Published in final edited form as:
J Womens Health Phys Therap. 2014 September ; 38(3): 118–124. doi:10.1097/JWH.0000000000000020.

Shoulder impairment before breast cancer surgery

Ann Marie Flores, PT, PhD, CLT[1] and **Kathleen Dwyer, PhD, RN**[2]

Ann Marie Flores: am.flores@neu.edu

[1]Department of Physical Therapy, Rehabilitation and Movement Sciences, Center for Cancer Survivorship Studies, Northeastern University, Boston, MA

[2]College of Nursing, The University of Oklahoma Health Sciences Center, Oklahoma City, OK 73117

Abstract

Objective—To compare pre- and post-operative shoulder active range of motion (AROM) values from female breast cancer survivors to population norm values for shoulder AROM; and to compare shoulder AROM differences pre- and post-surgery between female African American and White breast cancer survivors (BCA).

Study design—This pilot study used a convenience sample and longitudinal design measuring participants 2 times (T0 = baseline, after biopsy but within 2 weeks before BCA surgery; T1 = 2nd postoperative week).

Background—The U.S. has the largest BCA survivor population in history and yet the mortality burden remains highest among AA BCA survivors. AAs may also have greater burden of physical and functional side effects compared to whites and the general population.

Methods and Measures—The data were collected from a convenience sample (n = 33; n_{AA} = 9, n_W = 24) and included data on shoulder AROM, medical chart review for pre- and co-morbid conditions, and self-reported demographics and medical history. We used t-tests to compare sample AROM means to population norms. We then compared our sample across 2 timepoints (T0 = pre-surgery; T1 = 2 weeks post-surgery) using independent samples t-tests and repeated measures analysis of variance ($p < .05$) to compare AA to White sub-samples AROM means.

Results—African Americans had significantly less shoulder abduction (at T0) and flexion (at T1) than whites. However, 100% had significantly reduced AROM for all movements at T0 (prior to surgery but after biopsy) when compared to population norms.

Conclusions—The significant reduction in shoulder AROM after biopsy but before surgery points to a possible unmet need for early physical therapy intervention. Further research using randomized controlled trial design is recommended.

Keywords

breast cancer; physical therapy; shoulder range of motion; cancer survivorship

INTRODUCTION

Females with breast cancer (BCA) constitute 22% of the 13.7 million U.S. cancer survivors and 41% of female cancer survivors[1] More people are living with side effects of cancer and its treatment than ever before, with 4.1 million in 2007[2] which is expected to exceed 18 million by 2020.[3]

While we know a great deal about incidence, prevalence and mortality of breast cancer, we know very little about the BCA survivorship experience in terms of physical impairments prior to curative treatment and survivorship experiences of minorities. The literature on BCA survivorship is largely confined to those who are at least a year after completion of acute treatment (e.g. surgery, radiation, chemotherapy).[2,4,5]

Women who have had BCA surgery, especially those with mastectomy followed by radiation and chemotherapy[16], report impaired joint range of motion, fatigue, pain, and alteration in activities of daily living and self-perceived function.[4–17] Few studies include minority women and none have examined physical impairment for minorities between the time of diagnostic biopsy and surgery.[18–21] AROM generally decreases after BCA surgery, especially status-post mastectomy with or without reconstruction.[18–22] Continued impairment without intervention can interfere with function to the point of disability.[23] Twenty percent of BCA survivors report some sort of physical limitation and many ranked this as a number one concern.[18] Among those with axillary dissection, at least 12% reported a significant loss of range of motion and half reported pain and/or loss of strength regardless of type of surgery (breast conservation or mastectomy) and time since surgery.[22] Cancer treatment-related surgical resection of muscle, lymph nodes and nerves; pain, lymphedema,[6–11,14,22,24] fatigue and weight gain or loss are also important factors moderating the extent of ROM loss.[17,25] Radiation desquamation, tissue fibrosis, axillary web syndrome, and chest wall adhesions also limit range of motion.[7,26] In the case of mastectomy, the breast is removed and, often, a small amount of muscle tissue is removed to obtain disease-free surgical margins.[4,21,27] Natural tissue reconstructive surgeries involve muscle relocation from a breast mound leaving a shoulder girdle muscle imbalance.[28] Sentinel lymph node biopsy may be followed by additional dissection and be just as invasive as an axillary dissection.[12,14,29,30] This too contributes to altered shoulder mechanics and lymph drainage.[12–14,31–33] Reliance on large muscles (lattisimus dorsi, trapezius) place considerable torque on the shoulder leading to bursitis, tendonitis, adhesive capsulitis, or premature osteoarthritic changes all of which can reduce ROM.[27,34] Compensation by smaller muscles (teres major and minor, supraspinatus, infraspinatus, subscapularis, rhomboideous major and minor muscles, and the serratus anterior)[35] can also create a situation of overuse, muscle fatigue and spasm. This can be compounded by poor posture and pain creating a vicious cycle of limited movement, pain and reductions in strength due to disuse.[7]

The time between BCA biopsy and pathology results is anxiety provoking but also presumed to be free of cancer-related physical impairment. However, this may also be a time when a reduction in AROM occurs because of guarding of the biopsy site and biopsy- related pain, albeit less invasive than surgery. In support of, and extending previous work, it was

hypothesized that not only is shoulder ROM reduced on the involved side after surgery, but that it may also be reduced even *prior to* surgery as compared to normal population values. While post-surgical AROM limitation is clearly linked to surgical intervention and recovery, no evidence exists to support or refute whether limitation in AROM is detected prior to surgery in otherwise healthy individuals without a medical history of pathology that could affect shoulder range of motion (e.g.: diabetic shoulder).

In addition to the possibility of early presentation of AROM reduction, few studies of minority BCA survivors consider differences in physical impairment as most studies focused on incidence, prevalence and mortality.[19,20,37–39] Minorities and the poor and medically underserved experience cancer disparities.[40–50] However, cancer survivorship disparities is a new area of research.[20,51,52] Biomechanical and structural changes (e.g. range of motion, strength, removal or re-attachment of muscle, transection of motor or sensory nerves and lymphedema) are not described or cited as possible underlying causes of physical limitations or disability in the BCA survivorship literature.

With the exception of a small handful of studies[18,19,20,53] there is a dearth of published research examining disparities in function and ROM after cancer. AA BCA survivors report lower physical functioning than whites using self-report measures.[53] Long-term self-reported function is worse in those who have had mastectomy and combined chemotherapy and radiation persisting 5 years after diagnosis.[18] With few exceptions[19,20] self-report measures are used to represent AROM. It can be argued that disparities related to BCA incidence, prevalence and mortality may also place minorities at greater risk for developing disability. No studies have examined the combination of range of motion prior *to* curative treatment and disparities in physical impairment. The aim of this investigation was to fill that gap and this study was the first to examine this possibility. The objectives of this pilot study were to compare 1) pre- and post-operative shoulder AROM values from female BCA survivors to population norm values for shoulder AROM; 2) shoulder AROM differences pre- and post-surgery between female AA and white BCA survivors.

METHODS & MEASURES

This pilot study utilized a prospective, repeated measures design comparing data from a convenience sample of women with BCA. Each participant reviewed and signed an Institutional Review Board approved informed consent document. Three study staff members (the PI and 2 research assistants trained on the protocol) collected all data for the study. The participants completed a survey of sociodemographic characteristics and relevant medical history information. Medical history information obtained from the survey was verified using information from the participant's medical chart. Participants agreed to be measured for AROM one to two weeks prior to surgery (coinciding with the pre-operative testing appointment) and again approximately two to three weeks after surgery to ensure removal of surgical drains for those participants who were status-post mastectomy. Active range of motion was measured with a two-armed twelve-inch goniometer according to the guidelines described by Norkin and White.[35] Specifically, all measurements were taken in the supine position, except for shoulder extension which was measured in a supported, seated position with normal postural alignment. Normal population values for each range of

motion were used to compare our sample data to the population. The population data were derived from the American Academy of Orthopaedic Surgeons.[54] For shoulder flexion, the normal range for flexion was 180 degrees, and the normal ranges for extension, abduction internal rotation and external rotation were 60, 70, 70 and 90 degrees, respectively. Inter- and intra-rater reliability were tested for all study staff on normals prior to the study using the same protocol procedure (each motion measured 3 times and then averaged). The ICCs for each motion were high (ICC=.90) for all study staff.

Participants had their active range of motion measured for shoulder flexion, extension, abduction, internal and external rotation and were instructed to move only in the pain free range. All motions were first demonstrated by trained study staff. The participants were asked to move the involved and uninvolved shoulder in each range three times. The measures for each range were then averaged for each measurement time on the involved side.

To evaluate the first objective, a t-test was conducted comparing sample means prior to BCA surgery to normal population values for each range of motion ($p<.05$) at T0 and T1. To address the second objective, the differences between T0 (prior to surgery) to T1 (two – three weeks after surgery) were compared to the entire sample using one-tailed independent t-tests ($p < .05$). Next, the differences between AA and white BCA survivors between T0 and T1 were evaluated using a repeated measures ANOVA. Since only two groups were compared, post-hoc testing was not pursued. All analyses were performed with SPSS version 17.0 (SPSS Inc. Chicago, IL).

RESULTS

All participants had T0 measures taken within 2 weeks of their scheduled breast cancer surgery and most (95%) were measured 1 week prior to surgery. All T0 measures coincided with pre-operative testing appointments. All but 1 participant had T1 measures taken within 2 weeks. This participant had her drains removed at post-operative week 2.5.

Descriptive characteristics

Table 1 presents the descriptive characteristics for the sample. Thirty-three BCA survivors participated in the study (24 White; 9 AA). On average, participants were 55 years old with at least one year of college. Fifty percent of the overall sample reported annual household incomes of $50k or more per year. Five participants (15%) reported annual household income of less than ten thousand dollars. Of these five participants with annual household incomes of less than $15k, 60 percent were African American. The opposite was true for Whites in that 66 percent of these participants reported annual household incomes of at least $35k.

Two thirds had breast conservation (lumpectomy) surgery. Fourteen percent of the total sample did not know what type of surgery they had. Twenty two percent of the African American sub-sample could not name and did not know what type of surgery they had. This percentage was smaller for Whites (8.3%).

Range of Motion – Overall Sample

Table 2 compares sample averages to population norms for shoulder range of motion. With the exception of shoulder extension and internal rotation prior to surgery, all participants had shoulder ranges of motion that were statistically significantly lower than the population norms after diagnostic biopsy, but before surgical intervention. One participant had a history of a partial rotator cuff tear contralateral to the breast cancer site. When this participant's data were excluded from the analyses, the results were no different than when the data were included.

As expected, all involved shoulder ranges of motion were statistically significantly reduced compared to normal population values at T1. The uninvolved side did not significantly differ from population norms.

Range of Motion Disparities

Table 3 shows that AAs had significantly reduced active shoulder abduction on the involved side prior to surgery compared to Whites (120 versus 161 degrees, a 41 degree difference between the groups [$p < .05$; one tailed test]). In order to receive radiation treatment, 120 degrees of range of motion is required for axillary radiation.[35] At T1 (2 weeks after surgery) every participant experienced reduced shoulder abduction. However, AA particpants had significantly reduced shoulder flexion when compared to Whites (90 versus 110 degrees). In no case did the White sub sample have a significantly lower range of motion than AAs for any of the shoulder movements prior to or after surgery.

DISCUSSION

All participants in this pilot study demonstrated active shoulder range of motion limitations (flexion, abduction, and external rotation) that were significantly lower than normal population values, despite the fact that none of the participants had any significant co-morbidities that may be associated with shoulder impairment. This difference was greatest for the African American participants. These findings hold important implications for clinical practice and identification of the candidates for physical therapy. McNeely[55] and Shamley et al[56] showed support for delayed exercise interventions after BCA surgery to reduce the risk of seroma formation, improve mood, and anxiety, yet none of these studies looked at dysfunction prior to surgery. Silver suggested that rehabilitation for breast cancer survivors has a great deal to offer in terms of improving strengthening, cardiac endurance, pain and fatigue that has been shown to occur due to cancer treatment.[29] Additional research shows that exercise, including resistance exercise, is critical to the management of lymphedema.[17,57] These pilot data suggest early and significant shoulder impairment may be present after biopsy and before surgery for curative intent. Early intervention/prospective surveillance of lymphedema beginning with pre-operative surgical pathways has been shown to be an effective and cost-savings approach.[58] The findings of this investigation provide further support to the prospective surveillance approach.

This pilot study is particularly timely because the effects of exercise prior to curative treatment have not yet been studied despite evidence that exercise has preventive effects on

first time cancer diagnosis and recurrence.[42,59,60] Exercise has also been shown to be associated with improved quality of life for up to 10 years after treatment.[61] Exercise has also been shown to decrease fatigue, and improve cardiovascular endurance, physical function,[16,55,62–65] and symptom management.[66] Currently, none of the exercise protocols rigorously tested with RCTs have been translated into the standard of care.[67–70] Early identification of shoulder impairment may be an even more critical issue for AA BCA survivors. Satariano and colleagues have already shown that AA BCA survivors report more functional limitation and impaired self-reported shoulder range of motion than Whites.[19–20] The present study used precise clinical goniometric measurements, and provides preliminary evidence that health disparities in BCA survivorship may exist in terms of physical impairments.

Clinically speaking, baseline shoulder AROM of BCA patients is presumed to be normal prior to surgical intervention, with the exception of those with pre-existing shoulder impairments. In the case of this study sample, none of the participants had pre-existing conditions that are associated with shoulder dysfunction. Considering that the natural course of recovery from BCA surgery has a time period of expected shoulder range of motion reduction, the combination of a pre-morbid reduction in shoulder range of motion, along with the reduction necessitated by surgery and postoperative precautions (especially for mastectomy procedures[71]), can have a large negative impact on the functional ability making things as simple as hugging, brushing one's hair, putting on a seat belt, or reaching in overhead cabinets problematic. As with any pilot study, the small sample size poses limitations on the generalizability of results. However, the results preliminarily suggest that physical and functional recovery after breast cancer may be another source of disparities in cancer care.

There may be a variety of other reasons for the reduction in shoulder range of motion prior to surgical intervention. First, it is quite possible that the participant had reduced active shoulder range of motion prior to the diagnostic procedures. However when the medical chart review data were examined, only one participant had a history that would indicate a possible shoulder impairment or condition associated with shoulder involvement (e.g.: history of rotator cuff tear more than 5 years prior to the study on the contralateral side of the breast cancer surgery). When excluded this case was excluded from the analyses, the results were unchanged. It is also possible that these reductions may be related to the aging process.[72,73] Considering that this study based comparisons to normal population values across the age spectrum, and that the sub-samples were similar in age, the possibility that aging may play a role was limited. A plausible third reason was that muscle guarding of the involved side may overflow to guarding on the uninvolved side. While data were not collected on muscle guarding, some of the participants related that they were "favoring" the involved side.

The present study was the first to provide clinical measures suggesting that AAs may be disadvantaged in terms of objective physical impairment before formal cancer treatment begins. AA BCA survivors have been reported as having lower levels of functional quality of life than Whites, which has been attributed to age and income but not necessarily shoulder AROM.[18] In this study, AA participants comprised the majority of BCA survivors

with household incomes of less than $15k. This too may have confounded the results in that impoverished individuals may be at greater risk of physical impairment than those with greater financial resources, as is the case with mortality and other sources of disparities.[49,50,74,75] We recognize that the AA sub-sample was smaller than the White sub-sample. However, our AA BCA survivors comprised 27% of the entire sample – a sizeable amount compared to the previously mentioned studies.[49,50,74,75] With larger and comparable sample sizes, it may be able to better detect whether disparities in physical impairment exist by income status and/or race.[74]

The most dramatic difference prior to surgery was for shoulder abduction. Most movement requires combined planes of movement especially in the shoulder in order to accomplish independent activities of daily living such as those described earlier. This pilot study points to a possibility that shoulder range of motion may need to be addressed in the pre-surgical phase, particularly for AA BCA survivors.

An important strength of this study was that nearly thirty percent of the sample was African American. The AA and White sub-samples were comparable in terms of age and surgical type. Another strength of the study was the ability to recruit participants prior to surgery and usually within one week after the biopsy procedure. This required a great deal of coordination and close communication with community physicians and their clinic staff. As such, the team was careful to cultivate mutual trust and respect by community physicians and leaders in the local AA and BCA communities served by community hospitals, physician practices and a local comprehensive cancer center. This study had a relatively small sample but plans are underway to expand this project to include longitudinal data collection and randomization with a larger sample and more minority group representation.

CONCLUSIONS

In summary, this was the first study to prospectively examine range of motion prior to surgical intervention for breast cancer survivors. All participants had active shoulder range of motion limitations (flexion, abduction, and external rotation) that were significantly reduced from normal population values despite the fact that none of the participants had any significant co-morbidities that could sufficiently explain the differences. The significant reduction in active shoulder range of motion prior to surgery but after biopsy points to a potential cause of physical limitation for breast cancer survivors that may merit early physical therapy intervention. This merits further study. Of noted importance is that range of motion limitation was greatest for African American participants which comprised nearly thirty percent of the sample. Limitations in physical function may be worse for African American breast cancer survivors and this may contribute to increased cancer related burden during the survivorship phase. Despite the limitations of this study (i.e.: small sample size, lack of randomization, case-control comparisons, and longitudinal measures), this pilot project points to important avenues to explore for physical and functional recovery after breast cancer surgery.

Acknowledgments

Acknowledgment of funding: This study was supported in part by NIH grants U54CA091408, P20 MD000516, and UL 1RR024975. We are grateful to Britney Hagy and Leah Watson for assistance with data collection.

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Table 1

Descriptive Characteristics of BCA Survivors.

	All n=33	AA n=9	White n=24
Mean (SD) Age in years	55 (1.9)	56 (2.9)	53 (1.4)
Household Income			
< $10,000	5	3	2
$10,000 – $14,999	4	2	2
$15,000 – $24,999	1	0	1
$25,000 – $34,999	3	0	3
$35,000 – $49,999	2	1	1
$50,000 – $74,000	3	0	3
$75,000 – $99,999	3	1	2
$100,000 – $149,999	4	0	4
$150,000 – $199,999	2	0	2
≥ $200k	1	0	1
Refused to answer/missing	5	2	3
Mean (SD) Years of Education	14 (.4)	13 (.8)	14 (2.5)*
Type of BCA Surgery			
# Lumpectomy	23	6	17
# Unilateral Mastectomy (modified radical or radical)	4	1	3
# Bilateral Mastectomy or Unilateral Radical Mastectomy	2	0	2
Don't Know	4	2	2

* p<.05, independent samples t-test

Table 2

Mean (s.d.) shoulder AROM in degrees

	Normal AROM	T0 n=26	T1 n=25
Flexion	180	151* (9.1)	105* (11.1)
Extension	60	58 (5.4)	37* (3.9)
Abduction	180	144* (8.4)	83* (10.1)
Internal Rotation	65	64 (3.5)	59 (6.5)
External Rotation	90	76* (3.9)	52* (6.0)

* $p<.05$, t-test comparing to normal values

Table 3

Mean shoulder AROM in degrees for AA and whites compared to norms[**]

	Normal AROM	T0		T1	
		AA (n=7)	White (n=19)	AA (n=7)	White (n=19)
Flexion	180	158[*] (9.6)	157[*] (9.5)	90[*,†] (19.8)	110[*] (13.4)
Extension	60	72[*] (15.5)	56[*] (3.69)	35[*] (7.5)	37[*] (4.7)
Abduction	180	120[*,†] (16.4)	161[*] (3.93)	80[*] (16.6)	85[*] (12.7)
Internal Rotation	65	63 (5.5)	68 (2.78)	63 (13.2)	59 (7.5)
External Rotation	90	77[*] (4.7)	80 (2.95)	48[*] (10.7)	54[*] (7.4)

[**] For participants with complete data at T0 & T1; $n_{AA}=7$, $n_{white}=19$

[*] $p<.05$, single sample t-test (comparing T0 to normal values)

[†] $p<.05$; Repeated measures ANOVA; 1-tailed t-test (comparing AA & whites)

J Womens Health Phys Therap. Author manuscript; available in PMC 2015 September 01.