Evaluation of Response to Treatment in Breast Cancer-related Lymphedema

EZGİ YILDIZ GÜVERCİN (✉ mdezgiyildiz@gmail.com)

Ege University Faculty of Medicine: Ege Üniversitesi Tıp Fakültesi <https://orcid.org/0000-0001-5543-4541>

Sibel EYİGÖR

Ege University Faculty of Medicine: Ege Üniversitesi Tıp Fakültesi

Göksel Tanigor

Ege University Faculty of Medicine: Ege Üniversitesi Tıp Fakültesi

Menekşe İnbat

Ege University Faculty of Medicine: Ege Üniversitesi Tıp Fakültesi

Sedef Kabayel

Ege University Faculty of Medicine: Ege Üniversitesi Tıp Fakültesi

Research Article

Keywords: Lymphedema, breast cancer, rehabilitation

Posted Date: November 9th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-686706/v1>

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Abstract

Objective

The aim of this study was to assess and compare the response to the BCRL treatment with CLUE scores, bioimpedance spectroscopy and the volume-assessments /measurements. A secondary aim of the study was to show whether CLUE has a place in the treatment response, and its correlation with the other measures of lymphedema.

Design

The design of our study is a retrospective study.

Setting

A rehabilitation center.

Participants

A total of 40 patients were included in the study. Mean age and the body mass indices of the patients weres 57.8 ± 12.46 , and 30.99 ± 4.69 , respectively. Ninety-five percent of the patient were right handed, and the prevalence of the right arm lymphedema was 50%.

Interventions

Not applicable.

Main Outcome Measures

Assessment of the upper-extremity volumes, CLUE (Breast Cancer-Related Lymphedema of the Upper Extremity) score, functional assessment of the upper extremities, bioimpedance Spectroscopy, hand-grip strength.

Results

Correlation analyses showed that CLUE total score and BIS values were correlated with the reduction in the volumes ($p=0.04$ and $p<0.001$, respectively). Moreover, CLUE total score was also found to be positively correlated with the BIS values ($p<0.001$). Hand grip strength and QuickDASH scores were not found to be correlated with the changes in the volume ($p=0.475$ and $p=0.210$, respectively) and CLUE total scores ($p=0.21$ and $p=0.57$, respectively).

Conclusions

In conclusion, development of a structured clinical assessment like CLUE provides clinicians a standardized evaluation for BCRL. For the novel studies aiming to assess treatment responses to patients

with BCRL, use of CLUE and BIS alongside with routinely used volumetric methods are encouraged.

Introduction

Breast cancer is the most common type of cancer among women [1]. Increased survival rates due to screening and early treatment results in functional impairments and disabilities after survival rather than the death, with long-term complications of the disease and the treatment becoming more and more common [2],[3].

Breast cancer related lymphedema (BCRL) is one of the most common problems in the course of the treatment. Having an incidence of 5–42%, BCRL has devastating effects on the quality of life and the healthcare costs in patients with breast cancer [4]. After the treatment for malignancy, lymphatic system may have dysfunctions resulting in excess protein-rich fluid in interstitial compartment, which is manifested as lymphedema.

There are many methods for the diagnosis of lymphedema, including circumferential measurements, water displacement method volumetry, perometry, bioimpedance spectroscopy, tonometry, lymphography, lymphoscintigraphy and magnetic resonance imaging[5]. Although there is not a consensus about the preference for the methods, volume related methods (Circumferential measurements, water displacement method volumetry, perometry) are usually preferred over other methods, while bioimpedance spectroscopy becoming more common for the earlier diagnosis for the BCRL[6, 7].

CLUE (Breast Cancer-Related Lymphedema of the Upper Extremity) is a tool that was developed by Spinelli et al to assess the presence and severity of the lymphedema in these patients[8]. Having both objective and subjective measures, CLUE scores are shown to be a valid and reliable scale to assess BCRL.

While there are many therapeutic approaches in the management of BCRL, the gold standard method is considered the complete decongestive therapy[9]. The lack of a consensus is also valid for the measures of follow-up in the course of the therapy, with volume related methods preferred more often, like the diagnostic measures[10]. Use of bioimpedance spectroscopy and CLUE scores also require more evidence for justification of their use in evaluating the effectiveness of the therapy [8].

The aim of this study was to assess and compare the response to the BCRL treatment with CLUE scores, bioimpedance spectroscopy and the volume-assessments /measurements. A secondary aim of the study was to show whether CLUE has a place in the treatment response, and its correlation with the other measures of lymphedema.

Material And Methods

Participants:

Sixty-two patients who were admitted to the lymphedema diagnosis and treatment clinic with BCRL were invited to take place in this study. Inclusion criteria were being older than 18 years and the presence of unilateral lymphedema in the affected upper extremity after mastectomy for breast cancer. Exclusion criteria were the presence of bilateral lymphedema, primary bone tumours or bone metastasis, circulatory problems of the upper extremities (peripheral vascular disease, thrombosis etc), elephantiasis, local infections involving upper extremities or systemic infections, lymphangitis carcinomatosa, congestive heart failure, ongoing radiotherapy, having a history of prosthetics for the upper extremities and the present use of medications which could affect fluids or electrodes, such as diuretics. After the application of these criteria, 40 patients were eventually included in this study.

This study was approved by ethics committee of the institution, and all patients were obtained informed consent before their inclusion in the study.

Outcome Measures:

After medical histories of the patients were taken, a detailed physical examination by a physician was performed. Details of the cancer therapy history were recorded, as well as the findings obtained in the physical examination. Diagnosis of lymphedema was confirmed by a physician specialized in this area. Joint range of motion and manual muscle tests were also measured for the patients' upper extremities.

Assessment of the upper-extremity volumes: Bilateral upper-extremity volumes were assessed using circumferential measures according to the frustum model, with measurements being taken at 5 cm intervals, starting from 1st to 5th metacarpal joints' level and ascending upwards[11]. Clinically significant lymphedema was defined as the 10% difference between extremity volumes, and patients were followed-up weekly with the measurements, with the final assessment being after the therapy[10].

CLUE (Breast Cancer-Related Lymphedema of the Upper Extremity) score: Patients were evaluated with CLUE score before and after the therapy. Consisting of four domains defined as obscuration of anatomical architecture (0–18 points), deviation from normal anatomical architecture (0–18 points), tissue score (0–18 points), edema score (0–18 points), this tool was designed by Spinelli et al in 2019 to assess the presence and the severity of the upper extremity lymphedema in patients with breast cancer-related lymphedema in three areas: Hands and fingers, wrists and forearms, from elbows to shoulders[8]. This tool was applied to the patients by a qualified physician in lymphedema, and former scores of the patients were blinded to the evaluator when applying the tool after the therapy.

Functional assessment of the upper extremities: Upper extremity functions were assessed using The Disabilities of the Arm, Shoulder and Hand Score (QuickDASH). QuickDASH includes 19 questions regarding the functional use of the affected upper extremities. Each question has a score of 0 to 5, with higher scores indicating worse functional state. QuickDASH was shown to be valid and reliable to assess the functional use of the upper extremity, by Duger et al[12].

Bioimpedance Spectroscopy: Before and after the therapy, a lymphedema index was measured using a bioimpedance spectroscopy device, L-Dex U400 (Impedimed, Brisbane-Australia). Using electricity below

the sensory thresholds of the patients, this device detects the changes in the interstitial fluid and produces a lymphedema index score. Indices higher than 10 are considered pathologic, indicating the presence of lymphedema. Patients were instructed about the measurement in detail, and were told to get adequate hydration, and avoid liquids that may have diuretic effects, such as tea or coffee, in order to preserve their normal balance of electrolytes before the measurements. Reliability and validity of the bioimpedance spectroscopy methods was shown by Avila et al [13].

Hand-grip strength: Hand-grip strength was measured using a JAMAR hand dynamometer. Measurements were obtained with patients standing up, with their arms adducted in a neutral position, and elbow positioned in a 90 degree angle. This measurement was performed 3 times consecutively, and the mean of their values were recorded as kgf. Hand-grip strength measurements by JAMAR dynamometers were shown to be valid and reliable in a study performed by Shechtman et al [14].

Complete Decongestive Therapy (CDT):

All patients were included in the complete decongestive therapy program. This therapy includes patient education, skin care, exercises, manual lymphatic drainage (self), and compression bandage therapy. After this intensive phase of the therapy, maintenance phase, which includes the preservation of the gains through the use of stockings and maintaining the exercises and manual lymphatic drainage, begins. This study encompasses only the intensive phase of the complete decongestive therapy.

Patients were informed about skin care and protective approach for lymphedema. They were asked to hydrate adequately and control their weight [15]. A booklet containing the information above alongside with exercises and frequently asked questions were also given to all patients, and the things they would have to do were told in each visit.

All patients were prescribed lymphedema specific exercises involving muscle contractions on the upper extremity joints while taking complete decongestive therapy, 30 minutes each day. They were specifically informed that exercise does not aggravate the severity of their lymphedema. A daily self-applied manual lymphatic drainage technique which helps the drainage of the lymphatic fluid through anatomical pathways was also instructed [16].

Multilayer short stretch bandages were applied to the patients with self manual lymphatic drainage. Intensive phase was given 5 days a week, and short stretch bandages applied for 23 hours a day with 1 hour interval. To increase the local pressure on the areas required, foams were added. Patients were screened with arm circumferential measurements once a week and after gaining a plateau in the volumes, patients were prescribed compression garments. All of the patients completed the therapy without any adverse events observed.

Statistical Analysis

Statistical analyses of the data was conducted using SPSS (Statistical Package for the Social Sciences) version 22 (IBM Corporation). Descriptive statistics were used to evaluate demographic and clinical data.

To assess whether the data were compatible with normal distribution, Shapiro-Wilk test was used. Variables were expressed either as median (minimum-maximum) or mean $\pm$ (standard deviation) for numeric data, and number(%) for categorical data. Dependent variables compatible with normal distribution was tested using t tests for dependent variables, and for the ones with non normal distribution, Wilcoxon's signed rank test was used. Spearman's correlation test was used to assess the correlation between variables. Statistical significance was set as $p < 0.05$.

Results

A total of 40 patients were included in the analyses. Mean age and the body mass indices of the patients weres 57.8 ± 12.46 , and 30.99 ± 4.69 , respectively. 95% of the patient were right handed, and the prevalence of the right arm lymphedema was 50%. Demographic and clinical characteristics of the patients are presented in Table 1.

Table 1
Demographical and clinical properties of the patients

Variables	n
Age(Mean $\pm$ SD)	57.8 $\pm$ 12.46
Height (Mean $\pm$ SD)(cm)	157.8 $\pm$ 11.65
Weight (Mean $\pm$ SD)(kg)	80 $\pm$ 17,007
BMI (Mean $\pm$ SD)	30.99 $\pm$ 4.69
Gender	
Female (n,%)	38 (%95)
Male (n,%)	2 (%5)
Marital status	
Married (n,%)	34 (%85)
Widowed (n,%)	6 (%15)
Single (n,%)	0 (%0)
Educational status	
Illiterate (n,%)	3 (%7.5)
Elementary or middle school (n,%)	25 (%62.5)
High school (n,%)	7 (%17.5)
University or higher (n,%)	5 (%12.5)
Occupation	
Housewife (n,%)	29 (%72.5)
Retired (n,%)	7 (%17.5)
Office worker (n,%)	2 (%5)
Other (n,%)	2 (%5)
Dominant hand	
Right (n,%)	38 (%95)
Left (n,%)	2 (%5)

DC: Ductal carcinoma, LC: lobuler carcinoma, TM: Total mastectomy, PM: Partial mastectomy, AD: Axillary dissection, BMI: Body- mass index

Variables	n
Limb with Lymphedema	
Right (n,%)	20 (%50)
Left (n,%)	20 (%50)
Cancer type	
DC (n,%)	35 (%87,5)
LC (n,%)	5 (%12.5)
Type of surgery	
TM + AD (n,%)	25 (%62.5)
PM + AD (n,%)	11 (%27.5)
Lobectomy (n,%)	4 (%10)
Lymphangitis attack-Yes (n,%)	5 (%12.5)
Chemotherapy-Yes (n,%)	38 (%95)
Radiotherapy-Yes (n,%)	35 (%87.5)
The number of chemotherapy sessions (Mean $\pm$ SD)	8.75 $\pm$ 5.05
The number of radiotherapy sessions (Mean $\pm$ SD)	22.72 $\pm$ 10.31
Post-op duration (Mean $\pm$ SD)(month)	82.25 $\pm$ 60.5
Post-op weight gain (Mean $\pm$ SD)(kg)	5.35 $\pm$ 4.87
Lymphedema duration (Mean $\pm$ SD)(month)	61.27 $\pm$ 59.24
The number of excised lymph nodes (Mean $\pm$ SD)	15.65 $\pm$ 6.85
The number of pathological lymph nodes (Mean $\pm$ SD)	5.75 $\pm$ 6.35
DC: Ductal carcinoma, LC: lobular carcinoma, TM: Total mastectomy, PM: Partial mastectomy, AD: Axillary dissection, BMI: Body- mass index	

Comparisons of the outcomes before and after CDT showed improvements in volumes (14.43% reduction), bioimpedance spectroscopy values (BIS) (46.25% reduction) and CLUE scores (31.77% reduction in total score), including CLUE total, anatomic, edema, and tissue subscores in the extremities with lymphedema ($p < 0.05$). Changes in hand-grip strength (3.59% reduction) and QuickDASH scores (1.35% reduction) were not found to be statistically significant before and after the therapy ($p > 0.05$).

Correlation analyses showed that CLUE total score and BIS values were correlated with the reduction in the volumes ($p = 0.04$ and $p < 0.001$, respectively). Moreover, CLUE total score was also found to be

positively correlated with the BIS values ($p < 0.001$). Hand grip strength and QuickDASH scores were not found to be correlated with the changes in the volume ($p = 0.475$ and $p = 0.210$, respectively) and CLUE total scores ($p = 0.21$ and $p = 0.57$, respectively)(Table 2)

Table 2
Changes before and after the treatment

	Pre-treatment	Post-treatment	p	%
Volume Measurement (extremity with lymphedema)	3840.5±820.3	3285.95±560.11	<0.001	14.43
BIS value	54.85±31.88	29.48±15.51	<0.001	46.25
Hand Grip Strength	18.34±5.64	17.68±5.47	0.177	3.59
Quick DASH score	39.03±18.67	38.5±17.86	0.572	1.35
CLUE				
Total	37.45±17.36	25.6±14.56	<0.001	31.77
Anatomic Score	20.95±11.79	13.87±7.91	<0.001	33.79
Tissue Score	7.25±4.06	4.6±3.92	<0.001	36.55
Edema Score	8.85±4.23	6.75±4.38	0.001	23.72
%: Difference before and after the treatment in percentage				

Discussion

Results of this study indicates that a complete decongestive therapy is an efficient management method for the patients with breast cancer-related lymphedema. Moreover, the improvements also accompany changes in CLUE scores and BIS values, shown in both comparisons and correlation analyses. Conversely, hand-grip strengths and QuickDASH scores do not show these changes.

Assessment of lymphedema with standardized measures is a critical issue for both clinical and academical purposes. Therefore, Spinelli et al have proposed a new method to assess BCRL of the upper extremity[8]. Although this scoring system (CLUE) is based on a physical examination, the main difference is CLUE's being structurized and having scores that require to be recorded for each area of the affected extremity, as well as the characteristic findings of lymphedema. Common clinical practice usually involves the recording of positive findings for BCRL, which is subjective for each observer in severity. We aimed to compare this novel standardized tool for lymphedema with volumetric changes, BIS, hand grip strength and disability related to upper extremity (QuickDASH). Our another goal was to test CLUE's potential to be used in evaluating the treatment response. The only use of the CLUE in evaluating the treatment response was in a study conducted by Schmitz et al, which evaluated the effects of the exercise or weight loss in patients with BCRL[17]. All of the groups except controls were found to

benefit from these interventions in their outcome measures without any differences in their interventions, including CLUE. Still, the study had a longer follow-up interval of 12 months, and use of CLUE in a short-term, more intensive form of therapy alongside with BIS is an important contribution to the literature. We have found that a 31.77% reduction in CLUE scores was present with the complete decongestive therapy. Moreover, these changes were found to be correlated with the volume reductions and BIS values.

Volumetric measurements are used in follow-ups of BCRL extensively, both in clinical practice and studies. They were found to be useful for follow-ups in a study evaluating the effects of complete decongestive therapy on quality of life, depression, neuropathic pain and fatigue in patients with BCRL[18]. Our study also showed reductions in volumes (14.43%), which was found to be statistically significant.

BIS values of the patients showed improvements after the therapy, which were found to be statistically significant. The value of BIS for treatment response is still is not clearly defined in the literature, making this study the first one to use BIS for this purpose. Stout et al proposed BIS as a method to assess subclinical lymphedema [7]. Shortly after its introduction to lymphedema assessment methods, BIS has been in use to assess subclinical lymphedema. Ward et al showed that BIS was a more sensitive indicator of lymphedema when compared to volumetric methods [13]. Improvements in BIS scores and positive correlations found between BIS and volumetric changes as well as CLUE scores also indicate that BIS can be helpful for the assessing treatment response and following up BCRL patients.

Although QuickDASH scores were found to be improved after the therapy, these changes were not found to be statistically significant. Gencay et al used QuickDASH in a study evaluating the effects of kinesiotaping on BCRL patients, and it was found not to be significantly improved either[19]. QuickDASH is a patient reported measure of upper extremity functions and effects of the disabilities on activities of daily life, and it was applied to the patients right after the therapy. Complete decongestive therapy involves bandaging, immobilization, and problems related to these practices, such as pain and joint restrictions. Application of QuickDASH right after the therapy may have resulted in patients' being unable to realize the positive changes the volume reduction that may provide, and focus on the negative aspects of this therapy involving restriction of the affected extremity instead.

Hand-grip strength is a commonly used parameter in the studies involving lymphedema. Johansson et al used hand-grip strength in a study for upper extremity lymphedema treatment [20]. Similarly, O'Neill et al showed that complete decongestive therapy improves hand-grip strength in patients with upper extremity lymphedema[18]. However, a recent study by Baklaci et al showed that hand-grip strengths may also decrease throughout the CDT, while not being statistically significant[21]. Similarly, our study has shown a 3.5% decrease in the hand-grip strength, which is statistically insignificant. As a result of the relative immobilization as a part of the intervention, this finding underlines the importance of preserving strength in this group of patients through strengthening exercises. Although the patients were given remedial exercises, resistance exercises were not a part of the interventions in this intensive phase of the complete

decongestive therapy. Since there is no data regarding this issue in the current literature, this may prove to be very important for the clinical practice.

Strengths and limitations:

This is the first study that uses both CLUE score and BIS for the follow-up of the complete decongestive therapy for BCRL. It also has volumetric measurements, hand-grip strength and functional status of the upper extremity outcome measures, which provides multi-dimensional assessment of the therapy. Detection of a correlation between CLUE scores and volumetric changes as well as the changes in BIS values strengthens the value of CLUE for the clinical practice.

The main limitation of the study was the limited number of patients. A higher number of patients could have given a more precise result with the statistical analyses. Moreover, this study was conducted in a single center. Although inter-rater variability of CLUE were shown to be excellent [8], multi-centric studies would give a better idea for the use of the measures in this study for the routine clinical practice.

Conclusion

In conclusion, development of a structured clinical assessment like CLUE provides clinicians a standardized evaluation for BCRL. For the novel studies aiming to assess treatment responses to patients with BCRL, use of CLUE and BIS alongside with routinely used volumetric methods are encouraged.

Abbreviations

DC: Ductal carcinoma, LC: lobular carcinoma, TM: Total mastectomy, PM: Partial mastectomy, AD: Axillary dissection, BMI: Body-mass index, BCRL: Breast cancer related lymphedema, CLUE: Breast Cancer-Related Lymphedema of the Upper Extremity.

Declarations

Funding:

No funding was received.

Conflicts of interest/Competing interests:

The authors declare that they have no conflict of interest.

Availability of data and material:

Data is available and transparent

Code availability:

N/A

Authors' contributions:

All authors took part in data acquisition, data analysis, and article writing.

Ethics approval:

The study protocol was approved by the ethics committee of Ege University Medical School (31.07.2019-19-7T/53)

Consent to participate:

Informed consent was obtained from all individual participants included in the study.

Consent for publication:

Consent for publication has been obtained.

References

1. Salonen, P., et al., The quality of life and social support in significant others of patients with breast cancer - a longitudinal study. *European Journal of Cancer Care*, 2013. 23(2): p. 274-283.
2. Paiva, D.M.F., et al., Prevalence of lymphedema in women undergoing treatment for breast cancer in a referral center in southeastern Brazil. *BMC Women's Health*, 2013. 13(1).
3. Gillespie, T.C., et al., Breast cancer-related lymphedema: risk factors, precautionary measures, and treatments. *Gland Surgery*, 2018. 7(4): p. 379-403.
4. Ozaslan, C. and B. Kuru, Lymphedema after treatment of breast cancer. *The American Journal of Surgery*, 2004. 187(1): p. 69-72.
5. International society of lymphology, 10th international congress of lymphology. *Veterinary Immunology and Immunopathology*, 1985. 9(1): p. 103.
6. Reichart, K., Lymphedema: Improving Screening and Treatment Among At-Risk Breast Cancer Survivors. *Clinical Journal of Oncology Nursing*, 2017. 21(1): p. 21-25.
7. Stout Gergich, N.L., et al., Preoperative assessment enables the early diagnosis and successful treatment of lymphedema. *Cancer*, 2008. 112(12): p. 2809-2819.
8. Spinelli, B., et al., Intra- and Interrater Reliability and Concurrent Validity of a New Tool for Assessment of Breast Cancer–Related Lymphedema of the Upper Extremity. *Archives of Physical Medicine and Rehabilitation*, 2019. 100(2): p. 315-326.
9. Forner-Cordero, I., et al., Predictive Factors of Response to Decongestive Therapy in Patients with Breast-Cancer-Related Lymphedema. *Annals of Surgical Oncology*, 2009. 17(3): p. 744-751.

10. Hayes, S., et al., Prevalence and Prognostic Significance of Secondary Lymphedema Following Breast Cancer. *Lymphatic Research and Biology*, 2011. 9(3): p. 135-141.
11. Liao, S.-F., et al., The efficacy of complex decongestive physiotherapy (CDP) and predictive factors of lymphedema severity and response to CDP in breast cancer-related lymphedema (BCRL). *The Breast*, 2013. 22(5): p. 703-706.
12. Yakut, E., et al., Validation of the Turkish Version of the Oswestry Disability Index for Patients With Low Back Pain. *Spine*, 2004. 29(5): p. 581-585.
13. Avila, M.L., et al., Normal Values for Segmental Bioimpedance Spectroscopy in Pediatric Patients. *PLOS ONE*, 2015. 10(4): p. e0126268.
14. Shechtman, O., L. Gestewitz, and C. Kimble, Reliability and Validity of the DynEx Dynamometer. *Journal of Hand Therapy*, 2005. 18(3): p. 339-347.
15. Lanza, M., et al., Quality of Life and Volume Reduction in Women with Secondary Lymphoedema Related to Breast Cancer. *International Journal of Breast Cancer*, 2015. 2015: p. 1-6.
16. Damstra, R.J., et al., Lymphatic venous anastomosis (LVA) for treatment of secondary arm lymphedema. A prospective study of 11 LVA procedures in 10 patients with breast cancer related lymphedema and a critical review of the literature. *Breast Cancer Research and Treatment*, 2008. 113(2): p. 199-206.
17. Schmitz, K.H., et al., Effect of Home-Based Exercise and Weight Loss Programs on Breast Cancer–Related Lymphedema Outcomes Among Overweight Breast Cancer Survivors. *JAMA Oncology*, 2019. 5(11): p. 1605.
18. O'Neill, J. and J. Beatus, The Effects of Complete Decongestive Physical Therapy Treatment On Edema Reduction, Quality of Life, and Functional Ability of Persons with Upper Extremity Lymphedema. *Journal of Women's Health Physical Therapy*, 2006. 30(1): p. 5-10.
19. Gencay Can, A., Is kinesiphobia associated with lymphedema, upper extremity function, and psychological morbidity in breast cancer survivors? *Turkish Journal of Physical Medicine and Rehabilitation*, 2019. 65(2): p. 139-146.
20. Ozkan Gurdal, S., et al., Abstract P5-15-04: A Randomized Trial Comparing Intermittent Pneumatic Compression with Manual Lymphatic Drainage for Treatment of Lymphedema in Patients with Breast Cancer, in Poster Session Abstracts. 2010, American Association for Cancer Research.
21. Baklaci, M., Eyigör, S., Tanıgör, G., İnbat, M.Ö., Kabayel, S. Ç. Assessment of Muscle Strength and Volume Changes in Patients with Breast Cancer-Related Lymphedema. *Oncology Research and Treatment*, 2020. 43(11): p. 584-591.