underwent breast reconstruction, including immediate and delayed autologous, alloplastic, and combined types of reconstructions. A larger proportion of patients who developed BCRL underwent adjuvant chemotherapy (80.0% versus 44.9%, $P < 0.001$), RT (80.0% versus 19.4%, $P < 0.001$), and hormonal therapy (94.3% versus 75.0%, $P < 0.001$) compared with the non-BCRL population. Furthermore, those within the BCRL cohort more commonly underwent ALND (74.3% versus 14.3%,

Table 1. Demographics and Comorbidities

Variable	Study Population (N = 266)	BCRL (N = 70)	Non-BCRL (N = 196)	<i>P</i>
Age at BC diagnosis (y)*	54.8 $\pm$ 11.5	52.1 $\pm$ 11.2	55.7 $\pm$ 11.5	0.026
Race				0.826
White	257 (96.6%)	69 (98.6%)	188 (95.9%)	
Black	7 (2.6%)	1 (1.4%)	6 (3.1%)	
Other	2 (0.8%)	0 (0.0%)	2 (1.0%)	
BMI (kg/m ²)*	28.5 $\pm$ 6.0	29.0 $\pm$ 5.2	28.3 $\pm$ 6.2	0.418
Diabetes mellitus	21 (7.9%)	4 (5.7%)	17 (8.7%)	0.462
Tobacco use				0.321
Active use	39 (14.7%)	14 (20.0%)	25 (12.8%)	
Former	49 (18.4%)	13 (18.6%)	36 (18.4%)	
Never	178 (66.9%)	43 (61.4%)	135 (68.9%)	

Reported as n (%). Bold indicates statistical significance ($P < 0.05$).

*Reported as mean $\pm$ SD.

Table 2. Oncological Characteristics

Variable	Study Population (N = 266)	BCRL (N = 70)	Non-BCRL (N = 196)	<i>P</i>
Neoadjuvant chemotherapy	54 (20.3%)	20 (28.6%)	34 (17.3%)	0.057
Adjuvant chemotherapy	144 (54.1%)	56 (80.0%)	88 (44.9%)	<0.001
Adjuvant RT	94 (35.3%)	56 (80.0%)	38 (19.4%)	<0.001
Adjuvant hormonal therapy	213 (80.1%)	66 (94.3%)	147 (75.0%)	<0.001
Lymph node management				<0.001
None	3 (1.1%)	0 (0.0%)	3 (1.5%)	
SLNB	183 (68.8%)	18 (25.7%)	165 (84.2%)	
ALND	80 (30.1%)	52 (74.3%)	28 (14.3%)	
No. lymph nodes removed*	8.5 $\pm$ 8.6	15.8 $\pm$ 9.4	5.9 $\pm$ 6.7	<0.001
Breast reconstruction performed	168 (63.2%)	38 (54.3%)	130 (66.3%)	0.084

Reported as n (%). Bold indicates statistical significance ($P < 0.05$).

*Reported as mean $\pm$ SD.

$P < 0.001$) and experienced a significantly higher number of lymph nodes removed (15.8 versus 5.9, $P < 0.001$). There was no difference in receipt of breast reconstruction between those who developed BCRL and those who did not.

Overall, 70 patients were diagnosed with BCRL (26.3%), among which a slight majority of patients (55.7%) experienced left-sided lymphedema. Across all patients, BC laterality was nearly equal (left, 49.6% versus right, 50.4%), with no difference between the BCRL and non-BCRL cohorts. Similarly, there was no difference in HD when compared across the presence or absence of BCRL. The majority of patients (89.8%) were right-hand dominant (Table 3).

Regarding the association of BCRL and HD, a greater proportion of patients with contralateral BC and HD developed BCRL (30.3%) compared with those with ipsilateral BC and HD (22.4%), although this difference was not statistically significant ($P = 0.129$). (See table, **Supplemental Digital Content 1**, which displays the association of BCRL and HD, <https://links.lww.com/PRSGO/E450>.) When stratified by lymph node management type, this relationship was not observed among those who received SLNB (9.6% versus 10.0%, $P = 1.000$). However, among patients who underwent ALND, the trend reemerged, with a greater proportion of patients with contralateral BC and HD developing BCRL (68.1%) when compared with those with ipsilateral BC and HD (60.6%), although this difference also did not reach statistical significance ($P = 0.634$) (Fig. 1).

Multivariable logistic regression (Table 4) evaluated predictors of developing BCRL, including age and BMI at BC diagnosis; number of lymph nodes removed; neoadjuvant chemotherapy; adjuvant chemotherapy, RT, and hormonal therapy; BC and HD laterality; and breast reconstruction. Hosmer–Lemeshow goodness-of-fit testing indicated adequate model fit ($\chi^2 = 10.269$, $df = 8$, $P = 0.247$). The number of lymph nodes removed exhibited a significantly positive relationship with BCRL, with each lymph node removed increasing the odds of developing BCRL by 9.0% (OR, 1.090; $P < 0.001$). Furthermore, patients who received postoperative RT had 7.4 times higher odds of developing BCRL than those who did not (OR, 7.416; $P < 0.001$). No additional significant relationships were noted, including BC and HD laterality (OR, 1.465; $P = 0.292$).

DISCUSSION

BCRL occurs in approximately 20% of patients with BC, as a result of disruption of the lymphatic drainage of the upper extremity due to surgery, radiation, or other treatment modalities.^{11,34,35} Due to the known impact of BCRL on patient health, function, and psychosocial well-being, recent research and innovation efforts have focused on prevention and early intervention.^{6,8,9,36–39} Identifying associated risk factors or protective mechanisms is critical for this purpose.^{38–41} To our knowledge, this is the first study to investigate the role of HD on the development of BCRL, which would potentially improve patient counseling, and allow for development of preventative protocols before, during, and after BC treatments.

Previously established risk factors include ALND, RT, BMI, and history of infection.^{34,35,41–44} There is evidence that the number of removed lymph nodes correlates with the overall injury to the lymphatic system and is an independent risk factor, which explains the increased incidence of BCRL following ALND compared with SLNB.⁴⁵ The findings of our study demonstrated that the odds of developing BCRL increased by 9% per lymph node removed. These results are supported by Kilbreath et al,⁴² who demonstrated that patients with 5 or more removed lymph nodes experienced BCRL at a significantly higher rate than those with less removed.³⁴ When considering radiotherapy, Miller et al⁴³ noted that of those who underwent SLNB or ALND, or patients who received breast or chest wall RT experienced BCRL at a greater rate than those who did not. This is consistent with our study findings that demonstrated 7.4 times higher odds of developing BCRL after receiving adjuvant RT. Although the impact of BMI and breast reconstruction on the development of BCRL was not notable in the present study, there is some evidence supporting higher BMI and lack of breast reconstruction as independent risk factors for BCRL development.^{35,41,46–51} In contrast, there is discord in the current literature regarding the impact of age and chemotherapy—both neoadjuvant and adjuvant—in developing BCRL.^{34,41,52} The results of this study demonstrate that both the number of removed lymph nodes and the delivery of postoperative RT represent significant predictors of developing BCRL, which aligns with the existing literature and reinforces well-known risk factors in the field.

Table 3. Lymphedema and Hand Dominance Characteristics

Variable	Study Population (N = 266)	BCRL (N = 70)	Non-BCRL (N = 196)	P
Lymphedema	70 (26.3%)	70 (100%)	0 (0.0%)	—
Lymphedema laterality				
Right	31 (11.7%)	31 (44.3%)	0 (0.0%)	—
Left	39 (14.7%)	39 (55.7%)	0 (0.0%)	
BC laterality				0.164
Right	134 (50.4%)	30 (42.9%)	104 (53.1%)	
Left	132 (49.6%)	40 (57.1%)	92 (46.9%)	
HD				0.656
Right	239 (89.8%)	64 (91.4%)	175 (89.3%)	
Left	27 (10.2%)	6 (8.6%)	21 (10.7%)	

Reported as n (%). Bold indicates statistical significance ($P < 0.05$).

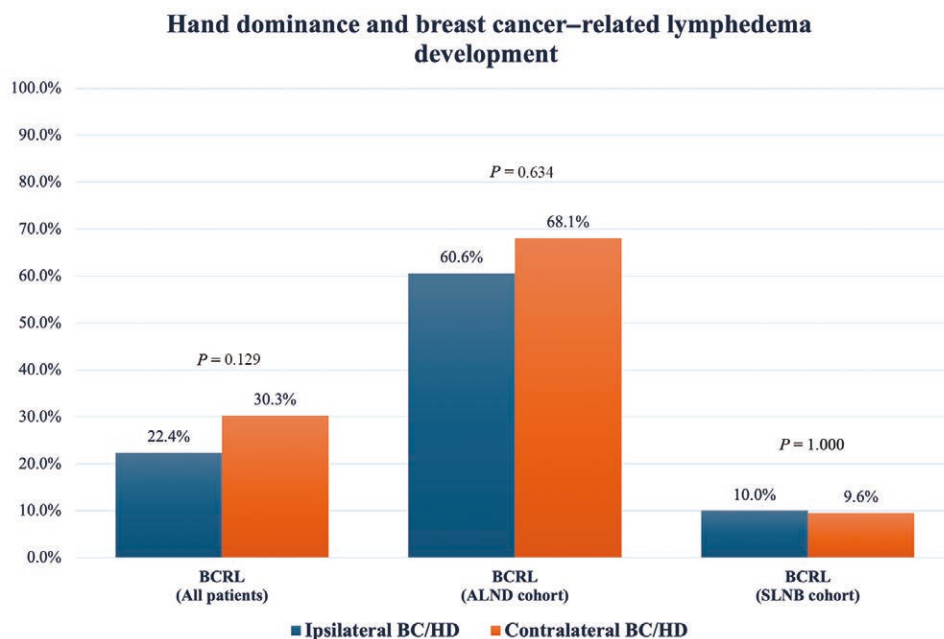


Fig. 1. A graph showing comparison of BCRL development among those with ipsilateral BC and HD and those with contralateral BC and HD.

Table 4. Patient Factors Associated With Breast Cancer–related Lymphedema Development in a Multivariable Logistic Regression

Variable	OR of BCRL Development (95% CI)	P
Age at BC diagnosis	0.978 (0.942–1.012)	0.202
BMI at BC diagnosis	1.024 (0.960–1.092)	0.474
No. LN removed	1.090 (1.037–1.146)	<0.001
Neoadjuvant chemotherapy		
No	1	—
Yes	0.849 (0.357–2.019)	0.712
Adjuvant chemotherapy		
No	1	—
Yes	1.032 (0.428–2.488)	0.943
Adjuvant RT		
No	1	—
Yes	7.416 (3.185–17.270)	<0.001
Adjuvant hormonal therapy		
No	1	—
Yes	2.872 (0.781–10.563)	0.112
BC/HD laterality		
Ipsilateral BC/HD	1	—
Contralateral BC/HD	1.465 (0.720–2.981)	0.292
Reconstruction performed		
No	1	—
Yes	0.996 (0.453–2.192)	0.992

Bold indicates statistical significance ($P < 0.05$).

CI, confidence interval; LN, lymph node.

In the present study, we theorized that HD ipsilateral to the site of surgical BC intervention may function as a protective factor against developing BCRL. This hypothesis was based on the concept that the dominant limb is used more often and has greater baseline strength, which would result in an increase in the extrinsic pump

mechanism and, therefore, an increase in lymphatic drainage. Cyclic compression and expansion of the lymphatics by contraction of skeletal muscle and surrounding tissues play a role in enhancing lymph flow, potentially reducing the risk of fluid accumulation.^{12,14–16} This theory is further supported by several studies that have demonstrated that specialized exercise protocols may decrease the risk of developing BCRL after BC treatment or may at least delay its development.^{12,17–26} We hypothesized that these mechanisms may serve as a protective factor both preoperatively, and postoperatively, due to the increased use of the dominant limb before and after surgery.

This principle also aligns with the basis of CDT, which serves as the standard of care in lymphedema management.^{10,12,18,20,53,54} CDT combines multiple therapeutic modalities, consisting of manual lymphatic drainage, compression bandaging, skin care, and physical therapy, which promote lymphatic fluid mobilization through structured movement and supervised exercise, effectively mitigating lymphedema severity.^{10,13,54} Previous studies have reported that exercise, through an increase in blood pressure and cardiac output, causes an improved capillary filtration, therefore increasing interstitial pressure, promoting fluid entry into lymphatic vessels, and mobilizing lymph, whereas others have demonstrated that regular exercise stimulates lymphangiogenesis to create new collateral pathways to restore outflow.^{7,55–59}

As the role of immediate lymphatic reconstruction (ILR) at the time of axillary lymphadenectomy evolves, identification of factors that place patients at elevated risk of BCRL is paramount to determine the appropriate candidates.^{6,8,9,36,37,60} If patients were determined to be at increased risk of BCRL due to their handedness in addition

to other factors, this may warrant further consideration. Our institution began offering ILR to all patients undergoing complete axillary lymphadenectomy after the current study period, with no patients who underwent ILR included in this study. If HD was demonstrated to play a pivotal role in the development of BCRL, the possibility of extending ILR indications to patients undergoing targeted axillary dissection or SLNB could be considered in addition to other risk reduction strategies, as previously discussed.

Despite the physiological rationale supporting this theory, our results demonstrated no statistically significant difference between ipsilateral BC and HD, and contralateral BC and HD in predicting BCRL. However, of those with contralateral BC and HD, a greater proportion of patients developed BCRL among the overall study population (30.3% versus 22.4%) and among those that underwent ALND (68.1% versus 60.6%), suggesting a trend consistent with our hypothesis (Fig. 1). One potential explanation is our small sample size, which could be insufficient to detect a true effect. Conversely, if our hypothesis is incorrect and HD does not influence the development of BCRL, this may highlight the pivotal role of lymphatic anatomy disruption with BC treatments. The number of damaged lymphatic channels due to lymph node dissection, radiation, and other interventions may outweigh any compensatory benefit of increased muscle activity. Multiple previous studies have suggested that this may not be accurate, because intentional exercise protocols and weight training have been described as potential protective factors for BCRL.^{12,17–26} Perhaps, lymphatic collateralization and lymph fluid mobilization promoted by the inherently increased muscle activity of increased dominant limb use may be too variable, slow, or ineffective to overcome the injury and obstruction of the extremity lymphatic drainage pathways when compared with intentional exercise and weight-training programs. Additionally, patients without prescribed exercise or therapy regimens may also demonstrate a form of limb protection in the postoperative period that nullifies the benefits of the theoretical increased limb use due to dominance, causing them to avoid using that limb or use their nondominant limb more often for completion of daily activities. Quantification of dominant and nondominant limb use pre- and postoperatively may allow for further elucidation of this relationship. This potential barrier could be overcome with interventions such as preoperative counseling and education, preoperative and postoperative physical therapy sessions, and prescribed exercise or weight-training protocols, as described in previous literature.

Our study was inherently limited due to its retrospective nature and single-institution access, leading to a limited number of included patients. Due to the available records, our study had approximately 32% power to detect the observed effect size at a significance level of 0.05, resulting in an increased risk of type II error due to limited power. Additionally, HD was largely self-reported, introducing subjectivity and definitive ambiguity. Lastly, as previously mentioned, regardless of handedness, patients may inherently restrict postoperative use of the limb on the surgical side due to pain or discomfort. In this study, we were unable to

quantify extremity use pre- and postoperatively. As a result, our methodology and analysis relied on the assumption that patients typically use their dominant limb more frequently than their nondominant limb. Future studies with larger sample size and control of potential confounding factors would be valuable to further investigate the role of handedness on the development of BCRL.

CONCLUSIONS

Current research and innovation continue to target preventative or early treatment approaches to avoid or alleviate the burden of BCRL. This is the first study to examine the role of handedness in developing BCRL. After mastectomy, a greater proportion of patients with contralateral HD and BC laterality developed lymphedema, although this was not statistically significant. This trend was also noted among those who underwent ALND. An increased number of lymph nodes removed and the receipt of adjuvant RT were identified as independent risk factors for developing BCRL, supporting existing literature. Further studies are warranted with larger sample size, multi-institutional collaboration, and quantification of extremity use, as this area represents a potential opportunity for improved patient counseling and prophylactic interventions in the setting of BCRL.

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DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

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