THE EFFECTS OF A SPECIFIC EXERCISE PROGRAM ON SHOULDER FUNCTION FOR BREAST CANCER SURVIVORS, 6-9 MONTHS POST-SURGERY

CLAIRE BIAFORE

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ABSTRACT

Background: The most common complication following breast cancer intervention surgery is a lack of shoulder function of the affected side, which has been linked to a decrease in quality of life. Presently, few reports are available that examine the benefits of a limited active, rehabilitative shoulder program to assist this population during their recovery period (6-9 months).

Hypothesis: Implementing a specific active exercise program (9 weeks) for breast cancer survivors, 6-9 months post-surgery will improve this population's perceived quality of life, perceived shoulder function, improve their observational posture, decrease lymphedema and improve their active shoulder range of motion.

Study Design and Methods: This study was approved by York University's Human Participants Review Sub-Committee and Mount Sinai's Toronto Academic Health Sciences Network. The exercise program targeted muscle range of motion, strength, endurance and included the following exercises: static pectoralis stretch, active shoulder lateral raises with internal rotation, bent over row and standing push-ups. The exercise program was progressive (an increase of 5 repetitions per week) and was the same four exercises for each participant within the study. All participants (n=6) were assessed at baseline, four weeks post-baseline and eight weeks post-baseline. Only baseline measurements and final assessment were analyzed for the overall true effect of the exercise intervention. Outcome measures included: Quality of Life questionnaires (EORTC QLQ-C30, QLQ-BR23 and DASH), clinical postural evaluation, measurement of lymphedema (by a cloth measuring tape) and range of motion using a standard manual goniometer.

Results: Upon the completion of the study, participants found a perceived improvement in the social functioning scale, with a mean change from baseline to final assessment: 58.0-77.7 (t=-2.91, p=0.03, SD ±11.79), and pain scale, with a mean from baseline to final assessment: 41-22 (t=3.80, p=0.01, SD±11.79). Furthermore, participants perceived an improvement in their shoulder function in approximately 20% of the DASH questionnaire items and clinically, the participant's shoulder range of motion made a relevant improvement from baseline to final assessment.

Conclusion: The implementation of an active and daily exercise program was statistically significant and clinically relevant in the perceived improvement of quality of life, both a perceived and an observational improvement in shoulder function for breast cancer survivors 6-9 months post-surgery.

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Dad: My zest of learning comes from you…I'm a better person today because of your guidance, love and support…thank you for giving me a drive to make the world a better place

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INTRODUCTION

Breast cancer is the most common cancer for women over the age of 40 according to the Canadian Cancer Society's Advisory Committee on Cancer Statistics (2017) and Statistics Canada (2016). It is estimated that approximately 25, 000 women were diagnosed with breast cancer last year alone (Canadian Cancer Society's Advisory Committee on Cancer Statistics (2016). However, with present breast cancer diagnoses and interventions, the incidence of survival has increased.

The pursuit of this study resulted from witnessing many women in private practice whereby they had undergone breast cancer interventions, namely mastectomy and lumpectomy, and were unable to move their shoulder at one-year post-surgery. Preliminary research questions included:

1. Why are breast cancer survivors presenting at one-year post-surgery with shoulder dysfunction?
2. Currently, what program is the medical community implementing for breast cancer survivors, up to one-year post-surgery?
3. Is there a different program implemented for breast cancer survivors of mastectomy versus lumpectomy?
4. Is there a program that is the usual standard care for all breast cancer survivors, within the Greater Toronto Area?
5. What does the current rehabilitation program, immediately following surgery, include? What are the exercises specific to shoulder dysfunctions? How many repetitions are performed? How many sets?
6. How do women know when to stop the exercise program?

Upon further research as to why these women presented with shoulder issues one year post-surgery, it was discovered that women, post-surgery, are given active rehabilitation interventions up to 6 weeks post-surgery but then are left to their own devices to maintain a "normal life" thereafter (Lauridsen, et al., 2005; Cinar et al., 2008). Every woman is seen, by their general surgeon, 6 months post surgery but the typical focus of the visit relates to surgically related cancer outcomes versus potential alterations in their daily life activities.

The goal of this research is to help women focus on a better quality of life: beginning with shoulder function. Numerous articles (Karki et al., 2005; Yang et al., 2010; Box et al., 2002; Wingate, 1985; Kuehn et al., 2000; Winters-Stone et al., 2002; Courneya et al., 2003) linked breast cancer survivor's shoulder function to quality of life in terms of their ability to use their shoulder within their daily life activities. Therefore, it is critical to consider initiating an appropriate and efficient exercise rehabilitation program that targets shoulder mobility within the one-year post-surgery to offset potentially permanent shoulder dysfunction. As a result of the researcher's clinical observation and preliminary research (Lauridsen et al., 2005; Cinar et al., 2008), this study implemented a daily short exercise regimen that aimed at improving over-all shoulder function prior to the onset of shoulder dysfunction. The research to date has revealed that women who presented with shoulder dysfunction at 6 months also presented with shoulder dysfunction at one-year post-surgery (Tasmuth et al., 1996; Vinokur et al., 1990; Sugden et al., 1998). The results of the study found participants improved their perceived quality of life, perceived shoulder function and improved their overall shoulder range of motion when provided an active program between 6-9 months post-surgery.

LITERATURE REVIEW

2.1 Incidence of Breast Cancer

The research outcomes from a number of investigations suggest that the typical age of incidence for the diagnosis of breast cancer was approximately 56.5 years of age (Key et al., 2001; Cinar et al., 2008; Wingate, 1985; Satariano et al., 1990; Springer et al., 2010; Tasmuth et al., 1996; Michels et al., 2013). Multiple factors cause breast cancer including genetics and prolonged exposure to factors including lifestyle choices and carcinogens in the environment (Canadian Cancer Society's Advisory Committee on Cancer Statistics, 2017). Rates tended to be higher in more developed countries and some common risk factors have included a younger age for the beginning of menstruation, women who did not have any full-term children and had a shorter length of breast feeding their children (Canadian Cancer Society's Advisory Committee on Cancer Statistics, 2017). Presently, there are multiple ways in which breast cancer is managed: one is surgical intervention.

2.2 Surgical Intervention

Numerous parameters determine what type of surgery is required. According to Gillespie (2011) and Rosenberg (2011), the type of surgery is dependent on the size and location of the tumor, the size of the actual breast itself, multiple areas of cancer within the breast, the spread to the lymph nodes, the affected woman's general health, personal preference of the woman and previous treatments for breast cancer or to the breast tissue. Depending on the outcome of the diagnostic parameters, there are various types of surgeries in the management of breast cancer: breast-conserving surgery (also known as lumpectomy), or mastectomy.

Gillespie (2011) described breast-conserving surgery, lumpectomy, as an operation that is less invasive and removed the tumor and some of the healthy tissue surrounding the tumor. It

kept the breast intact and the potential adverse effects of the surgery were not noticeable following this type of surgery. However, there is another adjunct procedure to standard lumpectomy: a sentinel lymph node biopsy or an axillary node dissection.

According to Greene and Heniford (2001) a sentinel lymph node biopsy is a procedure used by surgeons to examine the closest lymph nodes to the tumor found in the breast tissue. The surgeon examines which lymph nodes are in close proximity and injects a dye into the surrounding tissue. The dye marks the lymph nodes closest to the tumor and helps the surgeon identify which lymph nodes are to be removed. The final step is the removal of the lymph nodes to allow for appropriate testing in the identification of the threat of cancer and the spread to other areas of the body. The axillary node dissection involves the removal of the lymph nodes located within the axilla. This adjunct procedure begins with the same procedure as lumpectomy surgery but results in a more invasive examination as the pectoralis major and minor muscles are typically affected during this procedure.

The most invasive type of surgery is the mastectomy. This type of procedure removes the entire breast tissue and is typically a result of a larger area of cancer within the breast tissue, or if the tumor has spread to other areas of the breast. Greene and Heniford (2001) described three types of mastectomy: total mastectomy, modified radical mastectomy and radical mastectomy.

Typically, there are no long term effects to the shoulder's nerves and muscles post-surgery. (Greene et al., 2001). A total mastectomy involves the removal of the entire breast, the nipple and the fascial lining around the pectoral muscles. A modified radical mastectomy removes the entire breast tissue, the nipple and more or all of the lymph nodes in the axilla and interrupts the pectoral fascia surrounding the pectoralis muscles.

Lastly, a radical mastectomy involves the removal of the entire breast tissue, the nipple, all of the lymph nodes in the axilla and the muscles in the thorax. This is the least common type of surgery as it is the most invasive of all of the mastectomies and requires the most interruption of the muscles, fascia and tissue surrounding the tumor(s). This last type of surgery has become the least common and is used in larger tumor removals and advanced progressions of breast cancer. Typically, this type of procedure leads to long-standing shoulder neural interruption and muscular imbalances.

If the axilla is affected for the necessity of lymph node dissection: between 10-40 lymph nodes can be biopsied for the presence of cancer. This number varies and is dependent on the severity of the cancer and personal preference of surgeons. These surgical interventions cause tethering of the fascia, also known as cording, and musculature within the axilla and surrounding shoulder musculature is damaged leading to the inability to perform daily tasks such as brushing one's hair or teeth (Karki et al., 2005). Cording, or Axillary Web Syndrome, is a term used to describe any residual scarring within the axilla following invasive breast cancer surgery. O'Toole et al. (2013) found that 31% of women reported cording at 6 months post-surgery and 36% at 24 months post-surgery and found that cording occurred as a direct result of axillary lymph dissection and coincided with an increase in shoulder functional impairment. They, along with other studies suggest that the timing of an active exercise intervention following surgery could attenuate the affects of cording (Wingate, 1985; Cinar et al., 2008, Galantino et al., 2013, Courneya et al., 2003).

2.3 Survival Rates

According to the Canadian Cancer Society's Advisory Committee on Cancer Statistics (2017) and Statistics Canada (2012), the five-year survival rate for women with stage 1 (least

severe) was 75% in the mid 70's but today is close to 100%. An increase in today's survival rates is attributed to the enhancement in the early diagnosis of breast cancer, the advancement of research in the identification of pre-existing genetic markers and the inclusion of surgery in the removal of the tumor. Regardless of how advanced the stage of cancer was, surgery leads to a disruption in the fascia and musculature surrounding the affected shoulder: and results in multiple complications including shoulder dysfunction.

2.4 Postural Adaptations and Biomechanics

Shoulder biomechanics and movement includes multiple joints, ligaments and muscles that act synergistically to allow for mobility. The joints include the glenohumeral joint, sternoclavicular joint, acromioclavicular joint, and scapulothoracic joint (Herrmann, 2016). Herrmann noted that a strong joint capsule is necessary to facilitate the movement of all joints in addition to creating stability within the shoulder. Ligaments and muscles have multiple origins and insertions throughout the shoulder complex and allow for the ease of movement of the joints. Herrmann described the motion of the shoulder relative to the scapular plane as humeral rotation that occurred around the sagittal axis and resulted in abduction and adduction. Rotation of the glenohumeral joint occurs around the frontal axis but is directed in a medial-lateral direction termed flexion. Extension and rotational movement around a longitudinal humeral axis is referred as external-internal rotation.

More specifically, the scapulothoracic articulation is one of the least harmonizing joints in the body (Paine et al., 2013). Paine et al. (2013) noted that there is no actual articulation between the thorax and the scapula, however this joint utilizes ligamentous and muscular attachments to allow for a full range of motion in the shoulder complex. According to Paine et al. (2013), the glenoid is the frame of reference when describing scapular motion. McClure et al.

(2001) found that when a standardized, non-injured population performed scapular plane elevation of the arm, the scapula performed upward rotation, posterior tilting and external rotation along with clavicular elevation and retraction. Additionally, McClure et al. (2001) described a term called "Scapular dyskinesis" as an alteration of scapular motion. Many factors lead to scapular dyskinesis including surgery (Karki et al., 2005; Sugden et al., 1998; Satariano et al., 1995; Tasmuth et al., 1996; Vinokur et al., 1990; Kuen et al., 2000; Thomas-MacLean et al., 2008; Yang et al., 2009, Hayes et al., 2005, Hidding et al., 2014). Following surgery, cording occurs in the axilla and the surrounding musculature, like the pectoralis minor. McClure et al. (2001) reported that the pectoralis minor inserted on the coracoid process of the scapula therefore, scapular motion changed due to the disruption of healthy tissue and the shortening of the pectoralis minor muscle. The research to date suggests that women experience some form of shoulder impairment at 6 months (38.5%) and one-year post-operation (40.6%) (Karki et al., 2005; Sugden et al., 1998; Satariano et al., 1995; Tasmuth et al., 1996). Overall range of motion and shoulder function is one of the concerning issues following breast cancer treatment.

The research outcomes from a number of investigations (Karki et al., 2005; Yang et al., 2010; Lauridsen et al., 2005; Box et al., 2002, Haddad et al., 2013) underscore that post-surgical patients tend to present with varying degrees of posture and muscular imbalances. Haddad et al. (2013) reported that women post breast cancer surgery had altered postures confirmed by imaging. They noted that women developed modifications in their posture, such as shoulders rounded forward and head more anterior to their body, modifications to their spine and presented with multiple muscular imbalances. This phenomenon was confirmed with the treatment of treating breast cancer survivors in clinical practice and was termed "Anterior typology". The anterior typology may have been a direct result of surgical intervention, which disrupted muscle

and fascial tissue, but possibly as a result of a psychological and emotional trauma that manifested within the affected tissue. Some breast cancer survivors of lumpectomy or mastectomy, have anecdotally mentioned that they realized their posture was "not great" but that they perceived their posture to be as a result of being ashamed about no longer having their original breast tissue. This insecurity may be psychologically based or physiologically based and results in an anterior typology. An anterior typology presents with guarding of the affected shoulder and slightly rounded forward due to muscular atrophy and resulted in muscular imbalances between the anterior and posterior aspect of the body. It also displays with an increase in the kyphosis of the thoracic cavity, head and neck anterior to the shoulder and hip in a coronal plane and winging of the scapula. One consequence of an anterior posture is the presence of winging of the scapula.

Winging of the scapula is described as the migration of the medial border of the scapula away from the thoracic cage with the lateral deviation of the inferior angle from the vertebrae (Goldstein, 2004). Winging of the scapula causes more of a superior elevation of the scapula, in the frontal plane, on the thoracic cage during all ranges but specifically in abduction and flexion (Crosbie et al., 2010). These patients tended to initiate their abduction and flexion movement with their upper trapezius and levator scapulae, and caused the superior pull on the scapula's medial superior border. These structural changes resulted in different biomechanical adaptations that lead to various musculoskeletal issues like adhesive capsulitis or rotator cuff issues (Goldstein, 2004; Crosbie et al., 2010).

Once a breast cancer survivors' shoulder is affected, their body attempts to adapt in order to perform daily life tasks. Normally, the humerus and the scapula have a smooth synchronous motion. Post-surgery, this motion is altered due to muscular imbalances following cording of the

fascia and muscles (Crosbie et al., 2010; Shamley et al., 2012, Karki et al., 2005). This imbalance between the interplay of all the shoulder musculature leads to a loss of mobility within the shoulder with a breakdown of the functionality of the upper limb.

Multiple theories suggest reasons for shoulder dysfunction for this population (Hadler et al., 2000, Crosbie et al., 2010). One reason is the biomechanical change that occurs post surgery and the second is the changing composition of the musculature following surgery, radiation and chemotherapies.

Biomechanical changes result in an anterior typology (Hadler, et al., 2000, Chopp et al., 2010) whereby a shortened pectoralis minor muscle, elevates the scapula anteriorly with a higher migration of the superior border of the scapula and results in a rounded position of the shoulder. When the shoulder is rounded forward, there is an unnatural immediate superior humeral head migration of the greater tuberosity as well as the inability of the humeral head to externally rotate during arm/shoulder abduction to clear the greater tuberosity from the coraco-acromial arch. This motion of external rotation may not occur with an anterior typology due to the muscular imbalances, pectoralis minor, deltoid and supraspinatus, within the force couples. Force couples are groups of muscles that synergistically move together, to produce movement around a joint. Movements of the shoulder joints are created by the recruitment of muscle groups that create pulls and forces to allow for a joint to move (Shamley et al., 2012).

The rotator cuff muscles are comprised of the supraspinatus, the infraspinatus, the teres minor and the subscapularis muscle. Within the deltoid-rotator cuff force couple, the supraspinatus is an initiator of abduction and acts throughout the motion of abduction to stabilize the glenoid. It has equal power to the deltoid and assists the pull on the head of the humerus to counteract the deltoid that displaces the humerus superiorly into the fossa.

The shoulder joint is structured to have extreme mobility in numerous directions. Because of this range of motion, the shoulder relies on its muscular attachments to provide support: force couples (See Figure 1) (Bechtol, 1980, Shamley et al., 2012, Paine et al., 1993).

Figure 1: Muscle Force Couple

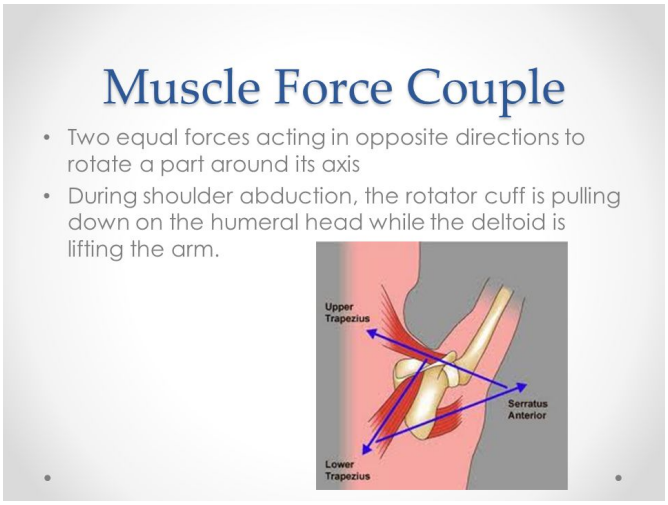


Figure by Harold Charles: slideplayer.com/slide/6990443

Elevation of the humerus requires an equal force applied to it by means of the rotator cuff muscles (supraspinatus, infraspinatus, teres minor and subscapularis) as well as the deltoid complex (Bechtol, 1980). During 0° of abduction, the humerus is forced upward onto the glenoid fossa because of the hinge effect of the deltoid at it's insertion on the deltoid tuberosity. As abduction increases, the force of the deltoid's pull forces the humerus deeper into the fossa. At extreme abduction, the deltoid forces the head of the humerus to be displaced inferiorly out of the glenoid. Conversely, the hinged effect of the deltoid is counteracted by the rotator cuff musculature which ensures that the humeral head is fixed within the glenoid. When these two force couples act synergistically, the torque generated is necessary at the shoulder joint and results in a smooth abduction of the arm. Following surgery, there is a disruption of the tissues'

continuity which leads to muscular imbalances. A physical shortening of the pectoralis minor muscle, pulls the superior border of the scapula more superiorly and rounds the shoulders anteriorly. This causes a lengthening and a weakness of the supraspinatus, infraspinatus and teres minor which all inserts on the greater tubercle. With an anterior typology, the deltoid muscle becomes atrophied whereby the majority of the movement has to be performed by the rotator cuff muscles.

The research outcomes from a number of investigations suggest that an immediate atrophy of the supraspinatus muscle following surgery (Ellenbecker et al., 1989; Litchfield et al., 1995; Moseley et al., 1992). Following surgery, cording affects the axilla and any of the musculature that passes through or close to it including the supraspinatus muscle. The supraspinatus muscle originates on the supraspinous fossa of the scapula. It then passes laterally beneath the acromion and attaches onto the greater tubercle of the humerus (Ellenbecker et al. 1989). This muscle initiates abduction, therefore a post-surgical exercise program should include an exercise for the supraspinatus muscle. One post-surgical program by Phan (2015) did not include any rehabilitative exercises for the supraspinatus with little emphasis on the stabilization of the scapula by it's muscles: including supraspinatus, infraspinatus and teres minor (Functional Rehab After Breast Cancer Surgery). This six week program is part of the usual standard of care immediately following breast cancer surgery and focuses on range of motion for the shoulder to help decrease the incidence of lymphedema. However, following the 6 week time-frame, there is no progression or implementation of an exercise program to refine proper shoulder biomechanics. If atrophy exists of the supraspinatus muscle, abduction could be initiated (up to 50% force) but once the arm reaches 90°, the torque ability of the muscle is compromised and the person would be unable to continue the abduction movement (Bechtol,

1980, Crosbie et al., 2010). In this instance, the deltoid muscle takes over to attempt full abduction of the shoulder. Therefore, an active exercise program geared toward the recovery of the supraspinatus would be beneficial in the return of the shoulder to its normal motion. This limitation of a scapular based exercise program post-surgery limits a woman's ability to freely move her arm overhead, consequently making tasks of daily living challenging like placing an object over head or washing their hair.

In addition to the movement of the humerus, the scapula plays a large role in the physiological differences that exist between a non-surgical population and post-surgical patients. Post-surgical patients that present with a winging scapula as a result of an anterior typology, which allow for an unnatural surface contact of the scapula onto the thorax. This positional alteration coincides with an elevated starting position of the scapula and a decrease in the posterior scapular tilt during arm elevation of the involved limb due to the axis of the scapular rotation changing position as the arm is elevated (Bagg et al., 1988, Ludewig, 2009). Typically, the scapula rotates around its lower midportion between 0-60° of abduction but moves its center of rotation closer to the glenoid fossa throughout the full range of abduction. During the "middle phase" of abduction, described between 81.8-139.1°, scapular rotation is more pronounced than glenohumeral motion. One hypothesis for this occurrence is that this larger scapular contribution is due to the moment arm of the scapular rotators being larger than those of the deltoid and the supraspinatus (Bagg et al., 1988). In addition, during this motion, the lower trapezius muscles provide additional rotary force during abduction.

This altered motion, along with an increased anterior tilt and superior migration of the scapula results in a decrease within the subacromial space, which leads to impingement of the rotator cuff muscles within the coracoacromial space (Goldstein, 2004; Ludewig, 2009, Crosbie

et al., 2010). Shamley et al. (2012) examined the role of the scapula in breast cancer survivors and found that the decreased posterior tilt and internal rotation of the scapula was similar to patients with impingement syndrome. Impingement is a medical term used to describe the irritation or inflammation of the rotator cuff muscles (muscles include: supraspinatus, infraspinatus, teres minor and subscapularis) as they pass through the subacromial space and beneath the acromion. It typically presents with pain in an active overhead movement and pain with flexion of the glenohumeral joint between 60º-120º (Crosbie et al., 2010). The internal rotation of the scapula decreases the subacromial space and results in compression of the superior portion of the rotator cuff muscles. When this occurs, there is less serratus anterior muscular activation and an increase in upper trapezius. This dysfunction further contributes to a posterior tilt and a decrease in the protraction of the scapula.

The inability of the shoulder to manage its center of scapular rotation may lead to shoulder dysfunction following mastectomy. During shoulder abduction, the center of rotation begins to transfer toward the acromioclavicular joint by 120-150° of abduction. More specifically, during shoulder abduction or forward arm flexion, the scapula is upwardly rotated, internally rotated, and posteriorly tilted relative to the thorax (Crosbie et al., 2010, Shamley et al., 2012). This begins to occur at approximately 60-90° of shoulder abduction, whereby the clavicle's elevation around the sternoclavicular joint becomes slight when reaching the acromioclavicular joint by the 120-150° mark. With atrophy of the trapezius or an unbalanced force couple, the shoulder is unable to manage this new location of the center of rotation. Normally, the middle trapezius develops a force that favours downward scapular rotation, as well as upward rotation produced by the upper trapezius, lower trapezius and the serratus anterior (See Diagram 1). With an atrophy of the middle or lower trapezius, women will will not be able

to retract the scapula, and manage the middle trapezius from opposing the upward rotatory force of the lower trapezius.

Typically, an anterior typology presents with tightness of the pectoralis minor and causes a higher migration of the superior border of the scapula as well as a restriction in scapular motion. Tightness of the pectoralis minor occurs due to its origin on the coracoid process of the scapula. With surgical removal of the axillary lymph nodes, there is a disruption of the fascia that surrounds the pectoralis muscle and axilla. Consequently, the subcutaneous tissue adheres to the pectoralis minor muscle. These adhesions cause a structural "anchor" and limit shoulder mobility and normal scapular motion. This exhibits less scapular tilt and a greater scapular internal rotation during arm elevation (See Diagram 1) (Shamley et al., 2012).

Normally, there is an area of focal stress within the rotator cuff tendon (Kim et al., 2010). Kim et al. (2010) found the most common area for a rotator cuff tendon occurred in the posterior location of the shoulder, near the junction of the supraspinatus and infraspinatus muscles, approximately 13-17 mm posterior to the biceps tendon. However, following surgery, the tissue surrounding the axilla, the chest and the pectoralis area is further affected in length and strength due to the surgical invasiveness of the breast cancer surgery as well as the changing composition of the musculature following radiation and chemo therapy (Kasper et al., 2000). Typically, the rotator cuff tendons are a combination of a more integrative structure than single muscles. Studies (Shamley et al., 2012, Halder et al., 2000) have described the insertions of the supraspinatus and the infraspinatus muscles as a five-layer structure comprised of superficial layers that move deep to become a continuation with the capsule. In addition, the fiber orientation differed along the length of the rotator cuff tendons. Within a healthy, non-surgical population that have not gone through breast cancer treatment, the rotator cuff injuries may occur

due to the various fiber orientations within these multiple layers. Significant shear forces likely exist at the fourth layer as it consists of "loose connective tissue with thick bands of collagen fibers running perpendicular to the primary fiber orientation of the cuff tendons. This layer may have a role in the distribution of forces between tendinous insertions" (Halder et al., 2000).

In addition to the pre-existing critical zone of injury for the rotator cuff tendon and following surgery, chemotherapy and radiation were found to have altered the health of the muscle fibers (Shamley et al., 2007). The radiation from plain film radiographs (X-rays) have been noted to interact with molecules of the tissues causing ionisation and the release of electrons. This results in secondary damage to tissue. Radiation injury to normal tissue is believed to be non-specific and is generally not thought to produce any long-term effect on the tissue. However, there exists a vascular change in the parynchema which causes ischemia in the healthy muscle fibers. Therefore, the muscles will have limited ability to expand and contract due to this vascular revision following therapy. This effect on vascularity was found to be chronic in nature with some initial improvement but has not been found to return to its pre-radiated state (Shamely et al., 2007).

2.5 Present Exercise Interventions

Current studies that have implemented an exercise program for breast cancer survivors. but did not implement shoulder specific rehabilitation programs, reported positive outcomes on the rehabilitation of breast cancer survivors following surgery. Courneya et al. (2007) found that when participants were randomly assigned to either usual care, a cardiovascular exercise program or a strength-related program, there was no statistically significant improvement in quality of life but that exercise intervention helped the women to better manage their mood and self-esteem. It is important to note that the intervention applied by Courneya et al (2007) was

implemented for breast cancer survivors during chemotherapy and radiation therapy. In addition, the resistance program was a generalized program that included: leg extension, leg curl, calf raises, chest press, seated row, tricep extension, biceps curls and modified curls. The exercises were performed three times per week, 8-12 repetitions and at approximately 60-70 1RM.

Herrero et al. (2005) implemented a similar protocol as Courneya et al. (2007), however the population used was breast cancer survivors that had already completed chemotherapy and radiation therapy. Herrero et al. (2005) implemented an eight-week program consisting of eleven exercises including chest press, shoulder press, leg extension, leg curl, leg press, leg calf raise, abdominal crunch, low back extension, arm curl, arm extension, and lateral pull down. The researchers observed that a combined program of cardiorespiratory and resistance training is effective in improving breast cancer survivor's quality of life and overall fitness. Therefore, the implementation of an active exercise program for breast cancer survivors is necessary to manage any weaknesses following surgery.

Winters-Stone et al. (2012) performed a fifty-two week analysis of 2 maximal exercises for breast cancer survivors. The exercises included leg press and chest press. The study by Winters-Stone (2012) utilized a population that was very similar to this present study, but only implemented one upper body and one lower body exercise to determine the effects of resistance training. Their research findings demonstrated that the implementation of a resistance and impact training program significantly improved strength as compared to a stretching program. The researchers also observed that women who attended 50% or more of their prescribed resistance training sessions had significantly better changes in maximal strength measures as compared to less adherent women, post breast cancer surgery. The study by Winters-Stone supports the

implementation of an active exercise program for breast cancer survivors to improve strength following surgery.

The research conducted by Jones and Courneya (2002) utilized self-reported surveys for breast cancer survivors. The researchers observed that 84% preferred to receive exercise counselling at some point during their cancer experience. Fifty-six percent of these participants preferred to exercise at a moderate intensity rather than a high intensity. This study confirms the desire of breast cancer survivors to participate in an active exercise program following breast cancer surgery.

Table 1 summarizes the three studies that have similar aspects of the present study and that were considered when developing this study's methodology. Although shoulder mobility was not the focus of these studies and therefore there were no isolated measurements of improved shoulder mobility, given the exercises that were prescribed it is very likely that shoulder mobility did improve.

Table 1: Summary of Exercise Interventions

	Courneya et al. (2007)	**Herrero et al. (2005)**	**Winters-Stone et al. (2012)**	**Jones et al. (2002)**
N	242	16	106	307
Study Type	Randomized, controlled trial	Randomized, controlled pilot trial	Randomized, controlled study	Self-administered survey
Exercise Program	Three times per week, 2 sets of 8-12 reps. Nine exercises, 60-70% of 1RM	Three times per week, 11 exercises used	Three times per week, 2 exercises	None
Length of Intervention	17 weeks	8 weeks	52 weeks	None

To date, the post-surgical exercise programs offered by hospitals have been scarce and inconsistent. One hospital, within the Greater Toronto Area, (GTA) provide breast-cancer survivors a pamphlet titled: "Functional Rehabilitation After Surgery." This eight-page pamphlet provide numerous range of motion and some basic strengthening exercises but makes no mention of sets, repetitions or appropriate progressions. Page six states: "Be mindful of your progress. If you do not get full shoulder movement back in about 8 weeks, contact your therapist." On the same page, another statement that may be confusing for patients is: "Some discomfort is normal. However, if its very uncomfortable to do, take a break, but do not stop exercising completely. Start slow and build your tolerance gradually," yet there are no instructions describing a starting point for exercise, or how to gradually progress them. All the exercises described in this pamphlet are range of motion exercises for the neck and shoulders but

no specific exercises were incorporated for scapular stabilization. Although this program is important to aid breast cancer survivors in immediate improvement of shoulder function and to decrease lymphedema, as will be discussed in the latter part of this paper, scapular stabilization is one component of a shoulder exercise program that tends to be overlooked.

One hospital that performed breast-cancer surgeries, had anecdotally reported post-surgical patients were not provided any follow up exercise program. Upon meeting with a patient at 6 months post-surgery, she had already begun to exhibit various upper body adaptations including anterior typology, winging of the scapula and the inability to use her shoulder effectively in daily life activities. Another hospital offered a more specific plan for how to start a general exercise program versus a shoulder rehabilitative exercise regimen.

A large study (n=450) by Jones et al. (2004) found that when an oncologist recommended an exercise program to breast cancer survivors post-surgery, five weeks post-surgery, particularly if recalled one week after the first recommendation, patient's self-reported an increase in exercise behaviour. Upon discussion of this present study with multiple oncologists and physicians, all conceded that an active exercise program is not always recommended post-surgery or if recommended is only implemented short term. One surgeon reported to me that shoulder function is not considered an important focus when performing surgery on breast cancer patients. Their main focus is to rid the patient of the disease and once done, surgeons do not think about long term effects on the patient's shoulder. Therefore, if oncologists and surgeons were made more aware of the chronic effects of surgical intervention on shoulder function they may be more apt to discuss an active exercise program with patients pre-surgery or immediately following breast cancer surgery.

Within the Greater Toronto Area there are over 20 breast cancer support clinics all of which are inconsistent with regards to a structured exercise program post-surgery. They offer the patient and their support system information about health, wellness and overall recovery but if a patient has any questions regarding normal progression of their shoulder rehabilitation, a referral is made to the supporting hospital for follow up. The patients are caught up in a cycle of referrals to another location that perhaps is thought to have the skills and resources to help with exercise. but the reality is that these programs are lacking specificity and proper integration into their daily life.

There is ample research indicating the necessity of implementing an exercise program immediately following breast cancer surgery (Wingate, 1985; Cinar et al., 2008, Galantino et al. 2013). The benefits of implementing a program immediately post-surgery have been examined and have been found to be effective in improving shoulder function. Studies have mentioned that further examination was necessary at approximately 6-9 months post-surgery to aid in detecting any longer term functional impairments at one-year post-surgery (Wingate, 1985; Springer et al., 2010; Vinokur et al., 1990; Yang et al., 2009). The reason that identification of a specific shoulder dysfunction is difficult between 6-9 months is due to the limited research at this stage of rehabilitation and the various conflicting results about the severity of shoulder dysfunction. One study performed by Sagen et al. (2014) reported a decrease in shoulder function and pain up to two and a half years post-surgery. They confirmed the need for adjunct active rehabilitation following surgery but did not assess the exact dysfunctions that lie within the shoulder complex following surgery. There is no doubt that an impairment exists however, the extent of the intervention and outcome measures that lead to a specific shoulder dysfunction has to date not been systematically evaluated.

Immediately following surgery, the patient's primary focus is the rehabilitation of the surgical scar and body. Following chemotherapy and radiation and a "cancer-free" diagnosis, the patient's priority often shifts from active rehabilitation to the resumption of their normal daily life activities. What this population is not aware of, is that any biomechanical shoulder adaptations that they have developed during the course of their recovery do not typically resolve without some element of targeted shoulder rehabilitation. An active exercise program at approximately 6-9 months, typically the time-frame when all possible invasive therapies have been completed, is a way to help ensure that normal shoulder biomechanics are restored to offset future shoulder dysfunction.

In addition to implementing an exercise regimen at this time, the specificity of the exercise program is critical. Exercise programs that have been implemented during the 6-9 month time frame have either included a large number of exercises performed once a week or lacked specificity to the shoulder's biomechanics (Cinar et al., 2008; Lauridsen et al., 2005; Lee et al., 2010; Hayes et al., 2005; Shamley et al., 2007, Galantino et al., 2013). Lee et al. (2010) implemented a program involving exercises for the neck and shoulder that were performed under direct medical supervision once a week for eight weeks. The average time post-surgery for the exercise group was 350.2 days from their surgical date. Each exercise session was 40 minutes in duration and consisted of isometric contractions, pendulums, banded strengthening exercises, stretches and theraball proprioceptive exercises. They found that a scapular specific exercise program was more beneficial in restoring shoulder function for breast cancer survivors than a general "body conditioning exercise program." This study, along with other studies, did not note a starting resistance level for each participant, appropriate progressions given or the number of

sets of each exercise (Cinar et al., 2008; Lauridsen et al., 2005; Lee et al., 2010; Hayes et al., 2005; Shamley et al., 2007, Courtenay et al., 2013).

One benefit of the study performed by Lee et al, (2010) was the implementation of a more comprehensive exercise regimen to improve scapular specific biomechanics. However, the participants were only asked to perform the exercises once a week which does not coincide with basic exercise physiology principles for muscular endurance and strength. According to Al-Majid et al. (2008), a progressive resistive exercise training (PRT), performed on a daily basis, is the most effective way to decrease the effects of muscle atrophy following breast cancer surgery. He discussed that PRT may offset muscle wasting by increasing the level of amino acids within the muscle fibers.

2.6 Active Exercise Program

This research study implemented a modified version of a study performed by Moseley et al. (1992). Their study assessed functional shoulder rehabilitation exercises using an electromyogram (EMG) measurement. EMG is a standard diagnostic procedure which is used to assess the health of muscle and the conductivity of the muscle fibers within a movement (Wickham et al., 2009). The purpose of the study by Moseley et al. (1992) was to observe which shoulder exercises were most effective for the scapular muscles in a rehabilitation state. Out of sixteen shoulder exercises examined, their study found 4 specific exercises made an exceptional scapular muscle strengthening program: Abduction with internal scapation, Bent-over row, Push-ups with a plus and Press-ups. A limitation to their study was that Moseley et al. (1992) used 9 healthy subjects, only two of the participants were women, with no pre-existing shoulder injuries. In addition, the participants within the study were not recovering from surgery or shoulder injuries, therefore a modified version of the exercises was implemented for breast

cancer survivors post-surgery in this research study to ensure a minimization of injury from participation.

Of the four exercises identified to be the best for scapular stabilization, the "press ups" were eliminated from the current exercise intervention for this study's participants because a suitable modification could not be found. A pilot study was performed in the primary investigator's clinical practice on 12 shoulder rehabilitation patients to examine the ease of instruction for the identified scapular exercises. The "press up" exercise was the only exercise that patients had mentioned were difficult to perform or had expressed were painful.

Therefore, the study presented in this thesis utilized three of the four exercises from Moseley et al. (1992) with a comprehensive description of these exercises given within the methodology:

1. Internal rotation with abduction
2. Single arm bent over row
3. Push ups with a plus on the wall or chair

In addition to the implementation of three of the scapular strengthening exercises, a range of motion exercise was also utilized. A pectoralis major/minor stretch was implemented because of the pectoralis minor's origin on the scapula. The pectoralis minor muscle will be affected in its length following surgery and may become atrophied due to lack of an appropriate exercise regimen (Shamley et al., 2007) thereby restricting scapular motion.

The research to date reveals that implementing a stretching program improved the functionality of a joint. A study performed by Cipriani et al. (2008) had participants hold hip-related stretches for either ten seconds repeated six times per day or 30 second hold and performed twice per day. The researchers did not find a difference within the two groups but did

find that the key to improving hip range of motion was through a daily stretching exercise regimen. Another study by Ludewig (2002) focused on construction workers and asked the participants to perform a pectoralis stretch for injured construction workers within their shoulder rehabilitation program. They were asked to perform the pectoralis stretch twice per day and to hold it for 30 seconds. There was no specificity of time of day or if they could perform the exercise all at once in conjunction with the other exercises. The results demonstrated an improvement in shoulder range of motion following the pectoralis stretch further supporting the concept that some form of movement and stretching is beneficial to improving range of motion for targeted structures. While these studies were not consistent in identifying the appropriate duration of a stretch to improve range of motion, both utilized 30 second hold duration as a viable time and were consequently utilized for the current study for the pectoralis complex.

2.7. Outcome Measures: Quality of Life Questionnaires

This research study attempted to assess a change in shoulder function utilizing multiple outcome measures: quality of life questionnaires, clinical observation, sensory and motor testing, measurement of lymphedema and goniometer assessment.

Because of a limitation in shoulder function, arm morbidity has been noted to affect a breast cancer survivor's quality of life (Thomas-MacLean, 2008; Vinokur et al., 1989). Optimal upper body function is essential for maintaining independent living, performing tasks requiring physical strength and general function. In fact, Yang et al. (2009) reported that shoulder impairment that existed 6 months post-surgery was a good predictor of later upper limb dysfunction and overall decreased quality of life.

Because quality of life has been related to shoulder function, this study utilized two questionnaires. Firstly, the European Organization for Research and Treatment of Cancer

(EORTC) developed a questionnaire to assess overall health and well-being for cancer patients (QLQ-C30) and then produced a module specifically for breast cancer survivors (BR-23) (See Appendix A). According to the EORTC, the questionnaire was designed to be cancer-specific, multidimensional in nature, appropriate for self-evaluation and applicable over various cultures (http://groups.eortc.be/qol/qlq-c30-development). The EORTC QLQ-C30 includes 30 items with nine multi-level scales. The five functional scales include physical, role, cognitive, emotional, and social and cover differing aspects of health and well-being. Next, there are three symptom scales including fatigue, pain, nausea and vomiting and a global health and quality of life scale. According to the EORTC, all scores from the QLQ-C30 will be transformed linearly so that the scales range from 0 to 100. A higher score on the functional scale represents a higher level of functionality, however a higher score on the symptom scale represented a higher level of symptomology. The authors of the EORTC suggested that because the scale is complex and multi-faceted it is difficult to determine an absolute minimal score to imply clinical significance. Instead, they suggested that scores be compared to EORTC QLQ-30 Reference Values (http://groups.eortc.be/qol/sites/default/files/img/newsletter/reference_values_manual2008.pdf).

The Breast Cancer module is comprised of an additional 23 questions specifically relating to breast cancer patients. Typical questions included "During the past week, have you been worried about your health in the future or in the past week did you have a dry mouth?" The EORTC QLQ-C30 and QLQ-BR23 has been validated to ensure its reliability in the assessment of quality of life in breast cancer patients (Tan, et al., 2015; Aaronson et al., 1993). A study performed by Michels et al. (2013) found that the EORTC QLQ-C30 and QLQ-BR23 had a Cronbach's alpha coefficient of 0.846 and 0.873 respectively. Because of its reliability, the EORTC QLQ-C30 and QLQ-BR23 has been used by multiple studies to assess health at various

stages of breast cancer rehabilitation (Satariano et al., 1995; Michels et al., 2013; Kuehn et al., 2000; Karki et al., 2005; Lee et al., 2010).

Since this study focused on shoulder function for breast cancer survivors, the Disabilities of the Arm Shoulder Hand (DASH) is another questionnaire utilized to measure the dysfunction of the shoulder (Crosbie et al.,2010) (See Appendix B). The DASH focuses on the patient's perception of their upper body mobility as it pertains to dysfunction within daily life activities (i.e. brushing teeth or hair). For reliability, each item is transferred linearly to a scale from 0 to 100. A value of 0 represents no disability in the upper extremity and a scale of 100 is extensive disability. A study performed by Gummesson et al. (2003) found that the DASH questionnaire was valid and reliable when used in in a healthy/non-diseased population in various stages of shoulder recovery. It is important to note that a minimal change of 15 points, from baseline to final assessment, on the DASH questionnaire was found to be the most accurate in depicting a clinically significant change in shoulder function (Beaton et al., 2001). To date, the DASH questionnaire has not been validated for the use in examining upper limb dysfunction for a breast cancer population, however, multiple studies have used this questionnaire to examine shoulder dysfunction for breast cancer survivors post surgery (Hayes et al., 2008; Springer et al., 2010; Thomas-Maclean et al., 2008).

A pilot study performed by the researcher in private practice, found that the average time to complete both of the questionnaires was approximately 15 minutes. The two questionnaires combined were used to examine the quality of life of the participants in the current research project, 6-9 months post-surgery as well as data collection on this population's range of motion, strength and overall ability of the affected shoulder.

2.8 Clinical Observation

Clinical observation is a common outcome measure for examining the shoulder in breast cancer survivors (Goldstein, 2004; Kibler, 1998; Ludewig et al., 2009; Shamley et al., 2012, Constant et al., 1987).

A typical clinical observation included a visual inspection of the head, cervical, thoracic, lumbar and overall body posture in anatomical position in standing anteriorly, side-view and posteriorly (Goldstein, 2004). When performing an observational evaluation, studies (Constant et al, 1987; Goldstein, 2004) used a visual estimate in each position for an anterior typology including guarding of the shoulder complex, muscle atrophy, and muscular imbalance, the state of the scar post-surgery, bruising, and other skin changes. Lastly, a side view was performed to examine the head in a neutral position, the scapula was resting flat against the body, the rib cage was not compressed, the spine had its normal curves, the pelvis was in a neutral position, along with the knee joints and lower legs.

Evaluation of the back and trunk were important as any degree of lumbar lordosis, or leg-length asymmetry and hip rotational abnormalities must be noted to see if there are any underlying issues that were directing unnecessary forces to the shoulder (Goldstein, 2004). The inability to maintain normal lower body mechanics will lead to the inability of the transfer of forces to the lumbar spine and then consequentially through the mobility of the latissimus dorsi to the shoulder.

A study by Constant et al. (1987) used a scoring system performed by three researchers to validate the observational findings of the shoulder. The scoring system was reliable but did not include any other area of the body except for the shoulder complex. Following surgery, a breast cancer survivor will change their overall posture due to fascial restrictions and the interruption of

the fascia in the axilla and shoulder. Muscles, like the latissimus dorsi, affect multiple areas of the body. The latissimus dorsi originates at the spinous process of T7-T12, the 9^{th}-12^{th} ribs, the lumbar/sacral fascia and the iliac fascia. It inserts on the bicipital groove of the humerus. With an anterior typology, this will lengthen and weaken the latissimus dorsi as well as the rotator cuff muscles. Because of the latissimus dorsi's multiple areas of origination, it will cause an unnecessary pull on the thoracic area down to the lumbar spine.

In addition to the evaluation of the back and trunk, the thoracic and cervical posture were evaluated. Any excessive thoracic kyphosis or scoliosis can have a direct affect on the scapula and shoulder through transfer of muscular forces such as with the rotator cuff muscles and the latissimus dorsi muscles.

Some investigations have included an observation of the scapula in a posterior view, as well as active and passive range of motion of the shoulder (Goldstein, 2004; Shamley et al., 2012). The literature identifies the "Hiking test" as the most effective to evaluate the efficiency of scapular movement with respect to glenohumeral joint range of motion (Goldstein, 2004; Shamley et al., 2012). The common description of the test is that the participant is asked to perform a specific motion with an isometric contraction of the scapula to evaluate the "winging of the scapula." Any discrepancy between the scapulae is noted including but not limited to: initial movement of the upper trapezius ("hiking effect"), and inability of the scapula to move in conjunction with the glenohumeral complex. A "hiking effect" was more predominate in a post-surgical breast cancer population when a proper exercise program had not been initiated following surgery. This lead to an inappropriate learned adaptation of the shoulder complex, with inefficient movement of the scapula and glenohumeral joint.

2.9 Neurological Evaluation

Neurological impairments have been noted to be common following any surgical intervention as the invasiveness of the surgery disrupts the fascia and musculature (Shamley et al., 2007). There are numerous studies that have utilized neurological testing, including sensory and motor testing, during their clinical observation of the shoulder (Tasmuth et al., 1996; Babyar, 1996; Shamley et al., 2007).

Following surgery, we would suspect that sensory testing will be altered in the shoulder because of the cording in the axilla. The cording disrupts the fascia within the axilla which may restrict the nerves supplying the arm, shoulder and upper body. Studies have incorporated a neurological shoulder evaluation but have not noted the specificity of their neurological methodology including bilateral testing or the number of repetitions per sensory level (Tasmuth et al, 1996, Babyar, 1996; Shamley et al., 2007). Babyar (1996) includes sensory testing but does not describe the specific neurological levels tested.

Motor testing is commonly conducted as a standard in neurological testing however, the methodologies in the literature are quite inconsistent (Tasmuth et al., 1996; Babyar, 1996; Shamley et al., 2007). Babyar (1996) noted that motor testing was performed but did not discuss the specificity of the methodology.

2.10 Lymphedema

Lymphedema is a familiar occurrence following any type of breast cancer surgery accompanied by node biopsy or node dissection (Cinar et al., 2008; Wingate et al., 1985). Lymphedema refers to the presence of swelling in the affected shoulder's upper extremity following surgery. It occurs because the remaining lymph vessels are unable to drain enough fluid from the axillary area. The fluid builds up along the length of the arm and causes swelling

to remain in the affected upper extremity. The research outcomes from a number of investigators suggest that chemotherapy and radiation therapy around the axilla decreased lymph fluid flow in the arm, chest and breast area and lead to chronic swelling in the affected shoulder, arm and wrist (Cinar et al., 2008; Wingate et al., 1985).

The research to date consistently reveals the presence of lymphedema immediately following surgery (Cinar et al., 2008; Gerber et al., 1992, Sugden et al., 1998; Wingate et al., 1985; Aitken et al.,1989; Springer et al., 2010; Tasmuth et al., 1996; Michels et al., 2013; Kuehn et al., 2000, Hidding et al., 2014). The outcome of a number of investigations highlights that if lymphedema was left untreated, it caused an increase in pain of the shoulder and a decrease in the shoulder's range of motion. Michels et al (2013) found that women who had lymphedema had a poorer quality of life in comparison with women who didn't have lymphedema due to challenges with common everyday like brushing their hair or performing laundry tasks. Hidding et al. (2014) found that pain, lymphedema and a decrease in range of motion was noted by participants in approximately 60% of articles reviewed at one-year post-surgery.

The easiest and most common way to measure for lymphedema is by measuring circumferences using a soft cloth measuring tape. Comparisons between studies is challenging owing to the inconsistent locations for the circumference measurement of lymphedema (Ridner et al., 2007; Sugden et al. 1998, Wingate,1985; Aitken et al., 1989; Tasmuth et al., 1996). Some researchers have measured lymphedema between 10 to 50 cm superiorly from the ulnar styloid process in 10 cm increments (Ridner et al., 2007). Other researchers made only one circumferential measurement made at 15 cm above the styloid process and 10 cm below the olecranon (Aitken et al., 1989). This manual form of measuring lymphedema above and below the olecranon appeared to be the most consistent method supported by the majority of studies

listed above. The common standard of the true presence of lymphedema is a cloth measurement difference of greater than 2cm between the affected and non-affected arm above and below the olecranon (Sugden et al., 1998; Wingate, 1985).

Wingate (1985) noted the presence of lymphedema at 6 months was approximately 42 % of post-surgical patients. They also found that that risk of developing late lymphedema was unrelated to age, menopausal status, handedness, early lymphedema, surgical complication, the total amount of radiation therapy, the presence of drug therapy, and the extensiveness of the surgery performed on the breast tissue. Because the amount of lymphedema is difficult to predict before breast cancer surgery, all patients should initiate a muscle pump effect by beginning an active rehabilitation program to increase the capacity of the lymph vessels to contract and expand in hopes of minimizing the level of lymphedema in the shoulder.

2.11 Range of motion evaluation

Goniometer shoulder assessment has been validated for reliability and is a standardized means of manually measuring range of motion in the shoulder (Hayes et al., 2001). As discussed previously, a breast cancer survivor's quality of life has been linked to their perception of their ability to carry out normal activities of daily living. A dysfunction in shoulder range of motion is multi-faceted. It appears that the limitation in a shoulder's range of motion may be due to the invasiveness of the surgical procedure, improper or inadequate active rehabilitation following surgery, a psychological barrier or lack of education with respect to knowing when to begin to move their shoulder following surgery and physiological changes to the musculature or fascia following chemotherapy and radiation therapy.

The shoulder exhibits a common capsular pattern following any injury or surgery. This pattern is important to be aware of as it allows the breast cancer survivor to know when to be

concerned with their lack of range of motion and for the therapist to know how much of a dysfunction they exhibit. Magee (2014) described the shoulder's capsular pattern as a specific list of movements that will typically become restricted for an individual when inflammation was present within the shoulder complex. Although all movements in shoulder range of motion may become restricted, three movements have been found to be specifically related to moderate to severe inflammation and, if left untreated will lead to chronic shoulder dysfunction: external rotation, abduction and medial rotation. Chronic dysfunction is measured by the amount of time that a dysfunction has been present. As noted previously, breast cancer survivors can exhibit shoulder dysfunctions up to 2 years post-surgery. This is no surprise because if breast cancer survivors are not implementing a rehabilitation program to restore proper shoulder biomechanics, the effects of shoulder dysfunction can last an extremely long period of time. This chronicity can lead to permanent damage to the musculature surrounding the shoulder.

The research outcomes from a number of investigations have indicated the importance of measuring range of motion, many did not take into account the capsular pattern of the shoulder. They consisted of measuring range of motion of some or only one of the critically identified movements of external rotation, abduction or medial rotation. Cinar et al. (2008) measured flexion, abduction and adduction of breast cancer survivors post-mastectomy. Wingate (1985) measured shoulder flexion, abduction and external rotation. Aiken et al. (1989) measured abduction with internal rotation and abduction with external rotation. To ensure a proper measurement of true restriction, all ranges of motion of the shoulder should be assessed.

Goniometer shoulder assessment has been validated for reliability for manually measuring range of motion in the shoulder (Hayes et al., 2001, Cinar et al., 2008; Wingate, 1985; Aiken et al., 1985; Gerber et al., 1992; Springer et al., 2010). Typically, studies that have used

used a standard manual goniometer have done so with the participant in a seated position which does not mimic proper daily life activities like cleaning and lifting objects. Aiken et al. (1985) included their specific testing position to include bilateral shoulder range of motion with the participant in a seated position, feet firmly placed on the floor and the height of the chair adjusted for each subject to ensure that their trunk was stabilized without impairing the movement of the scapula. They specified their end points to be at the level of the compensatory movements of the shoulder girdle and/or trunk range of motion that was limited by pain or when the participant reported experiencing an uncomfortable level of tightness.

2.12 Visual Analog Scale

Multiple studies have used a visual analog scale (VAS) to denote any pain with the ranges of motion (Tasmuth et al., 1996; Kuehn et al., 2000; Gerber et al., 1992; Springer et al., 2010) (See Appendix C). A VAS is a clear, concise way for the participant to make a subjective decision on the level of pain with specific movements. It is a psychometric response scale whereby the person will specify their level of pain along a continuous line between two end-points: zero indicating no pain and 10 indicating the most pain ever felt. The VAS is considered a superior metric scale with discrete increments. A study performed by Bijur et al. (2001) found that the VAS was an effective and reliable assessment tool for acute pain. According to the authors "The clinical significance of this finding is that if the VAS were used to measure change in pain, a change of 10 mm or more would likely indicate a true change in the experience of pain for most patients. For research purposes the findings from this study suggested that mean differences between groups of patients smaller than 10 mm, which has been interpreted as the distance between two points on the scale, are within the error of the method, and should be

interpreted with caution." However, the studies that have implemented the VAS did not note on the specific instructions that were given to the participants to ensure reliability.

2.13 Theraband vs Weights

Cormie et al. (2013) found that an active strengthening program utilizing a heavy resistance program was beneficial and was safe for breast cancer patients approximately 6 months post-surgery. The authors incorporated a higher level of resistance, approximately 85% of their repetition maximum for 62 post-surgical participants. They noted that the role of any strengthening program for breast cancer survivors was important for regaining shoulder muscular endurance. Although, the research is limited, research to date is supportive of including a shoulder rehabilitation program using elastic resistance bands (Aronen, 1985; Ellenbecker, 1989; Litchfield, 1995; McCann, 1993; Colado, 2008).

A study performed by Hintermester et al. (1998) assessed electromyographic activity on nineteen healthy males during shoulder rehabilitation using elastic resistance bands. The researchers found the muscle activity patterns observed in the study effectively targeted the rotator cuff muscles and surrounding musculature while using elastic resistance bands during controlled, low-level resistance exercises. They found that elastic resistance bands were an appropriate intervention for a post-surgical rehabilitation program to improve strength: however, a healthy population was used in this study and not breast cancer survivors.

Anderson et al. (2011) found that an active and daily exercise program was effective in improving neck and shoulder mobility in patients who experienced chronic pain. A band exercise program was implemented for 174 women who suffered from various neck and shoulder muscular imbalances. The exercise program's duration was between 2-12 min and was implemented five days per week. The study found that as little as 2 minutes of daily

progressive resistance training for 10 weeks proved to be clinically significant in improving healthy adults' neck and shoulder function. The benefit of this study was that they used a larger sample size of women over the age of 18, however, the women in the study were a healthy population.

The use of elastic resistance bands is beneficial to breast cancer survivors who potentially have never performed a strengthening program in a while or ever. When using elastic resistance bands, the participant can perform each of the exercises in a slow, controlled manner while the targeted muscles are performing their concentric and eccentric movements. Unlike weights, the force produced by the elastic resistance bands are directly related to the elongation of the band. In addition, because of the ease in the usage of the elastic resistance band, the resistance of the band can be easily adjusted in small increments to equal the muscular progression of the participant. Additionally, an elastic resistance band is quite mobile and compact.

Theraband ®brand has been in operation since 1976 and produces a quality elastic resistance band used by many clinics and hospitals. In the Primary Investigator's private practice, Theraband ® has been used for approximately 15 years as the quality of the elastic resistance bands have been reliable. Theraband® produced their own standardized elastic resistance bands in various colours which coincided with their resistance: red is considered an easier resistance but within the medium category of bands. Next is green, which is slightly more resistive than red. These levels of resistance varied in subjectivity between the therapist and the patient, however in order to ensure a measure of reliability an appropriate subjective resistance level for each participant, the Borg Scale of Perceived Exertion (RPE) can be used.

2.14 Borg Scale of Perceived Exertion

The RPE (See Appendix D) has been found to be reliable and valid in determining exercise intensity (Day et al., 2004). They found the intraclass correlation coefficient for each training session RPE was 0.88. The following is a description of average RPE:

0: Nothing at all
1: Very light
2: Fairly light
3: Moderate
4: Somewhat hard
5: Hard
6:
7: Very hard
8:
9:
10: Very, very hard (maximal)

To date, there is no research that has been found to determine the appropriate level of resistance for breast cancer survivors. This level can be used through the progressions of each strength exercise.

2.15 Sets and Repetitions

For the safety of the participant and for the reliability purpose of each study, exercises are typically prescribed by performing specific sets and repetitions throughout the progression of an exercise program. To date, there is scarce research regarding the appropriate sets or repetitions for breast cancer survivors post-surgery. Within the Primary Investigator's private practice experience, each strength rehabilitative exercise is provided to each patient with one set of 10 repetitions to begin with, but that is not performed to failure to ensure there was no pain associated with the specific exercise. This form of rehabilitation has been successfully incorporated for over 15 years as an appropriate manner of progression in cases of muscular imbalance and atrophy.

Within research, there appears to be an inconsistency of a standard for a starting set or repetitions followed by the appropriate progression for this population. A study performed by Winters-Stone et al. (2012) used one set of between 8-12 repetitions for an overall strength program for breast cancer survivors. Another study by Courneya et al. (2007) utilized a starting set of 8-12 repetitions. Both studies made no mention to the reasoning behind the choice of sets or repetitions.

2.16 Purpose, Hypothesis and Objectives

Purpose: The purpose of the study was to help women focus on improving their perceived quality of life following breast cancer surgery through a specific and active shoulder exercise program.

Hypothesis: It is hypothesized that implementing a shoulder specific active exercise program for breast cancer survivors, 6-9 months post-surgery will improve this population's perceived quality of life by a minimum increase in the raw score of the EORTC QLQ-C30 of 10, a decrease in the symptom scale of the EORTC QLQ-C30 by a minimum raw score of 10, a decrease in DASH raw score by a minimum of 10, a decrease in lymphedema of 2 cm above and below the olecranon, a decrease in muscle atrophy, an improvement in shoulder range of motion of 5º in each goniometer measurement.

Objectives:

1. Gather shoulder related data for this population and at this time frame.
2. Improve this population's perceived quality of life
3. Improve this population's perceived shoulder function
4. Improve this population's clinically observable posture
5. Decrease this population's lymphedema

6. Improve this population's active shoulder range of motion.

METHODOLOGY

3.1 Participants – Inclusion and Exclusion Criteria

Prior to the commencement of the recruitment phase of this study, York University's Human Participants Research Committee approved the study on April 16, 2016 (Appendix E). Two attempts were made to recruit participants from various breast cancer support clinics in the Greater Toronto Area over a 5-month period. Recruitment included emails and phone calls made to the breast cancer support centers as well as postings were put up on the breast cancer support center's websites and social media outlets (See Appendix F). Contact was made with Dr. Jaime Escallon at Mount Sinai in September 2016. Dr. Escallon is a general surgeon specializing in surgical oncology at Mount Sinai's Marvelle Koffler Breast Cancer clinic. He performs approximately 250 surgeries per year and has access to other surgeons within the hospital as well as the University Health Network (UHN).

Participants were still recruited from the breast cancer survivor clinics, but additional participants were recruited from Mount Sinai's Marvelle Koffler Breast Centre following the approval from the Toronto Academic Health Sciences Network, Human Subjects Research Application. Approval was obtained by the Research Ethics Board at Mount Sinai on November 17, 2016 (Appendix G). All interested participants were informed of the details of the project and were required to provide informed written consent to be contacted by the Primary Investigator (See Appendix H), as well as consent to participate in the study (Appendix I).

A Data Transfer and Inter-Institutional Research Agreement was drafted between Mount Sinai and York University to allow for the researcher to analyze the data at York University.

Initially, the study was designed to include mastectomy patients as mastectomy surgery was the most invasive surgery in breast cancer treatment. However, to increase the sample size,

the decision was made in January 2017 to include lumpectomy patients in addition to mastectomy patients. Approval was obtained by York University for this amendment on April 20, 2017.

Inclusion and Exclusion Criteria utilized in this study were based on similar criteria found in articles dealing with exercise programs for breast cancer survivors. Below is a concise list of features of the inclusion and exclusion criteria along with their references or justifications.

Inclusion Criteria:

1. Unilateral Lumpectomy or Mastectomy Surgery, 6-9 months post-surgery
    a. Most breast cancer survivors are provided an exercise program immediately following surgery, up to 6 weeks post-surgery. Following that, there is no usual standard of care exercise regimen unless the patient reports to their surgeon that they are having shoulder issues. Jackman et al. (2004) reported that an exercise program for muscle atrophy applied longer than 12 months from the start of the atrophy will result in very little to no change in muscle atrophy. Therefore, this intervention at 6-9 months was chosen as patients typically follow up with their surgeons at 6 months, and therefore would be able to be approached for possible participation in this study. In addition, any exercise regimen implemented before 12 months post surgery would allow for the most benefit in decreasing muscle atrophy in the affected shoulder.
2. Completed all Chemotherapy and Radiation Therapy Treatment:
    a. Shamley et al. (2007) found that chemotherapy and radiation therapy alter the health of the muscle fibers. Secondary damage occurs due to a decrease in the blood supply to the muscles limiting their ability to expand and contract.

Therefore, to control for baseline variability, all participants prior to their participation had completed all chemotherapy or radiation therapy.

3. Diagnosed as stage 1-3 Breast Cancer:
    a. According to the Canadian Cancer Society (2017), staging is a way of classifying breast cancer based on the extent of the cancer within the body. Each stage is given a number: 0 is no sign of cancer to 4 whereby the tumor has spread to other areas of the body. Stage 4 cancer was not included in this study, because it encompasses various confounding factors: including exercise being contra-indication.
4. Self-reported diligence in at least 50% of exercises given immediately post surgery, if any exercises were given:

    There is no research to date on the level of compliance of a breast cancer rehabilitative exercise program immediately following surgery affecting the diligence of a longer term exercise program. Therefore, if a breast cancer survivor was diligent in at least 50% of their exercise program given immediately following surgery, they would be more likely to understand some of the movements associated with the present study. When participants self-reported compliance in their immediate post-surgical exercise program, they have already experienced the benefit of an active exercise and can build on their initial program. Any participants that self-reported non-compliance of 49% or less, were excluded from this study.

Exclusion Criteria:

1. Any neurological complaints including weakness with myotomal testing:

    a) Myotomal Testing: Myotomal testing is a common neurological test to assess a local non-progressive weakness of a muscle (Magee, 2017). Muscle weakness is an acceptable common behavior exhibited by breast cancer survivors at 6-9 months as their lack of a shoulder specific exercise program could have lead to a muscular imbalance that can be rectified with a proper active exercise program. If the participant reported pain while performing the myotome test, but was still able to resist the tested movement, they were included in this study.

    b) Sensory Testing: Sensory testing was documented to determine interruptions in breast and surrounding tissue which may not resolve until a year following breast cancer surgery (Jackman et al., 2004). All women will exhibit a sensory deficit as this can be common following breast cancer surgery with an axillary node dissection (Jackman et al., 2004).

5. Unable to actively flex arm to 90 º of flexion ± 5 ° and Abduction of 90 ° ± 5 °:

    a. Eligible study participants were able to actively abduct and flex their affected arm to 90 ° ± 5 °:. Work by Box et al., 2002 reported this specific inclusion criteria to minimize baseline variability within their study.

Table 2 is a synopsis of the specific inclusion and exclusion criteria for this study.

Table 2. Inclusion and exclusion criteria of participants.

Inclusion	Exclusion
Unilateral Lumpectomy or Mastectomy Surgery, 6-9 months ago	Any neurological complaints including weakness with myotomal testing
Completed all Chemotherapy and Radiation Therapy Treatment	Unable to actively flex arm to 90° degrees of flexion ± 5 ° and Abduction of 90 ° ± 5 ° (Box, Reul-Hirche, Bullock-Saxton, Furnival, 2002)
Diagnosed as stage 1-3 Breast Cancer	
Reported diligence in at least 50% of exercises given immediately post surgery, if any exercises were given	

3.2 Study Design

In September 2016, following approval from Mount Sinai, Dr. Escallon assisted in the recruitment of participants from the Marvelle Koffler Breast Cancer Centre by streamlining referrals from other physicians and surgeons within the center. His role was to assess each participant for their possible participation in the study.

All the assessments were performed at Marvelle Koffler Breast Cancer Center at Mount Sinai Hospital or at a private clinical office in Toronto. The study design included breast cancer survivors assessed at 6-9 months post-surgery, with unilateral lumpectomy or mastectomy. At the point of assessment, all participants completed follow up care including chemotherapy or radiation treatment however, participants who continued to receive medical treatment such as medication were not excluded. The data was collected at three specific time points:

a) Baseline (B): Between 6-9 months post-surgery;

b) Assessment (A1): 4 weeks post baseline; and

c) Assessment (A2): 8 weeks post baseline.

All participants were assessed at three time points and attended one exercise session, whereby they were given a demonstration of the exercises (5-10 minutes), a 5-10-minute discussion on the benefits of exercising for their quality of life and shoulder function and a handout of an explanation of the exercises with specific repetitions, sets as well as how to progress their exercises safely and effectively (Appendix J). Participants had the opportunity to attend three more exercise-guided sessions including further informative supervision, with verbal and tactile feedback, by an experienced rehabilitation professional(s) to ensure the fidelity of the performance of the exercises. The consultation included an observational review of all of the

exercises as well as an open dialogue regarding their active exercise program. A more detailed description can be found at 3.10 Weekly Progressions.

3.3 Procedures and Measurements

All participants opted to perform the clinical observation first followed by the questionnaires so as "not to be rushed." Questionnaires included the European Organization for Research and Treatment of Cancer with the breast cancer module attached (EORTC Q-C30/BR-32) and Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire. In addition, a visual analog pain-scale (VAS) was utilized for the purpose of regulating and minimizing any pain sensation that each participant felt during their clinical observation. Clinical observations included sensory testing, motor testing, measurement of lymphedema and a goniometer shoulder assessment were also performed.

Initially, a second researcher was recruited to validate the clinical observational findings of the principle investigator. Due to time constraints and scheduling the second researcher was unable to commit to the study's demands. To ensure that the study was completed in a timely fashion, the principle investigator completed each participants' clinical observations. To further ensure validity, the principle researcher did not review or preview any data collected until all participants had completed their involvement in this research study. In addition, there was no review of the assessments prior to the follow up assessments of each participant. Final review of all data to ensure no missing fields was completed prior to statistical analysis.

3.4 Questionnaires

The EORTC QLQ-C30 includes 30 items with nine multi-level scales. A higher score in the functional scales would be indicative of a participant's perception of overall better functioning however, a lower score in the symptom scale would be indicative of a participant's

better perception of their symptoms (e.g. pain or numbness). The EORTC QLQ-30/BR-23 is comprised of multiple scales and items. Functional scales consist of questions pertaining to Physical Functioning (PF2), Role Functioning (RF2), Emotional Functioning (EF), Cognitive Functioning (CF) and Social Functioning (SF). Symptom scales consists of Fatigue (FA), Nausea and Vomiting (NV), Pain (PA), Dyspnoea (DY) Insomnia (SL), Appetite Loss (AP), Constipation (CO), Diarrhea (DI), and Financial Difficulties (FI). The Breast Cancer module is comprised of an additional 23 questions specifically for breast cancer patients. The EORTC QLQ-C30 and QLQ-BR23 has been validated to ensure its reliability in the assessment of quality of life in breast cancer patients (Tan, et al., 2015). Tan et al. (2015) found that the EORTC QLQ-C30 and QLQ-BR23 had a Cronbach's alpha coefficient of 0.846 and 0.873 respectively. Therefore, the EORTC QLQ-C30 and QLQ-BR23 have a good internal consistency and the items that they proposed to measure do produce similar scores.

The Disabilities of the Arm Shoulder Hand (DASH) is another questionnaire that focused on the patient's perception of their shoulder mobility. A study performed by Gummesson et al. (2003) found that the DASH questionnaire was a valid and reliable tool when used in 109 post-surgical patients in various stages of shoulder recovery in a healthy population. The two questionnaires, EORTC QLQ-C30/BR-23 and DASH, were used to examine the quality of life for this study's participants at 6-9 months post-surgery as well as specifically collecting data on this population's range of motion (ROM), strength and overall ability of the affected shoulder.

The EORTC QLQ-C30 with QLQ-BR23 and the DASH was given to each participant at one time, so they would be able to complete both questionnaires in one sitting. In a pilot study performed by the principle investigator, the average time for completing the two questionnaires in one sitting was found to be approximately 15 minutes. The completed questionnaires were

placed in a sealed envelope and marked with the participant's Study ID, which was cross-referenced via a master list. This information was kept in a locked filing cabinet at Mount Sinai Hospital until the study's completion, to help avoid assessor bias.

3.5 Clinical Observations

All participants were asked to wear comfortable clothing such as sports bra and/or tank top to enable the principle investigator to adequately view and assess their bilateral shoulders and scapula. The clinical observations were initiated using a postural assessment with no verbal information relayed to the participant except for "Take a deep breath in and out and look straight ahead. Please don't move from your position." The set of observations included whole body posture with an emphasis on the upper body and was recorded on a clinical observation sheet (Appendix K). Each clinical observation sheet included the date of the assessment as well as the participants Study ID. As mentioned previously, no data was reviewed prior to the follow up assessments of the participants.

An initial observation was made with the participant in standing: anterior, lateral view and posterior view. A visual estimate was made in each position for an anterior typology which included guarding of the shoulder complex, shoulder muscle atrophy, and general muscular imbalance. A lateral view examined for the head in a neutral position, the scapula resting flat against the body, the thoracic cage not compressed, the normal and equally distributed curves of the spine, a neutral pelvic position, along with the knees and lower legs resting equi-distant between the anterior and posterior pelvic region for neutral alignment of the tibia over the lateral malleolus.

The scapula was subsequently observed from a posterior view. The participant began with arms at their sides and was asked to lift their arms to the front (flexion) as much as they

could within a pain-free range and then returned to the starting position. Any pain, tightness or discomfort was noted using the VAS. Next, the participant was asked to elevate their arms from their sides (Abduction-ABD) within a pain-free range and then returned to the starting position. Any pain, tightness or discomfort was noted using the VAS. To test for a winging scapula, the participant slowly forward flexed the arms to 90 degrees with their wrists extended and palms facing away from the body in a push up position. With the hands adhered to a wall in the push up position, the participant was asked to push against the wall in an isometric contraction for 3-5 seconds. Any discrepancy between the position of the scapulae on the thoracic wall during this contraction was noted. Observations included, but were not limited to: initial movement of the upper trapezius ("hiking effect"), and inability of the scapula to move in conjunction with the glenohumeral complex. Any pain, tightness or discomfort was noted using the VAS.

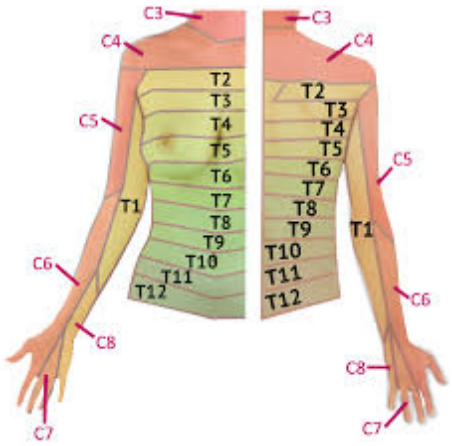
3.6. Neurological Assessment

A neurological assessment, including sensory and motor testing only, was performed to help rule out any underlying neurological deficits. Sensory testing was utilized as it related to the shoulder, arm and thoracic region as these areas tended to be most affected following surgery. The sensory testing was performed to allow the principle investigator to provide appropriate tactile feedback on a participant's body that may have been altered. The sensory tests were tested bilaterally beginning with the unaffected side followed by the affected side. The dull area of a pinwheel was used with light, consistent pressure along the length of the sensory level.

The researcher advised the participant prior to starting the sensory testing: "I'm going to be testing your sensation. Please let me know if both sides have equal, dull sensations or if your affected side is different from your unaffected side." The precise dermatomes that were tested

were C4, C5, C6, T1, T2, T3, T4, T5 and T6 (See Figure 2).

Figure 2: Dermatome Patterns of the Upper Extremity



http://instantmedic.netai.net/images/aptop.png

Dermatomes are defined as areas of skin that are innervated by a single spinal nerve (Magee, 2014) and are used to determine the exact nerve root that is affected following breast cancer surgery. Therefore, the usage of dermatomes in the clinical observation was used to collect data for future research in terms of what exact nerve roots were affected following breast cancer surgery.

Specific motor testing was performed to evaluate the muscles of the shoulder, elbow, and wrist (Magee, 2014) required to complete the study's exercise intervention. Motor testing was performed to validate that there were no neurological signs and symptoms that may have excluded the participant from the study. A positive motor test was considered to occur when a specific muscle was tested and demonstrated progressive muscle weakness when tested multiple times. A local muscle weakness, which was not an inclusion criteria, was when the muscle exhibited a non-progressive weak test. This is simply a weakness locally at the muscle and is not

a neurological defect in the muscle. The motor tests were assessed by asking the participant to meet the researcher's resistance (low-medium resistance) for a count of 5 seconds in an isometric contraction in the specified motion listed below. A rest of 10 seconds was allotted in between myotome tests. The unaffected side of the participant was tested first followed by the affected side. A positive myotome test, and subsequent removal from the study, was the inability to resist the isometric contraction in the opposite force of the researcher for 5 seconds. The myotomes were tested in a seated position as follows (See Appendix L):

C4: Shoulder Elevation
Description: The participant was asked to lift their shoulder to their ear and to hold that position as the researcher attempted to push the shoulder down to the floor by applying a downward pressure at the Acromioclavicular joint.

C5: Shoulder Abduction
Description: The participant was asked to bend the elbow to a 90-degree angle. Next, the participant was asked to move the shoulder in the direction outward laterally away from the body to a 90-degree angle. The participant was asked to maintain this position and then resisted the researcher's downward force, toward the floor, just superior to the elbow.

C6: Elbow Flexion/Wrist Extension
Description: The participant was asked to bend the elbow to a 90-degree angle with their elbow adhered to the side of their body. The researcher pushed down on the bent elbow just superior to the wrist in a downward motion toward the floor.
Note: Although the myotome includes the testing of wrist extension, only elbow flexion was done as it mimics the shoulder movement required for the exercise protocol.

C7: Elbow Extension/Wrist Flexion
Description: The participant was asked to bend the elbow to a 90-degree angle with their elbow adhered to the side of their body. The researcher applied pressure in an upward motion, just superior to the wrist, on the side of the back of the palm. The participant was asked to resist in a downward motion toward the floor by keeping their elbow close to their body.
Note: Although the myotome includes the testing of wrist flexion, only elbow extension was done as it mimics the shoulder movement required for the exercise protocol.

3.7 Measurement of Lymphedema

Lymphedema is a common occurrence following any type of breast cancer surgery accompanied by node biopsy or node dissection (Ridner et al., 2007). The possible presence of lymphedema causes an increase in the pain of the shoulder and thereby leads to a decrease in the ROM. Therefore, lymphedema measurement was assessed in this study. The manual form of measuring lymphedema via the circumference of the arm with a soft cloth measuring tape has been used throughout the literature (Ridner et al., 2007)

Participants were asked to lie supine (on their back) with arms by their sides. The primary investigator said: "Please try and relax your arms as much as you can." The anatomical landmarks used in this study were 10 cm below the olecranon (the point of the elbow) and 15 cm above the olecranon. The circumference of the arm was measured using a cloth measuring tape. This was performed three times with a recording made of each measurement, then an average of the three values, as well as any circumference difference greater than 2 cm between the arms.

3.8 Goniometer Shoulder Assessment

Goniometer shoulder assessment has been validated for reliability for manually measuring range of motion in the shoulder (Hayes et al., 2001). Participants were seated with their back pressed against a hard-back chair with no arms and feet planted on the floor. The only movements performed in supine were the internal and external rotation of the arm. The participant's comfort was of most importance so a stool was placed under the feet or a soft pillow placed on the seat of the chair to ensure proper position. To ensure comfort in a supine position, a pillow was placed under their head and/or knees. Any pain, tightness or discomfort was noted using the VAS. The participant was asked to rate any pain from 0-10 with 10 being the most pain ever felt and 0 is no pain. The measurements were performed on the unaffected arm first

and then the affected arm with the average of three measurements recorded. A manual goniometer was used and all the measurements were recorded. The principle investigator performed the shoulder range of motion assessments with the following limited verbal directions (See Appendix M):

a) **Shoulder Flexion**: The participant's arm began at their side with their palm facing their body. The axis of the goniometer was to be 1 inch below the acromion process. The moveable arm of the goniometer rested along the patient's humerus and the fixed portion of the goniometer was placed along the side of their body pointing in the direction of the floor. The fixed part of the goniometer remained in place and the moveable section glided with the humerus in flexion. The patient was asked to flex the arm in a forward motion toward the ceiling with the palm of the participant's hand still facing their body.

b) **Shoulder Extension:** The starting position was the same as in flexion. The axis of the goniometer was 1 inch below the acromion process. The fixed arm of the goniometer was pointed to the floor and the moveable part was along the humerus. The patient was then asked to extend their arm backward toward the back of the chair. The fixed section of the goniometer remained still and the moveable section followed the range of the humerus.

c) **Shoulder Abduction:** Measurement of abduction was performed with the goniometer posterior to the shoulder to avoid any irritation to the affected breast area. The axis of the goniometer was on the posterior glenohumeral joint at the lateral border of the scapula and just medial to the humerus. The moveable arm of the goniometer was placed along the lateral aspect of the humerus and the fixed section of the humerus remained pointing toward the floor. The patient was asked to move their arm to the side (Abduction) and away from their body leading with the thumb and their palm facing to the front.

d) **Shoulder Horizontal Abduction:** The participant's arm was pointed in front at a 45-degree angle to the body. The axis of the goniometer was on top of the acromion process. The fixed arm of the goniometer was pointed at a 90-degree angle to the body. The moveable arm of the goniometer was pointed on top of the humerus. The participant maintained the same starting position and then moved the arm parallel to the floor and away from the midline of the body. The fixed arm of the goniometer remained pointed forward as the moveable arm of the goniometer moved with the humerus.

e) **Shoulder Horizontal Adduction:** The participant's arm was pointed out to the side of the participant, away from the midline of the body at a 45-degree angle from the body. The axis of the goniometer was on top of the acromion process with the fixed arm of the goniometer out from the body and the moveable arm of the goniometer on top of the humerus. The participant kept their arm straight as they moved their arm parallel to the floor toward the midline of the body. The fixed arm of the goniometer was pointed out as the moveable arm of the goniometer traveled with the humerus.

f) **Shoulder Internal Rotation:** The participant began in a supine position with the humerus to the side of their body at a 45-degree angle and with the arm bent at 90 degrees. The axis of the goniometer was on the olecranon process. The fixed arm of the goniometer was pointing toward the floor and the moveable arm of the goniometer was along the ulna. With the participant maintaining the above arm position, the participant rotated the forearm down to the floor. The fixed arm of the goniometer remained pointed to the floor and the moveable arm of the goniometer moved with the ulna.

g) **Shoulder External Rotation:** The participant began in a supine position with humerus raised to the side of their body at 45 degrees but with the arm bent at the elbow at 90 degrees. The axis of the goniometer was on the olecranon process. The fixed arm of the goniometer was pointed to the floor and the moveable arm remained along the ulna. The participant maintained the same humerus position and then rotated the arm toward the ceiling. The fixed arm of the goniometer remained pointed to the floor and the moveable arm of the goniometer moved with the ulna.

3.9 Treatment Protocol

At approximately 6 months, breast cancer survivors found an inefficient substitution pattern necessary to carry on their daily life activities: mainly an anteriorly rotated shoulder on the affected side which causes a shortening of the pectoralis muscle as it attaches onto the coracoid process of the scapula (McClure et al., 2001; Karki et al., 2005). Once this occurred, there exists a muscular lengthening of the rhomboids (attachment onto the medial section the scapula) and middle trapezius (attachment onto the spine of the scapula). The muscles become weak in that chronic lengthened position and do not allow for proper mobility of the glenohumeral joint and scapula.

The exercise protocol utilized for this study was a revised version of the results by Moseley, Jobe, Pink, Perry, and Tibone (1992) performed on healthy adults. They performed EMG testing on 12 various upper body exercises for the shoulder to determine the exercises that recruited the most scapular activity. The program implemented for this study began with one stretch for the pectoralis major and minor complex performed three times per day, daily, and held for 30 seconds each time. Next, each strength exercise was performed slowly, in order to

initiate slow motor unit recruitment and through a pain free range. The participants were asked to perform the strength exercises in the same order, once per day and everyday. The main emphasis was being on low resistance but higher repetitions. They were provided a specific checklist/diary to ensure that they were adhering to the study's principles.

The Borg rating of perceived exertion scale (RPE) was used to determine their threshold level of resistance with a goal of 5 or 6 out of 10 following one set of 10 repetitions. The reliability of this scale was proven to be statistically significant with an intraclass correlation coefficient of 0.88 (Day et al., 2004). This starting resistance included either red (light) or green (medium) resistance band. Andersen et al. (2010) reported that resistance exercise with hand weights or resistance bands showed comparable increases in muscle activation with increasing resistance.

Each exercise pamphlet, provided to the participants, included a cover sheet with a detailed description of the starting number of sets and repetitions as well as a structured progression per exercise per week.

The exercise program consisted of the following, in the exact order with described progressions (see Appendix J):

1. **Pectoralis major/minor stretch**

   Description: The participant stood facing a corner of a room, then brought one foot forward toward the corner of the wall at approximately 1-2 feet in front of the body and approximately shoulder width apart. Next, the participant brought their arms to their sides to about 90 degrees with arms bent at the elbow with fingers toward the ceiling and palms facing in the direction of the wall. Thereafter, the participant placed their palm(s) on the wall in line with the foot that's in front and leaned their upper body into the wall focusing on bringing their chest to the wall. The participant began with only one arm pectoralis stretch and then when they perceived an improvement in their range of motion during the stretch and with no pain, were able will move to two arms in the corner, followed by both arms on the inside of a door-frame.

This exercise was performed three times per day and held for 30 seconds in the position closest to the wall.

2. **Shoulder movement with internal rotation**

   Description: The participant stood with their arms at their sides. They rotated their arms at their shoulders so their elbows were straight, thumbs are closest to their legs and palms were facing behind them. While standing with feet shoulder width apart, with shoulders down and away from their ears, the participant raised their arms up to the ceiling and stopped just below their shoulders or in a pain-free range. Afterward, the participant then returned to the starting position.
   One set of 10 repetitions were performed daily with the determined resistance provided to the participant by the primary investigator.

3. **Single arm, bent over row**

   Description: The participant's beginning position is standing next to a table or a chair, followed by the one foot closest to the table or chair approximately 1-2 feet in front of the other foot and shoulder width apart. Next, the participant bent forward from the hips and leaned their upper-body forward while placing their hand closest to the table or chair in a push-up position. The upper body was maintained bent forward at a 45-degree angle, while the "working arm" is extended toward the floor with the palm facing the participant. Following, the participant lifted the wrist of the working arm toward the ceiling and glided their arm close to their body making contact between the wrist and the side of their body and returned to the starting position. This exercise was performed one set of 10 repetitions daily with the determined resistance provided to the participant by the primary investigator.

4. **Push ups with a plus**

   Description: The participant began in a push up position on the wall and was only progressed to a chair push-up when the primary investigator instructed the participant to. The participant started in a standing position about 1-2 feet away from the wall with arms extended in front of them in a push up position with palms touching the wall and arms shoulder width apart and just below their collarbone. Afterward, they bent their arms at their elbows in an attempt to touch their chest to the wall (or chair when instructed to by the primary investigator using the Borg Scale for perceived exertion). They pushed themselves up and away from the wall and at the position when their elbows were completely straight, they accentuated their shoulder blades outward like the position of a cat. This was held for 1-2 seconds, next returning to the down position of the push-up. The participant began with one set of 10 repetitions performed daily.

3.10 Weekly Progressions

Each participant was advised on the proper technique and how to make the necessary progressions of each of the strengthening exercises. Each participant was seen a minimum of three times to a maximum of five times, to ensure a guided progression of their exercise regimen. The researcher supplied feedback to the participants either through verbal communication or email or telephone conversation which included questions regarding injury management or exercise position confirmation. Questions and feedback provided by the researcher included some of the following:

1. How are your exercises?
2. Do you have any pain in your shoulder, arm, or upper extremity?
3. Do you notice any regression in shoulder range of motion or a decrease in strength?
4. Are you able to perform all of the exercises as we have reviewed?
5. Do you have any additional questions regarding your exercises?
6. Do you feel able to now perform all of your exercises easily?
7. When your arm is tired while performing the exercises, does this sensation go away immediately following the completion of the exercises?
8. If so, then would you be comfortable in progressing your exercises another 5 repetitions for the week or until our next session?

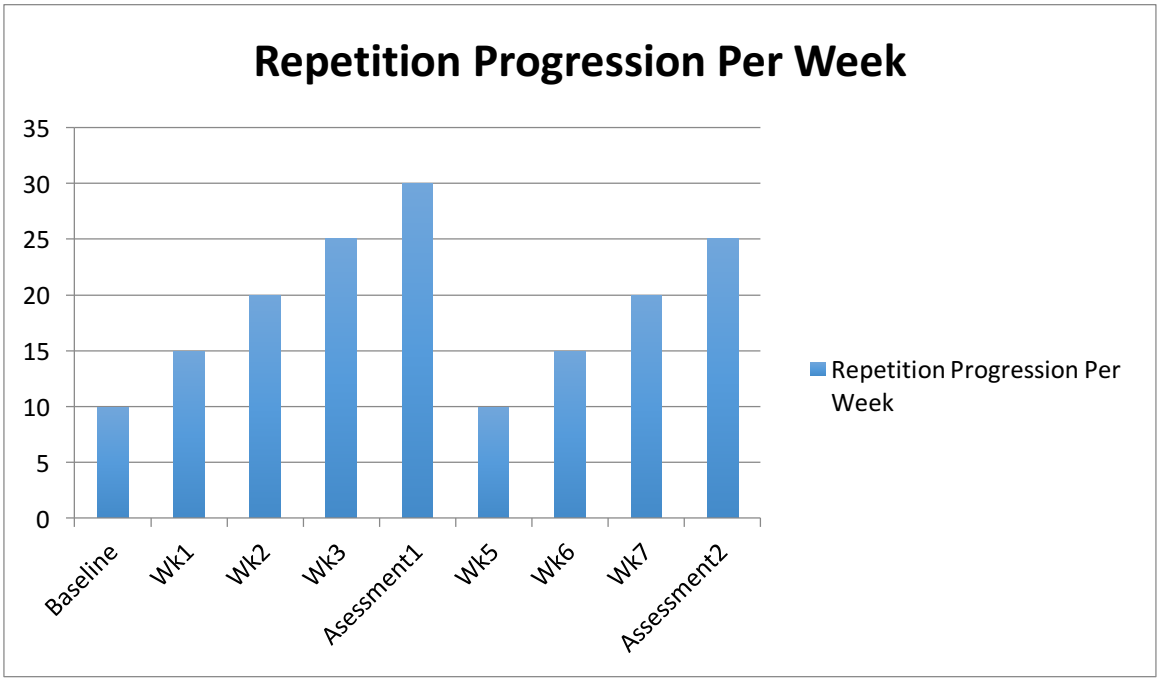
Responses verbalized by the participants included some of the following:

1. My exercises are going fine.
2. How long do I hold the stretch for?
3. How many times do I do the strengthening exercises?
4. How tight should the band be?

5. My shoulder is fine but my shoulder is tired at the end of the exercises, what should I do?
6. I'm not in pain but feel that the exercises are easy, can I progress them to the next level?

Each week, the participant recorded their progression on their exercise handout package provided (Appendix J) along with the resistance level that the strength exercises were being performed at. Each strength exercise (Shoulder Movement with Internal Rotation, Single arm, bent over row and Push ups with a plus) began with one set of 10 repetitions performed once a day and every day. The progression of repetitions for the strength exercises only, increased by 5 repetitions per week to a maximum of 30 repetitions. Once 30 repetitions were reached, a new resistance was determined again using the RPE scale beginning at 10 repetitions. All ranges of motion were performed in a pain-free motion and were not to elicit more pain in the affected shoulder. If this occurred, they were asked to contact the primary researcher immediately for consultation. The new assessed resistance was held constant throughout the remainder of the study (Graph 1).

Graph 1: Repetitive Progression Per Week



Baseline= Initial Clinical Assessment, Questionnaires, Goniometer Assessment, Determination of Starting Resistance for Exercise Program
Wk1= First weekly exercise intervention with an increase of 5 repetitions
Wk2= Second weekly exercise intervention with an increase of 5 repetitions
Wk3= Third weekly exercise intervention with an increase of 5 repetitions
Assessment1= Clinical Assessment, Questionnaires, Goniometer Assessment, Reassessment of Resistance for Exercise Program
Wk5= First weekly exercise intervention with new resistance
Wk6=Second weekly exercise intervention with new resistance with an increase of 5 repetitions
Wk7=Third weekly exercise intervention with new resistance with an increase of 5 repetitions
Assessment 2= Clinical Assessment, Questionnaires, Goniometer Assessment,

3.11 Participant Recruitment

Participants were recruited through multiple methods over the study's total collection period. Participant recruitment began in April 2017 to over twenty Breast Cancer Support Clinics within the GTA. Three attempts were made to recruit participants from the Breast Cancer support clinics via email, phone and interpersonal conversations from April 2016 to September 2016.

Thirteen women were contacted via email or telephone regarding their participation within the study. The method of contact was dictated by their preference listed on their consent to be contacted by the principle investigator forms. Eight women were confirmed to begin their study participation. However, one woman did not attend her initial assessment and subsequently did not respond to follow up emails and phone messages. Of the seven women that began the study, one discontinued the study due to a conflict in treatment that she was receiving at another rehabilitation facility. Of the six remaining, all women began and completed their study requirements from February 2017 up to and including August 11, 2017.

Following their participation in the study, a letter was either emailed or mailed to the participant in appreciation of their contribution in the study (See Appendix N). Additionally, all women expressed interest in their results of the study.

3.12 Participant Demographics

Of the six participants, one participant had a lumpectomy, one had an initial lumpectomy and then 6 months later proceeded to have a mastectomy on the same affected side. The other four remaining participants had only single mastectomy surgery with lymph node dissections. One participant had their surgical intervention on their dominant side, and the other five on their non-dominant side. The average age of the participants was 63.5 years of age (See Table 3).

Table 3: Participant Demographics

Study ID	Mastectomy	Lumpectomy	Node Dissection	Dom. Hand	Side of Surgery	Age	Last Surgical Date
1	X		X	R	L	61	February 10, 2016
2	X		X	R	R	65	July 22, 2016
3	X		X	R	L	67	August 31, 2016
4		X	X	R	L	65	July 26, 2016
5	X		X	R	L	54	Nov. 30, 2016
6	X	X	X	R	L	69	August 3, 2016

Note: R= Right hand dominant; L=Left hand dominant

Upon review of the compliance of each participant, their daily exercise checklist was examined for adherence to the daily exercise program. The participants were found to be 90-100% compliant to the exercise program (56.7 days-63 days out of the total 63 days). All participants were within the 6-9 month required time frame from their last surgical intervention. Only one participant exercised regularly, including Yoga and weights (low weight), approximately 3-4 times per week at a guided exercise program at Wellsprings Westerkirk House at Sunnybrook Hospital in Toronto. The other five women were quite sedentary, performing any form of physical activity less than once per week, outside of their daily active lifestyle. Only two of the women had not returned to work and the other four women were

retired or never worked outside the home. It is uncertain at this time, what level of physical activity all participants had prior to breast cancer surgery.

3.13 Statistical Software

All data was analyzed using a statistical method package (SPSS), version 24.

3.14 Statistical Analysis

Prior to the commencement of the study, an estimation of the sample size required was used to ensure a power of 0.80 and an alpha level of 0.05. These two parameters of statistical significance were used for the analysis of the six participants.

Although three assessments were performed, only the assessments from baseline (T0) to the final assessment (A2) were used for statistical analysis and are reported as the mean and standard deviation (SD). This was done to determine the true efficacy of the program in it's entirety from baseline to final assessment. Because all the participants were assessed at baseline and at final assessment, a paired samples t-test was performed on all of the outcome measures. The three main dependent variables included:

1. Quality of Life (QLQ-C30/BR-23)
2. Shoulder Function (DASH questionnaire)
3. Clinical Analysis:
    - Muscle Atrophy (clinical and objective assessment of deltoid, upper trapezius and pectoralis complex)
    - Winging Test
    - Lymphedema (Soft-cloth measurement)
    - Shoulder Range of Motion (Goniometer measurement)

RESULTS

Each of the three dependent variables will be addressed separately below.

4.1 Quality of Life Analysis

Quality of Life was evaluated using the EORTC QLQ-C30/BR-23 questionnaire to assess the participant's total score of their perception of their overall quality of life (See Appendix O). The score was derived by taking the mean of the component items and using a linear transformation to standardize a raw score between 0-100.

Using the EORTC QLQ-C30/BR-23 to help evaluate breast cancer survivor's quality of life specifically, a paired samples t-test was performed on the group and the overall score of the EORTC QLQ-C30/BR-23 was found not to be statistically significant ($t=-2.23$, $p=0.08$). Mean baseline scores for the group were 75.97, SD ±8.69 and final scores for the group were 80.04, SD ±8.41.

Within the full score for the group, two individual items were found to be statistically significant. Social Functioning involved questions 26 (Has your physical condition or medical treatment interfered with your family life?) and question 27 (Has your physical condition or medical treatment interfered with your social activities?) were found to be statistically significant with a mean change 58.0 at baseline to 77.7 post-intervention ($t=-2.91$, $p=0.03$, SD±11.79). Therefore, an increase in the mean value from baseline to final assessment in the total score for social functioning suggested that the participant's perception of the magnitude of their impairment had decreased over the course of the study and therefore the participants perceived a higher level of life functioning at their final assessment.

Another item on the EORTC QLQ-C30/BR 23 that was found to be statistically significant was their symptom scale as it related to pain. Pain involved questions 9 (Have you

had pain?) and question 19 (Did pain interfere with your daily activities?) and was found to be statistically significant with a mean value of 41 at baseline to 22 at final assessment (t=3.80, p=0.01, SD±11.79). This suggested that the group's perception of their level of pain decreased from baseline to final assessment. The pain scale of the EORTC QLQ-C30 was calculated differently from the social functioning scale: pain scale should have decreased from baseline to final assessment and social functioning should have increased from baseline to final assessment: which both values did.

4.2 Shoulder Function Analysis

Shoulder function was evaluated using the DASH questionnaire to assess the participant's perception of shoulder function. A paired samples t-test was conducted on individual questions, for the group within the DASH questionnaire and resulted in statistically significant findings on 20% of the individual questions (Table 4). Within the group, there was a statistically significant change in the total perceived shoulder function (t=3.408, p=0.019, mean change of 12.75, SD±9.17). (Table 4).

Table 4: Improvements in Perceived Shoulder Function Using the DASH questionnaire

Question	N	Question Description	T value	P value	Baseline (Mean±SD)	Final Assessment (Mean±SD)
1	6	Open a tight or new jar.	1.17	0.30	3.00 ±0.89	2.50 ±1.05
2	5	Write	1.00	0.37	1.40 ±0.55	1.20±0.45
3	6	Turn a key.	1.58	0.18	1.50 ±0.84	1.17±0.41
4	6	Prepare a meal.	2.24	0.06	2.00 ±1.09	1.50±0.55
5	6	Push open a heavy door.	7.00	0.001**	3.17 ±0.98	2.00±0.89
6	5	Place an object on a shelf above your head.	4.00	0.016*	3.20±0.83	2.40±1.14
7	6	Do heavy household chores (e.g. wash walls wash floors).	2.00	0.10	3.17±1.47	2.50±1.76
8	5	Garden or yard work.	2.45	0.70	3.40±1.14	2.80±1.48

9	6	Make a bed.	0.54	0.61	2.00±1.27	1.83±1.33
10	6	Carry a shopping bag or briefcase.	0.54	0.61	2.00±0.89	1.83±0.98
11	6	Carry a heavy object (over 10lbs).	0.54	0.61	3.00±1.27	2.33±1.37
12	6	Change a light bulb overhead.	2.71	0.04*	3.17±1.47	2.33±1.51
13	5	Wash or blow dry your hair.	0.00	1.0	1.60±0.89	1.60±0.89
14	6	Wash your back.	2.01	0.93	3.50±1.64	2.67±1.51
15	6	Put on a pullover sweater.	2.00	0.10	2.67±1.03	2.00±1.27
16	6	Use a knife to cut food.	2.00	0.10	1.83 ±0.98	1.17 ±0.41
17	6	Recreational activities which require little effort (e.g. card playing knitting etc.).	-0.54	0.61	1.33±0.52	1.50±0.55
18	5	Recreational activities in which you take some force or impact.	3.16	0.03*	3.80±1.09	2.80±1.48
19	5	Recreational activities in which you move your arm freely (e.g. playing Frisbee badminton etc.).	1.00	0.37	3.00±1.41	2.60±1.67
20	6	Manage transportation needs(getting from one place to another)	0.00	1.0	1.17±0.41	1.17±0.41
21	3	Sexual activities.	0.00	0.00	1.67±1.16	1.67±1.16
22	6	During the past week to what extent has your arm shoulder or hand problem interfered with your normal social activities with family friends neighbors or groups?	1.00	0.36	1.67±1.21	1.17±0.41
23	5	During the past week were you limited in your work or other regular daily activities as a result of your arm shoulder or hand problem?	2.24	0.09	2.60±0.89	1.60±0.89
24	5	Please rate the severity of the following symptoms in the last week for your arm shoulder or hand pain.	1.00	0.37	2.80±0.45	2.60±0.55

25	6	Please rate the severity of the following symptoms in the last week for arm shoulder or hand pain when you performed any activities.	2.00	0.10	3.17±0.75	2.50±0.84
26	6	Please rate the severity of the following symptoms in the last week of tingling (pins and needles) in your arm shoulder or hand.	0.79	0.47	1.83 ±0.98	1.50 ±0.84
27	6	Please rate the severity of the following symptoms in the last week of weakness in your arm shoulder or hand.	2.00	0.10	2.67 ±0.82	2.00 ±0.63
28	5	Please rate the severity of the following symptoms in the last week Stiffness in arm shoulder or hand	4.000	0.016**	3.00 ±0.71	2.20 ±1.09
29	6	During the past week how much difficulty have you had sleeping because of the pain in your arm shoulder or hand?	2.00	0.10	2.50 ±1.23	1.83 ±0.75
30	6	I feel less capable less confident or less useful because of my arm shoulder or hand problem	3.796	0.013*	3.17±0.98	2.00±1.27

Note: * indicates significant for p<.05 and ** for p<.001
N= the number of participants that completed the specific question.

4.3 Clinical Analysis

4.3.1 Muscle Atrophy

Muscular atrophy was defined as the clinical observation of the absence of the mass of the muscle as compared to the non-affected side. Some observable characteristics of muscle atrophy included, but were not limited to, a decrease in muscle bulk, a decrease in muscle length and/or a noticeable loss of size and definition. However, if both sides appeared to have a decrease in the mass of the specified muscle, then this was also noted as muscular atrophy.

A paired samples t-test was performed on the group to determine differences on muscular atrophy from baseline to final assessment: all three values were statistically significant (Table 5). Therefore, there was an overall decrease in the observable presence of muscle atrophy at final assessment.

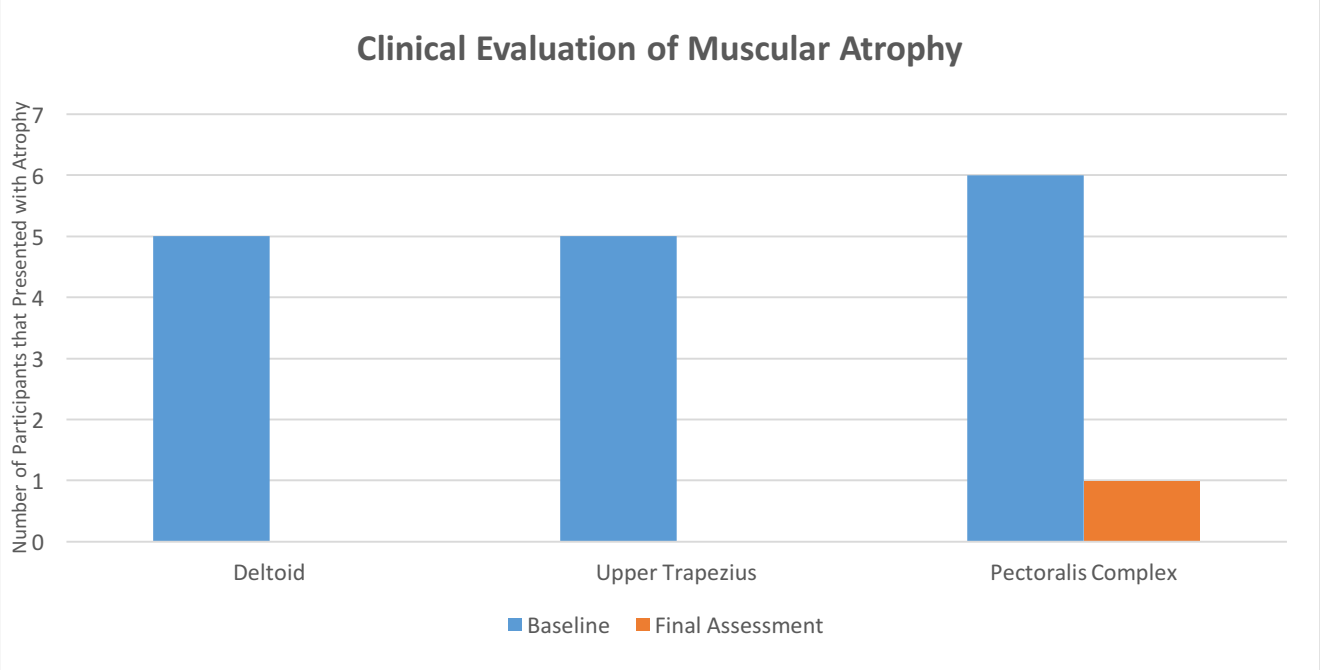
Table 5: Total Absence of Muscular Atrophy

Muscle	T-value	P-value	Baseline Mean±SD	Final Assessment Mean±SD
Deltoids	5.00	0.004*	0.83±**0.41**	0.00±**0.00****
Upper trapezius	5.00	0.004*	0.83±**0.41**	0.00±**0.00****
Pectoralis complex	5.00	0.004*	1.00±**0.00**	0.17±**0.41**

Note: * indicates significant for p<.05
** indicates that at Final Assessment the 0.00 values reflected that there was no reported atrophy for the Deltoids and Upper Trapezius

Clinically, upon final assessment only one participant presented with atrophy in the pectoralis complex (Graph 2). This participant had an initial lumpectomy and then subsequent mastectomy.

Graph 2: Clinical Evaluation of Muscular Atrophy at Baseline and Final Assessment



Note: The values represent the number of participants that presented with muscular atrophy: n=6.

4.3.2 Winging Test

A positive winging test is noted as the migration of the inferior angle of the scapula laterally from the midline during the isometric contraction. Therefore, any lateral deviation of the scapular inferior angle was noted as a positive test if it appeared on the affected side. In addition, if both scapula presented with the same lateral abduction of the inferior angle, this too was noted as a positive winging test.

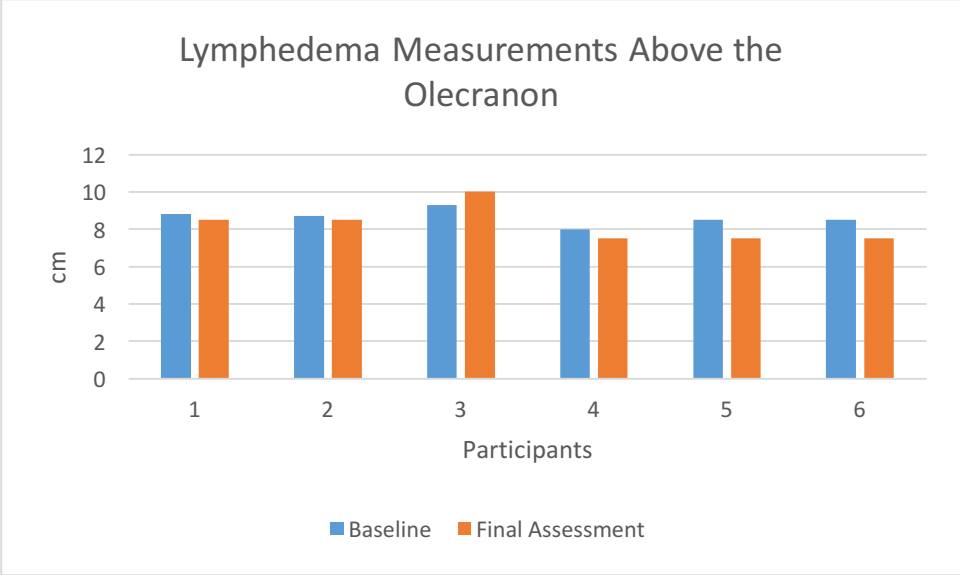
Clinically, upon baseline assessment, five out of the six women presented with a positive winging scapula. However, on their final assessment, only two women presented with a winging scapula. When the group was evaluated by a paired samples test, there was no statistically significant change in the number of women who presented with a positive winging test with a mean change from baseline of 0.83 to final assessment 0.33 ($t=2.24$, $p=0.08$, SD±0.55). Therefore, when the participants were assessed twice, clinically less women presented at final assessment with a positive winging scapula.

4.3.3 Lymphedema

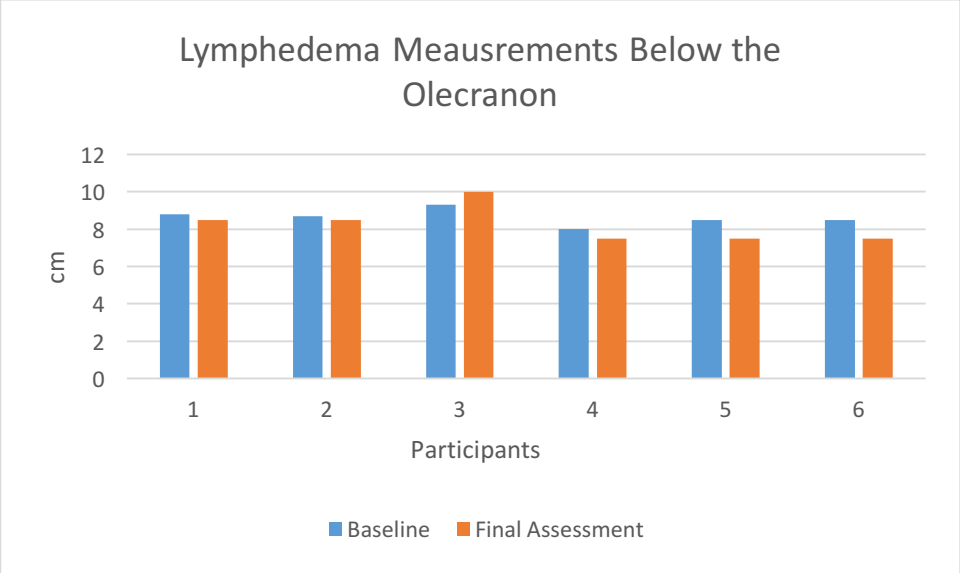
Lymphedema was a clinical measurement made by using a soft cloth measuring tape around the circumference of the arm: 15 cm above and 10 cm below the olecranon process. Any difference of 2 cm or more measured between the affected and the unaffected arm were noted as positive for the presence of lymphedema. Furthermore, all measurements were analyzed to determine change in circumference measurements from baseline to final assessment above and below the olecranon. Above the olecranon process, the circumference measurement mean change was from baseline 14.85 to 11.17 at final assessment ($t=-0.69$, $p=0.54$, SD±7.69). Below the olecranon process, the circumference measurement mean change was from baseline 8.63 to 8.25 at final assessment. ($t=1.60$, $p=0.27$, SD±0.63).

A paired samples t-test was performed on the group, which resulted in no statistically significant values either above or below the olecranon, respectively (t=1.17, p=0.29; t=1.49, p=0.2). Graphs 3 and 4 provide an overview of the changes in lymphedema for each participant from baseline to final assessment above and below the olecranon, respectively.

Graph 3: Lymphedema Measurements Above the Olecranon from Baseline to Final Assessment



Graph 4: Lymphedema Measurements Below the Olecranon from Baseline to Final Assessment



4.3.4 Goniometer Measurements

Ranges of motion in the shoulder were measured through the use of a standard manual goniometer. The unaffected side was measured first followed by the affected side. All measurements were reviewed upon the completion of the study as to not skew the clinical observation of the researcher prior to each measurement or observation.

Finally, a paired samples test was performed on the group to determine if there were improvements in degrees during goniometer measurements: extension was found to be statistically significant (t=-3.35, p=0.02, SD±4.73).

Clinically, there was a difference in the mean goniometer measurements at baseline and final assessment within the group (Table 6).

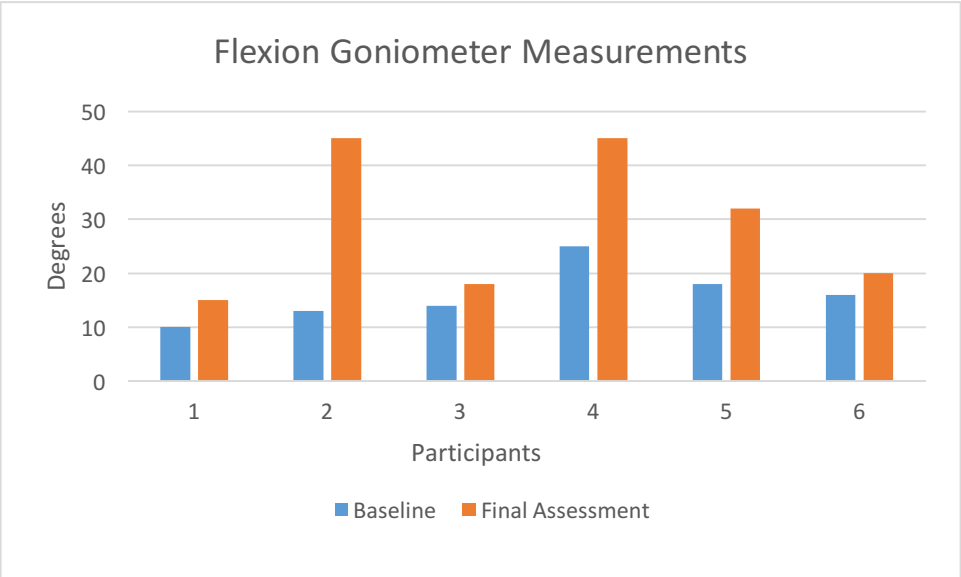
Table 6: Mean Goniometer Measurements in Degrees at Baseline and Final Assessment

Measurement	Baseline Mean Degrees ±SD	Final Assessment Mean Degrees ±SD
Flexion	124.33º±18.57	138.33º±5.53
Extension	46.33º±9.39	54.00º±4.73
Abduction	115.5º±25.66	132.17º±32.41
Internal Rotation	87.50º±6.62	90.00º±0.00*
External Rotation	51.33º±16.19	57.33º±14.65
Horizontal Abduction	67.17º±10.42	61.17º±16.22
Horizontal Adduction	16.00º±5.18	24.83º±18.46

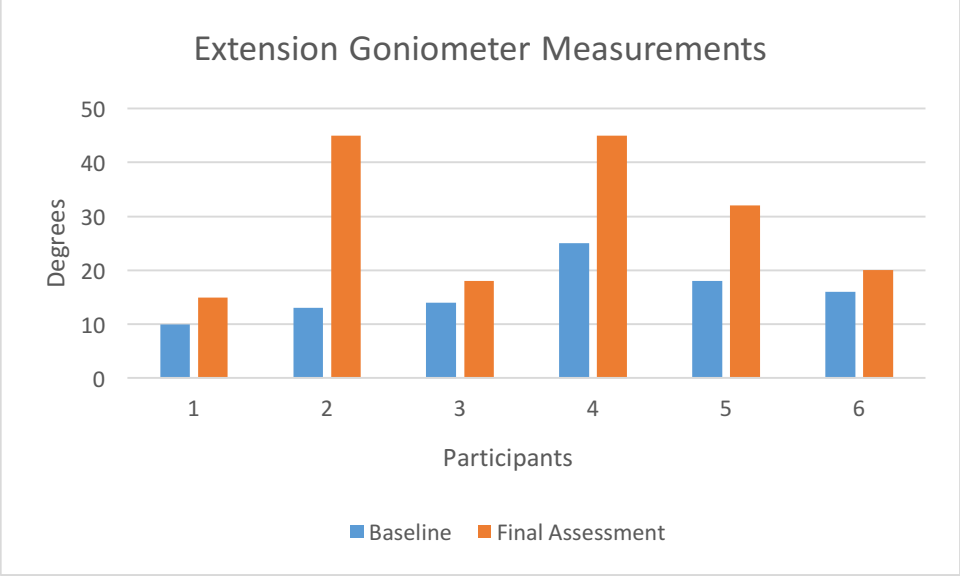
Note: All measurements are made in degrees based on the standard manual goniometer
* indicates that the SD ±0.00 reflects that 90 º was the maximum allowable measurement attained for this range of motion and all study participants achieved this

Graphs 5 to 11 provide an overview of each participant's goniometer measurement changes from baseline to final assessment for Flexion, Extension, Abduction, Internal Rotation, External Rotation, Horizontal Abduction and Horizontal Adduction, respectively.

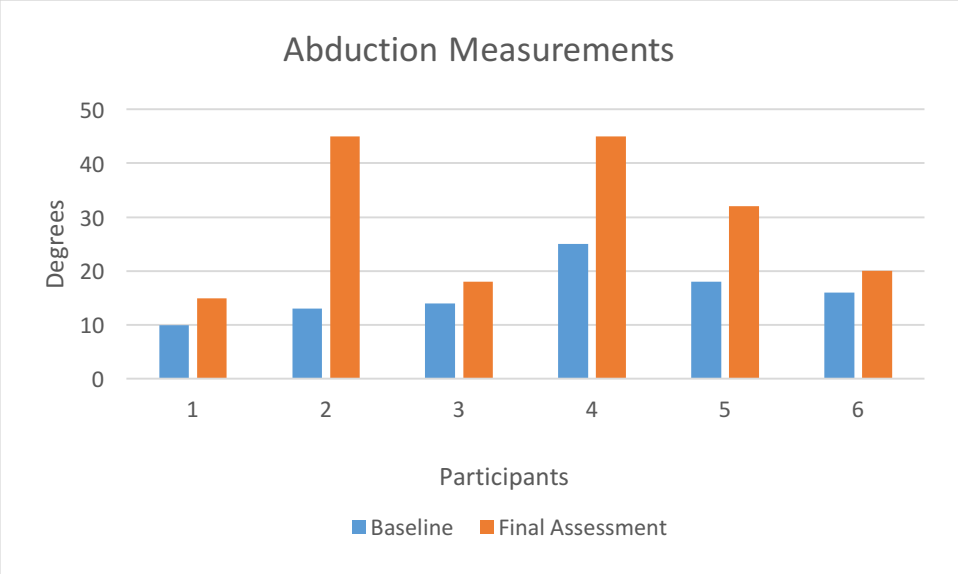
Graph 5: Flexion Goniometer Measurements for Each Participant from Baseline to Final Assessment



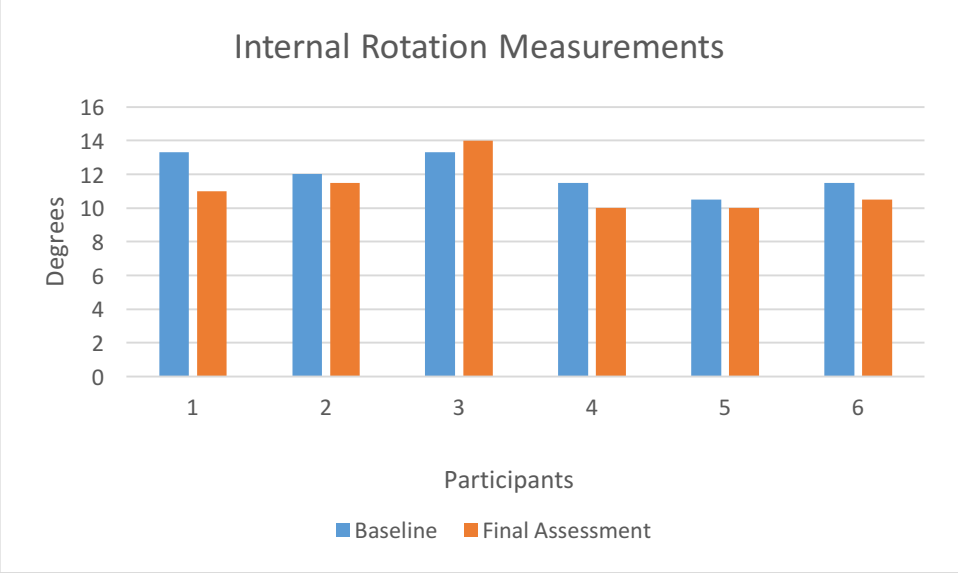
Graph 6: Extension Goniometer Measurements for Each Participant from Baseline to Final Assessment



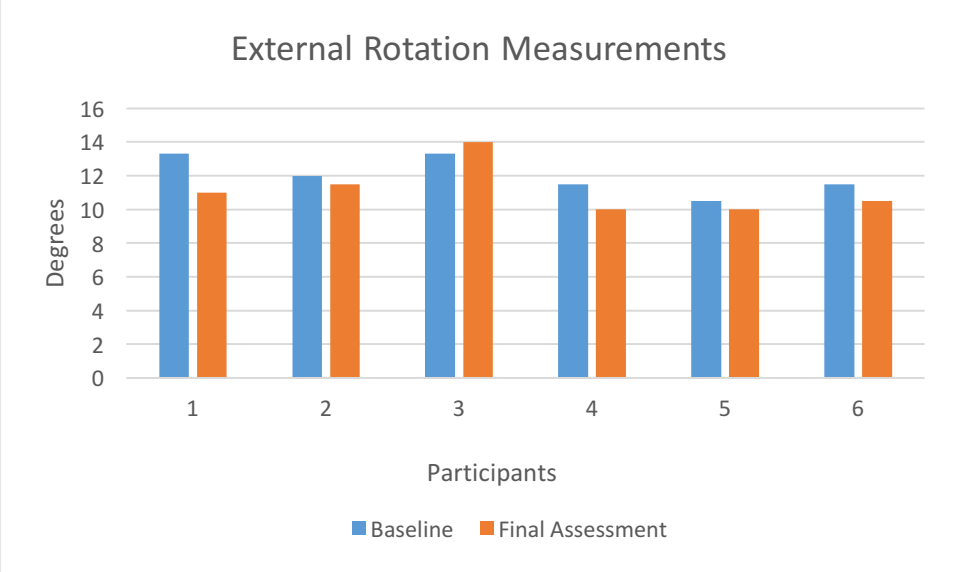
Graph 7: Abduction Goniometer Measurements for Each Participant from Baseline to Final Assessment



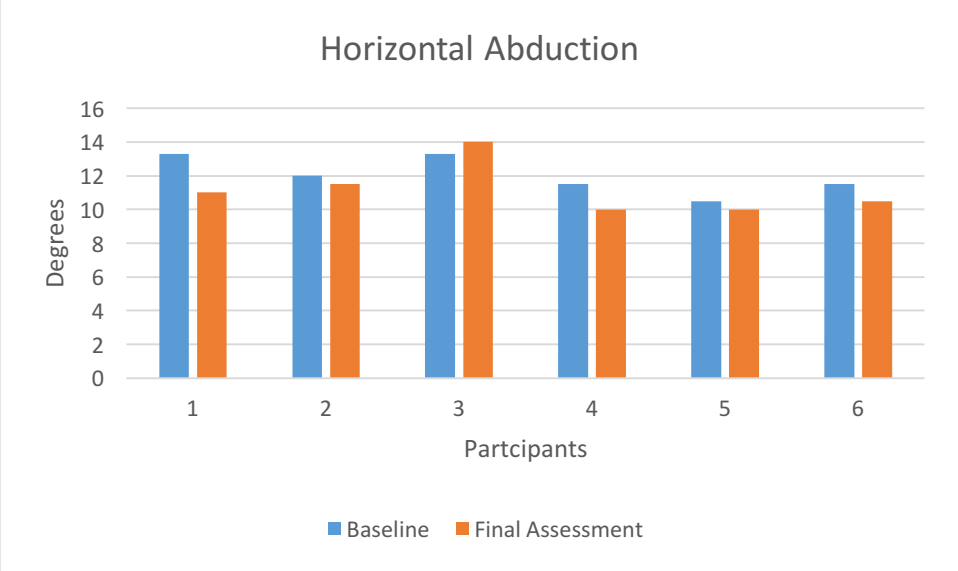
Graph 8: Internal Rotation Goniometer Measurements for Each Participant from Baseline to Final Assessment



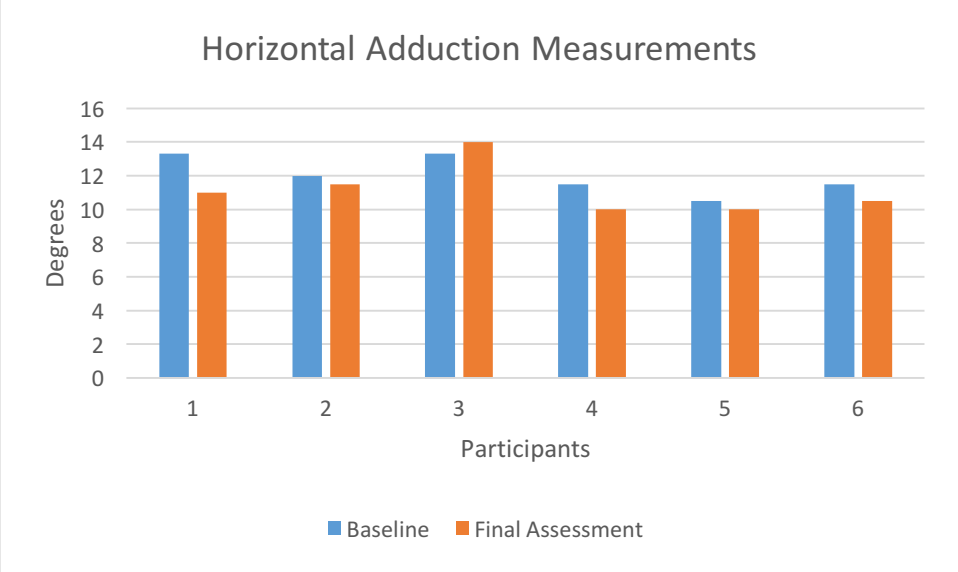
Graph 9: External Rotation Goniometer Measurements for Each Participant from Baseline to Final Assessment



Graph 10: Horizontal Abduction Goniometer Measurements for Each Participant from Baseline to Final Assessment



Graph 11: Horizontal Adduction Goniometer Measurements for Each Participant from Baseline to Final Assessment



DISCUSSION

To date, research targeted on shoulder rehabilitation following breast cancer surgery has been limited and inconsistent. Shoulder pain, for breast cancer survivors, following surgery, has become accepted as "normal" instead of "common." This sentiment was confirmed by the participants in this study as they were surprised that no shoulder program 6 months' post-surgery existed in present standard medical practice. Following their participation, the women began to realize that shoulder pain was a "common" phenomena following breast cancer surgery but that initiating an active exercise program helped them better manage the residual pain, stiffness and limited range of motion. This investigation supported the hypothesis that the implementation of an active daily exercise program would improve the perceived quality of life and perceived shoulder function of breast cancer survivors, 6-9 months post-surgery.

5.1 Participant's Experiences and Comments/Concerns

This study found that the six participants had common concerns regarding their post-surgical rehabilitation. It was reported by the participants, that they perceived they were given minimal direction with regard to their shoulder pain: mainly being told by their oncologist/surgeon that "more time" was needed before any intervention would be supplied to them. Gray et al. (1998) found that in their follow up protocols, there was a widespread confusion of women in their focus groups about their appropriate follow up care and a move toward women receiving less care following surgery. The women in the focus groups exhibited "feelings of abandonment" and questioned the quality of their follow up care.

Upon a preliminary discussion with a general surgeon, one of his initial questions was "Is shoulder pain a new phenomenon for breast cancer survivors?" This statement demonstrated that surgeons may have little knowledge of the effects of surgery on breast cancer survivors.

Therefore, a study of this specificity will aid surgeons in identifying chronic issues post breast cancer surgery. Gray et al. (1998) found that women perceived a mistrust in the medical community in the "inadequate information …or follow up policy change because of the processes of medical knowledge development, even when described as scientifically based, were related to cost reduction strategies endemic to current Canadian health care." With the acceptance that oncologists and surgeons have specific roles within breast cancer management, the awareness that women can take ownership of their shoulder dysfunction followed by a "cancer-free" diagnosis is one key component that has been overlooked by the current management of breast cancer post-surgery.

Participants expressed an eagerness to begin their exercise program and to be given the chance to actively participate in their shoulder rehabilitation. Upon final review of their daily exercise checklist, each participant was diligent, approximately 90%-100% compliant with their daily required exercises which was higher (70.2%) than a study performed by Courneya et al. (2007) on 242 breast cancer survivors. The higher rate of compliance in the present study, may have been as a result of the smaller sample size versus the larger sample size in the study by Courneya et al. (2007). Gray et al. (1998) found that when breast cancer survivors perceived that they had been provided information and education, they were better able to cope with stress, had a decrease in their level of anxiety, mood disturbances and had an increased ability to cope with their breast cancer treatment.

Post-study, it was clear that all women were disappointed in not being able to return to their "pre-cancerous" state. Once their involvement in the study was complete, conversation anecdotally transitioned to aiding the participants accepting and achieving a new "normal" state with various musculoskeletal limitations and restrictions: like limited range of motion, chronic

residual pain or limited strength. This sentiment was confirmed by a study performed by Gray et al. (1998) that qualitatively examined seventy women's opinions and perceptions pre and post surgery. They found that some women "had difficulty resolving what had happened" and other women "expressed dismay about the apparent confusion and contradictions related to breast cancer treatment." Consequently, post-study discussion emphasized overall activity as being beneficial and would solidify any improvement made to their shoulder function during their participation in the present study.

5.2 Quality of Life

Quality of life was determined by a score on the EORTC QLQ-C30/BR-23 which produced a mean baseline score for the group of 75.96, which was higher than the baseline score of 59.62 reported by Adamsen et al. (2006) performed on eighty-two women and higher than the sixteen women who scored 63 in a study by Herrero et al. (2005).

The participants perceived a statistically significant improvement in two scales of their quality of life: social functioning and pain. The social functioning subset included questions 26 and 27 respectively (the perception of how their physical condition or medical treatment interfered with family life and the perception of how their physical condition or medical treatment interfered with social activities) in the EORTC QLQ-30/BR-23 questionnaire and were found to be statistically significant for the group from baseline to final assessment with a mean value from baseline to final of 58.0-77.7, which was lower in a study of 82 women (77.85-82.32) performed by Adamsen et al. (2006). The lower value in the present study may have been as a result of the smaller sample size (n=6) versus Adamsen et al. (2006) (n=82).

The participants reported that following breast cancer surgery and recovery they were unsure of how to transition from total independence to now relying on others for help with some

daily life activities, like heavy lifting. These women reported that their ability to incorporate a daily exercise program helped improve their perceived self-esteem as this was one facet of their breast cancer rehabilitation that they were able to control and manage on their own. Courneya et al. (2007) found similar results when their study examined the effects of resistance training on two hundred forty-two breast cancer patients. The study found that resistance exercise was superior to usual care for improving self-esteem (P= 0.018).

The perception of pain was found to be statistically significant (p=0.01) at final assessment. A study performed by Adamsen et al. (2006) found that when an exercise intervention was incorporated for patients undergoing chemotherapy, they perceived their pain to be less than the control group who were receiving standard medical care (p=0.03). Although this present study did not include participants undergoing chemotherapy, pain is a common occurrence following surgery and is a protective mechanism of the body to alert an individual of an occurrence of damage within the body (Cleeland, 1982). Breast cancer surgery disrupts breast and axillary tissue which triggers the brain to interpret the disrupted neural signals to the brain as pain. To further protect the affected area, it can elicit a restriction or contracture from surrounding areas, including the shoulder, to minimize movement and further disruption to the affected tissue.

Chronically, breast cancer survivors 6-9 months post-surgery presented with shoulder and arm pain because of the surgical invasiveness of a mastectomy or lumpectomy to the axilla and surrounding musculature. The participants in this study reported that following surgery they were unclear as to what normal pain following surgery was and how aggressive to be in the exercise regimen immediately following surgery. Gray et al. (1998) noted that "many of the women were concerned about how to monitor their own bodily changes, especially about

knowing when to be concerned about their non-resolving pain. They also wanted guidelines about when and how to take action to have symptoms assessed."

In accordance with normal muscle physiology, neural regeneration can take up to a year or longer post-injury. If the muscle is left inactive, with a low level of muscle protein; for a prolonged period of time without appropriate use of neural pathways, the muscle will remain atrophied and may not recover following surgery (Jackman et al., 2004). Therefore, the incorporation of a daily, active exercise program at 6-9 months will increase the regeneration capacity of the nerves and re-educate the muscles following a surgical disruption.

The perception of pain may have decreased as muscular function increased. The participants also reported that feeling constant and chronic pain from 6 weeks post-surgery to 6 months post-surgery, was emotionally and physically draining but were happy to have achieved a level of minimal discomfort with their daily life activities, like raising objects overhead or gardening.

5.3 Shoulder Function

It was reported that when women are referred to a hospital-rehabilitation program for shoulder pain follow breast cancer surgery, Ontario Health Insurance Plan (OHIP) initially offers eight manual treatment sessions within a hospital setting by a Physiotherapist. Since there was no difference between the two groups for perceived improvement of shoulder function, one minimal suggestion would be to offer women, at their six month follow up with their surgeon, one exercise session implementing this study's active and daily exercise program. This session could be done within a hospital setting and could be guided by a healthcare professional trained in exercise execution and prescription. Currently, one hospital within Toronto is exploring the feasibility of incorporating this exercise program for breast cancer survivors 6 months post-

surgery. This would be a fee for service session but would be a minimal cost to the patient. The incorporation of this exercise program would possibly decrease the cost associated with prolonged shoulder rehabilitation for the patient.

There was a statistically significant change from baseline to final assessment in the participant's perception of shoulder function (65.1-53.0) which was higher than a study of shoulder function on 30 patients (48.6-14.6) (Beurskens et al., 2007). Question number 30 of the DASH questionnaire found that the participants perceived a statistically significant perception of their "feeling less capable, less confident or less useful due to their shoulder issue" ($t=3.80$, $p=0.01$). Following breast cancer surgery, cording is the visible thickening of the skin in the axillary region that is taut and painful and may have played a large role in the breakdown of the normal shoulder function (O'Toole et al., 2013). As a result of cording, the participants presented with muscular atrophy of the deltoid complex, upper trapezius and pectoralis complex and the presence of a winging scapula. Because of muscular imbalances that existed in the shoulder, the participants' ability to use their shoulder effectively, with no pain, became compromised and limited. In the end, the participants were unsure of their ability to use their shoulder effectively for performing daily activities, such as gardening, brushing their hair or reaching for things overhead. It was reported by one of the participants that the ability to grab pots/pans or carry them to the table during meal prepping was empowering for them and they were extremely motivated to continue their exercise program post-study.

5.4 Clinical Analysis

The clinical analysis of shoulder function included the observation for the presence of muscle atrophy, winging scapula, lymphedema and shoulder range of motion. Muscular atrophy was defined as the clinical observation of the absence of the mass of the muscle as compared to

the non-affected side. Some observable characteristics of muscle atrophy included, but were not limited to, a decrease in muscle bulk, a decrease in muscle length and/or a noticeable loss of size and definition. The presence of muscle atrophy was statistically significant from baseline to final assessment for the group including deltoid ($t=5$, $p=0.04$), upper trapezius ($t=5$, $p=0.04$), pectoralis complex ($t=5$, $p=0.04$). Al-Majid (2008) discussed the necessity of a progressive resistance exercise training (PRT) program to offset the effects of muscle atrophy. He found that nearly 50% of cancer survivors exhibited muscle atrophy and recommended that "PRT is a stimulus of growth in muscle mass and strength…." The results of this present study were interpreted as an absence of muscle atrophy at final assessment for each of the muscular atrophy components. These results are also clinically relevant to therapists focusing on re-educating shoulder muscular endurance and strength.

At final assessment, there was an absence of muscle atrophy and an improvement in the presence of a winging scapula, which suggests the appropriate muscle regeneration and education of proper shoulder biomechanics occurred as a result of the exercise program. Because there is no actual articulation between the scapula and the thorax, the scapula relies heavily on the muscular attachments to ensure proper range of motion at the glenohumeral joint. Clinically, one participant presented with muscle atrophy of the pectoralis complex at final assessment with no atrophy of the deltoid or upper trapezius. This participant initially had a lumpectomy followed by a mastectomy, hence had more scarring, adhesions and cording of the affected shoulder. Although she reported better mobility following the daily and active exercise program, she may require further treatment to decrease residual adhesions that may have inhibited her ability to regain the pectoralis complex strength.

Lymphedema presented with no statistical significance for the group from baseline to final assessment and resulted in similar non-significant results as McKenzie et al. (2003). However, it is also important to note that clinically all of the participants did not present with the presence of lymphedema at baseline as there was no recorded difference of 2 cm from the affected versus the unaffected side at baseline or final assessment. Although no observational presence of lymphedema was recorded, there was a clinical decrease in the circumference measurement from baseline to final assessment for the total group (mean change above the olecranon of 14.85 inches at baseline to 11.17 at final assessment and 8.63 inches below the olecranon from baseline to 8.25). One hypothesis for a decrease in lymphedema is the "muscle pump effect" (Cohen et al., 2001) which involves a change in tissue pressure that stimulates vessels of the lymphatic system to open and close and remove excess fluid. This change occurs as a result of a muscle contracting and expanding with an upper body exercise strengthening program. Once a muscle has been inactive due to surgery, it becomes more active through the implementation of an exercise program, and a pumping effect exists in addition to the accumulation and strengthening of muscle fibers to aid in a decrease in lymphedema.

Lastly, shoulder range of motion resulted in statistically significant values for extension (t=-.3.35, p=0.02, SD.±4.73). Clinically, any noted difference of 10 º (standard error of 3-5º) or more was substantial enough to note better range of motion and a perceived improvement in shoulder function. The following change in the total group's average range of motion in degrees, were recorded from baseline to final assessment: flexion (14º), extension (7.67º), abduction (16.67º), internal rotation (2.50º), external rotation (6º), horizontal abduction (6º) and horizontal abduction (8.83º). Box et al. (2002) found larger changes in flexion (44.6º), extension (7.45º) and internal rotation (20.7º). It is important to note that Box et al. (2002) performed a long term

study and assessed shoulder range of motion prior to breast cancer surgery in addition to 2 years post-surgery. Similarly, Sugden et al. (1998) performed a long term study (up to 18 months post-surgery) and noted differences in flexion (19º), extension (16º), abduction (18º), internal rotation (23º) and external rotation (14º). In this present study, of the seven goniometer measurements, two of the measurements had a minimum change of 10 º: flexion and abduction within a 6-9 month time-frame.

5.5 Limitations

The study began as a clinical observation from numerous patients that had presented with shoulder dysfunction approximately 12 months post surgery. Even though all women in this study benefitted from an exercise intervention, the sample size was the main limiting factor. Some values were statistically significant, but perhaps a larger sample size may have resulted in more reliable and valid statistical and clinical improvements.

Another reason for this small sample size was a difficulty in recruitment of participants. Immediately following surgery, there is no mention made regarding the benefit of an exercise program long-term. Many of these women, 6-9 months post breast cancer surgery had accepted shoulder pain and a limited range of motion as "normal" following surgery.

The inability to recruit another clinician to validate the observational findings was a limiting factor to the effectiveness, validity and reliability of the primary investigator's observations. To ensure that there was no bias when recording all of the data, the primary investigator did not preview or review any recorded data until the participant had completed their contribution to the study.

There were some confounding variables that may have resulted in the perceived improvement in shoulder function and quality of life including a guided exercise program. The

participants may have perceived an improvement as they were being "assessed" on a regular basis and were asked to demonstrate their exercises for fidelity.

5.6 Future Research

There are numerous recommendations for future research for breast cancer survivors 6-9 months post-surgery. This study truly was a preliminary study to demonstrate that an active exercise program was beneficial and resulted in statistically significant outcomes.

Firstly, a larger sample size recruited from multiple hospitals, may result in more statistically significant values. One method of increasing sample size would be to incorporate a pre-educational discussion immediately following breast cancer surgery, on the benefit of an exercise program 6 months post-surgery. If the oncologist and the rehabilitation specialists in the hospital setting would discuss this information with the patient, this may increase the rate of participation in a daily, active rehabilitation program.

The average age of the participants for this study was 63.5 years of age. It is common for women, with no chronic disease, of this age to also develop shoulder dysfunctions due to age-related issues such as adhesive capsulitis or rotator cuff impingement (Shamley et al., 2007). Therefore, future research should incorporate the exercise program bilaterally for each participant to determine the true efficacy of the exercises by using each participant's unaffected side as a control group versus their affected and surgical side. This would be a true measure of any differences within each participant as well as within the group. This would minimize the chance of presenting with age-related dysfunctions as each participant would act as their own control group with a full assessment of bilateral shoulders. By utilizing each participant as their own control group, this would increase the sample size and would give better control of age-related dysfunctions.

Therefore, future research in this area and time frame of breast cancer rehabilitation is not only important to the patient but to the allied health *and* medical community who aid in their rehabilitation.

5.7 Final Synopsis

The hypothesis of this study was that an active and daily exercise program for breast cancer survivors 6-9 months post-surgery would increase the participants quality of life, increase aspects of shoulder function, increase active range of motion and strength and decrease lymphedema. This study fulfilled all parts of it's purpose: even with a small sample size.

Moving forward, the results of this study can contribute to advancing the standard of care for breast cancer survivors. Due to the lack of understanding by the medical community, mainly oncologists and surgeons, on the long term effects of breast cancer surgery, this study would aid breast cancer survivors in complimenting an essential intervention for a better quality of life.

Not only would this study's results provide valuable information to the medical community but would educate breast cancer survivors that their shoulder pain is not "normal pain." They should be made aware, that within the first year post-surgery, shoulder function is important and that implementing an active exercise program would help them increase their perceived quality of life and shoulder function. A lot of attention is given to increasing the survival rate of breast cancer survivors however, equal attention should be given to what happens immediately following breast cancer surgery within the first year.

Another intriguing aspect, which was not examined, was the affect of guided versus non-guided exercise sessions. Some participants sought out more guidance of their exercise program than others. This facet of this study was not examined nor measured but future research could

measure the level of improvement in each group to determine the efficacy of a one time guided session versus multiple guided sessions.

It is difficult to speculate how much of an improvement was due to a guided, non-judgmental atmosphere provided by the researcher versus diligence and desire on behalf of the participant. This social empowerment may have been a factor in the level of improvement found with each participant and in the total group. In future, an overview of their daily physical activity level would be beneficial in determining how exercise-focused they may have been prior to their participation in the study. One possible way of assessing their level of activity during their participation would be to ask the participants to check the amount of times they were physically active per day or per week outside of their daily life activities. Each participant's activity level could be measured by using a physical activity tracker to determine their actual daily level of activity.

CONCLUSION

This investigation supported the hypothesis that the implementation of an active and daily exercise program would improve the perceived quality of life and perceived shoulder function of breast cancer survivors, 6-9 months post-surgery. From the inception of this study, much was learned and gained following the study's completion. Presently, breast cancer survivors are provided an active exercise program immediately following surgery which is not consistent throughout hospitals within the Greater Toronto Area and involves many exercises geared toward range of motion with little emphasis on muscular re-education and strength. The lack of knowledge on behalf of the breast cancer survivor and the medical community has resulted in numerous women with shoulder dysfunction at approximately one-year post-surgery. If this dysfunction is not managed properly, this may lead to permanent shoulder impairment. Although the sample size is small, this study's outcomes supports early shoulder intervention and education for breast cancer survivors, 6-9 months post-surgery.

The incorporation of a daily and active exercise program 6-9 months post-surgery resulted in several statistically significant findings including a perceived improvement in quality of life, a perceived improvement in shoulder function, an observed decrease in muscular atrophy, an observed decrease in the presence of a winging scapula, and an improvement in shoulder range of motion. Despite the small sample size, many aspects of the daily, active exercise program were clinically relevant in the treatment of shoulder dysfunctions post breast cancer surgery.

It is the hope that the implementation rehabilitation following breast cancer surgery becomes consistent with the incorporation of an active exercise program immediately following surgery as well as 6 months post-surgery to offset chronic shoulder dysfunction. Furthermore,

education on shoulder rehabilitation following surgery will halt the perception that shoulder discomfort following surgery is common, not normal. This will empower more women to incorporate an active program and resume a new state of health and well-being.

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Appendix A: EORTC QLQ-C30/BR-23 Questionnaire

ENGLISH

EORTC QLQ-C30 (version 3)

We are interested in some things about you and your health. Please answer all of the questions yourself by circling the number that best applies to you. There are no "right" or "wrong" answers. The information that you provide will remain strictly confidential.

Please fill in your initials:
Your birthdate (Day, Month, Year):
Today's date (Day, Month, Year): 31

		Not at All	A Little	Quite a Bit	Very Much
1.	Do you have any trouble doing strenuous activities, like carrying a heavy shopping bag or a suitcase?	1	2	3	4
2.	Do you have any trouble taking a long walk?	1	2	3	4
3.	Do you have any trouble taking a short walk outside of the house?	1	2	3	4
4.	Do you need to stay in bed or a chair during the day?	1	2	3	4
5.	Do you need help with eating, dressing, washing yourself or using the toilet?	1	2	3	4

During the past week:		Not at All	A Little	Quite a Bit	Very Much
6.	Were you limited in doing either your work or other daily activities?	1	2	3	4
7.	Were you limited in pursuing your hobbies or other leisure time activities?	1	2	3	4
8.	Were you short of breath?	1	2	3	4
9.	Have you had pain?	1	2	3	4
10.	Did you need to rest?	1	2	3	4
11.	Have you had trouble sleeping?	1	2	3	4
12.	Have you felt weak?	1	2	3	4
13.	Have you lacked appetite?	1	2	3	4
14.	Have you felt nauseated?	1	2	3	4
15.	Have you vomited?	1	2	3	4
16.	Have you been constipated?	1	2	3	4

Please go on to the next page

During the past week:	**Not at All**	**A Little**	**Quite a Bit**	**Very Much**
17. Have you had diarrhea?	1	2	3	4
18. Were you tired?	1	2	3	4
19. Did pain interfere with your daily activities?	1	2	3	4
20. Have you had difficulty in concentrating on things, like reading a newspaper or watching television?	1	2	3	4
21. Did you feel tense?	1	2	3	4
22. Did you worry?	1	2	3	4
23. Did you feel irritable?	1	2	3	4
24. Did you feel depressed?	1	2	3	4
25. Have you had difficulty remembering things?	1	2	3	4
26. Has your physical condition or medical treatment interfered with your family life?	1	2	3	4
27. Has your physical condition or medical treatment interfered with your social activities?	1	2	3	4
28. Has your physical condition or medical treatment caused you financial difficulties?	1	2	3	4

For the following questions please circle the number between 1 and 7 that best applies to you

29. How would you rate your overall health during the past week?

1	2	3	4	5	6	7
Very poor						Excellent

30. How would you rate your overall quality of life during the past week?

1	2	3	4	5	6	7
Very poor						Excellent

ENGLISH

EORTC QLQ - BR23

Patients sometimes report that they have the following symptoms or problems. Please indicate the extent to which you have experienced these symptoms or problems during the past week.

During the past week:	**Not at All**	**A Little**	**Quite a Bit**	**Very Much**
31. Did you have a dry mouth?	1	2	3	4
32. Did food and drink taste different than usual?	1	2	3	4
33. Were your eyes painful, irritated or watery?	1	2	3	4
34. Have you lost any hair?	1	2	3	4
35. Answer this question only if you had any hair loss: Were you upset by the loss of your hair?	1	2	3	4
36. Did you feel ill or unwell?	1	2	3	4
37. Did you have hot flushes?	1	2	3	4
38. Did you have headaches?	1	2	3	4
39. Have you felt physically less attractive as a result of your disease or treatment?	1	2	3	4
40. Have you been feeling less feminine as a result of your disease or treatment?	1	2	3	4
41. Did you find it difficult to look at yourself naked?	1	2	3	4
42. Have you been dissatisfied with your body?	1	2	3	4
43. Were you worried about your health in the future?	1	2	3	4

During the past four weeks:	**Not at All**	**A Little**	**Quite a Bit**	**Very Much**
44. To what extent were you interested in sex?	1	2	3	4
45. To what extent were you sexually active? (with or without intercourse)	1	2	3	4
46. Answer this question only if you have been sexually active: To what extent was sex enjoyable for you?	1	2	3	4

Please go on to the next page

During the past week:	**Not at All**	**A Little**	**Quite a Bit**	**Very Much**
47. Did you have any pain in your arm or shoulder?	1	2	3	4
48. Did you have a swollen arm or hand?	1	2	3	4
49. Was it difficult to raise your arm or to move it sideways?	1	2	3	4
50. Have you had any pain in the area of your affected breast?	1	2	3	4
51. Was the area of your affected breast swollen?	1	2	3	4
52. Was the area of your affected breast oversensitive?	1	2	3	4
53. Have you had skin problems on or in the area of your affected breast (e.g., itchy, dry, flaky)?	1	2	3	4

Appendix B: DASH Questionnaire

DISABILITIES OF THE ARM, SHOULDER AND HAND

Please rate your ability to do the following activities in the last week by circling the number below the appropriate response.

	NO DIFFICULTY	MILD DIFFICULTY	MODERATE DIFFICULTY	SEVERE DIFFICULTY	UNABLE
1. Open a tight or new jar.	1	2	3	4	5
2. Write.	1	2	3	4	5
3. Turn a key.	1	2	3	4	5
4. Prepare a meal.	1	2	3	4	5
5. Push open a heavy door.	1	2	3	4	5
6. Place an object on a shelf above your head.	1	2	3	4	5
7. Do heavy household chores (e.g., wash walls, wash floors).	1	2	3	4	5
8. Garden or do yard work.	1	2	3	4	5
9. Make a bed.	1	2	3	4	5
10. Carry a shopping bag or briefcase.	1	2	3	4	5
11. Carry a heavy object (over 10 lbs).	1	2	3	4	5
12. Change a lightbulb overhead.	1	2	3	4	5
13. Wash or blow dry your hair.	1	2	3	4	5
14. Wash your back.	1	2	3	4	5
15. Put on a pullover sweater.	1	2	3	4	5
16. Use a knife to cut food.	1	2	3	4	5
17. Recreational activities which require little effort (e.g., cardplaying, knitting, etc.).	1	2	3	4	5
18. Recreational activities in which you take some force or impact through your arm, shoulder or hand (e.g., golf, hammering, tennis, etc.).	1	2	3	4	5
19. Recreational activities in which you move your arm freely (e.g., playing frisbee, badminton, etc.).	1	2	3	4	5
20. Manage transportation needs (getting from one place to another).	1	2	3	4	5
21. Sexual activities.	1	2	3	4	5

DISABILITIES OF THE ARM, SHOULDER AND HAND

	NOT AT ALL	SLIGHTLY	MODERATELY	QUITE A BIT	EXTREMELY
22. During the past week, *to what extent* has your arm, shoulder or hand problem interfered with your normal social activities with family, friends, neighbours or groups? *(circle number)*	1	2	3	4	5

	NOT LIMITED AT ALL	SLIGHTLY LIMITED	MODERATELY LIMITED	VERY LIMITED	UNABLE
23. During the past week, were you limited in your work or other regular daily activities as a result of your arm, shoulder or hand problem? *(circle number)*	1	2	3	4	5

Please rate the severity of the following symptoms in the last week. *(circle number)*

	NONE	MILD	MODERATE	SEVERE	EXTREME
24. Arm, shoulder or hand pain.	1	2	3	4	5
25. Arm, shoulder or hand pain when you performed any specific activity.	1	2	3	4	5
26. Tingling (pins and needles) in your arm, shoulder or hand.	1	2	3	4	5
27. Weakness in your arm, shoulder or hand.	1	2	3	4	5
28. Stiffness in your arm, shoulder or hand.	1	2	3	4	5

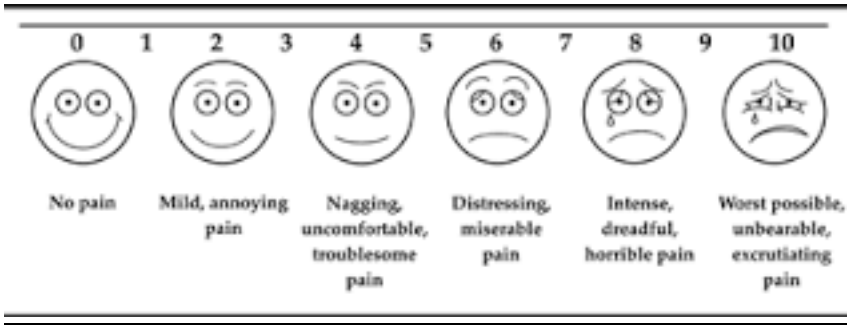
	NO DIFFICULTY	MILD DIFFICULTY	MODERATE DIFFICULTY	SEVERE DIFFICULTY	SO MUCH DIFFICULTY THAT I CAN'T SLEEP
29. During the past week, how much difficulty have you had sleeping because of the pain in your arm, shoulder or hand? *(circle number)*	1	2	3	4	5

	STRONGLY DISAGREE	DISAGREE	NEITHER AGREE NOR DISAGREE	AGREE	STRONGLY AGREE
30. I feel less capable, less confident or less useful because of my arm, shoulder or hand problem. *(circle number)*	1	2	3	4	5

DASH DISABILITY/SYMPTOM SCORE = $\left[\frac{(\text{sum of n responses})}{n} - 1\right] \times 25$, where n is equal to the number of completed responses.

A DASH score may not be calculated if there are greater than 3 missing items.

Appendix C: Visual Analog Scale (VAS)



www.operativeneurosurgery.com

Appendix D: Borg Scale of Perceived Exertion (RPE)

rating	description
6	NO EXERTION AT ALL
7	EXTREMELY LIGHT
8	
9	VERY LIGHT
10	
11	LIGHT
12	
13	SOMEWHAT HARD
14	
15	HARD (HEAVY)
16	
17	VERY HARD
18	
19	EXTREMELY HARD
20	MAXIMAL EXERTION

www.topendsports.com

Appendix E: York University's Human Participants Research Committee Approval

Certificate #:	**2016 - 133**
Approval Period:	**04/14/16-04/14/17**

ETHICS APPROVAL

OFFICE OF RESEARCH ETHICS (ORE)
5th Floor, Kaneff Tower

4700 Keele St.
Toronto ON
Canada M3J 1P3
Tel 416 736 5914
Fax 416 736-5512
www.research.yorku.ca

To: **Ms. Claire Biafore**
Department of Kinesiology, Faculty of Health

Professor Angelo Belcastro
Department of Kinesiology, Faculty of Health

Professor Loriann Hynes
Department of Kinesiology, Faculty of Health

From: Alison M. Collins-Mrakas, Sr. Manager and Policy Advisor, Research Ethics
(on behalf of Denise Henriques, Chair, Human Participants Review Committee)

Date: Thursday, April 14, 2016

Title: **Effects of a Specific Exercise Program on Shoulder Range of Motion in Breast Cancer Survivors, 6-9 months Post-Mastectomy**

Risk Level: ☒ Minimal Risk ☐ More than Minimal Risk

Level of Review: ☒ Delegated Review ☐ Full Committee Review

I am writing to inform you that this research project, **"Effects of a Specific Exercise Program on Shoulder Range of Motion in Breast Cancer Survivors, 6-9 months Post-Mastectomy"** has received ethics review and approval by the Human Participants Review Sub-Committee, York University's Ethics Review Board and conforms to the standards of the Canadian Tri-Council Research Ethics guidelines.

Note that approval is granted for one year. Ongoing research – research that extends beyond one year – must be renewed prior to the expiry date.

Any changes to the approved protocol must be reviewed and approved through the amendment process by submission of an amendment application to the HPRC prior to its implementation.

Any adverse or unanticipated events in the research should be reported to the Office of Research ethics (ore@yorku.ca) as soon as possible.

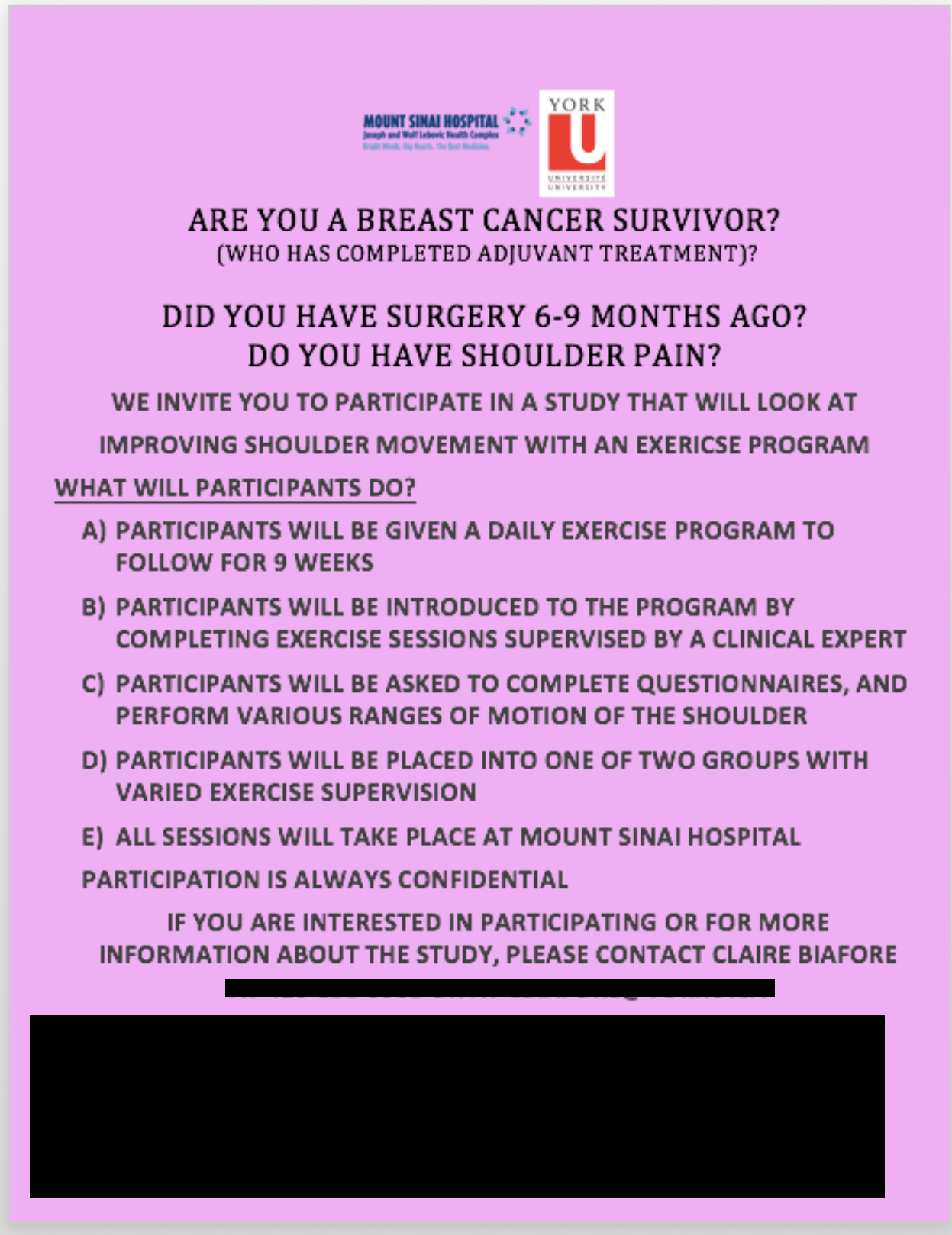
For further information on researcher responsibilities as it pertains to this approved research ethics protocol, please refer to the attached document, **"RESEARCH ETHICS: PROCEDURES to ENSURE ONGOING COMPLIANCE".**

Yours sincerely,

Alison M. Collins-Mrakas M.Sc., LLM
Sr. Manager and Policy Advisor,
Office of Research Ethics

Appendix F: Flyer for Participant Recruitment

Appendix G: Toronto Academic Health Sciences Network, Human Subjects Research



MOUNT SINAI HOSPITAL
Joseph and Wolf Lebovic Health Complex

YORK UNIVERSITÉ UNIVERSITY

ARE YOU A BREAST CANCER SURVIVOR?
(WHO HAS COMPLETED ADJUVANT TREATMENT)?

DID YOU HAVE SURGERY 6-9 MONTHS AGO?
DO YOU HAVE SHOULDER PAIN?

WE INVITE YOU TO PARTICIPATE IN A STUDY THAT WILL LOOK AT

IMPROVING SHOULDER MOVEMENT WITH AN EXERICSE PROGRAM

WHAT WILL PARTICIPANTS DO?

A) PARTICIPANTS WILL BE GIVEN A DAILY EXERCISE PROGRAM TO FOLLOW FOR 9 WEEKS

B) PARTICIPANTS WILL BE INTRODUCED TO THE PROGRAM BY COMPLETING EXERCISE SESSIONS SUPERVISED BY A CLINICAL EXPERT

C) PARTICIPANTS WILL BE ASKED TO COMPLETE QUESTIONNAIRES, AND PERFORM VARIOUS RANGES OF MOTION OF THE SHOULDER

D) PARTICIPANTS WILL BE PLACED INTO ONE OF TWO GROUPS WITH VARIED EXERCISE SUPERVISION

E) ALL SESSIONS WILL TAKE PLACE AT MOUNT SINAI HOSPITAL

PARTICIPATION IS ALWAYS CONFIDENTIAL

IF YOU ARE INTERESTED IN PARTICIPATING OR FOR MORE INFORMATION ABOUT THE STUDY, PLEASE CONTACT CLAIRE BIAFORE

[redacted]

[redacted]

Application

MOUNT SINAI HOSPITAL

Research Ethics Board

700 University Avenue, 8th fl., Suite 8-600
Toronto, Ontario, Canada, M5G 1Z5
t: (416) 586-4875 f: (416) 586-4715
www.mtsinai.on.ca

Notification of REB Initial Approval (Delegated)

Date: November 17, 2016

To: Dr. Jaime Escallon
Department of Surgery
Marvelle Koffler Breast Centre
Mount Sinai Hospital
600 University Avenue, Room 1266-C
Toronto, Ontario

Re: **16-0237-E**
The Effects of a Specific Exercise Program on Shoulder Function in Breast Cancer Survivors, 6-9 Months Post-mastectomy

Sponsor:	York University
REB Review Type:	Delegated
REB Initial Approval Date:	17 November 2016
REB Expiry Date:	17 November 2017
Documents Approved:	Questionnaire/Survey: EORTC QLQ-C30 (Rec. 09-Sep-2016) Questionnaire/Survey: EORTC QLQ - BR23 (Rec. 09-Sep-2016) Questionnaire/Survey: DASH (Rec. 09-Sep-2016) Telephone Script (Rec. 15-Jan-2016) Consent Form (Dated: 25-Oct-2016) Consent Form: Consent to Contact (Rec. 25-Oct-2016) Patient Diary: Daily Exercise Checklist (Rec. 25-Oct-2016) Exercise Handouts (Rec. 21-Oct-2016) Recruitment Letters/Tools: Poster (Rec. 25-Oct-2016) Thank You Letter (Rec. 25-Oct-2016)
Documents Acknowledged:	Other REB Approval Letter: York University (Dated: 14-Apr-2016)
Health Records Access:	Yes

The above named study has been reviewed and approved by the Mount Sinai Hospital Research Ethics Board. If, during the course of the research, there are any serious adverse events, confidentiality concerns, changes in the approved project, or any new information that must be considered with respect to the project, these should be brought to the immediate attention of the REB. In the event of a privacy breach, you are responsible for reporting the breach to the MSH REB and the MSH Corporate Privacy Office (in accordance with Ontario health privacy legislation – Personal Health Information Protection Act, 2004). Additionally, the MSH REB requires reports of inappropriate/unauthorized use of the information.

If the study is expected to continue beyond the expiry date, you are responsible for ensuring the study receives re-approval. The REB must be notified of the completion or termination of this study and a final report provided. As the Principal Investigator, you are responsible for the ethical conduct of this study.

The MSH Research Ethics Board operates in compliance with the Tri-Council Policy Statement 2, ICH/GCP Guidelines and Part C, Division 5 of the Food and Drug Regulations of Health Canada.

Sincerely,

[redacted]

Chair, Mount Sinai Hospital Research Ethics Board

Appendix H: Letter of Consent to be Contacted by Claire Biafore

Consent to allow Claire Biafore to contact you

Date: January 31, 2017

Study Name: Effects of a Specific Exercise Program on Shoulder Function in Breast Cancer Survivors, 6-9 months Post-Surgery

Researchers: Dr. Jaime Escallon [redacted] , *Claire Biafore* [redacted]*); Dr. Angelo Belcastro* [redacted]*) : Dr. Loriann Hynes* [redacted]*)*

Purpose of the Research: The purpose of this study is to evaluate the effects of implementing a specific shoulder exercise program for breast cancer survivors between 6-9 months post-surgery. Research targeting exercise protocols for post surgical patients is limited and you may not necessarily have access to this type of active rehabilitation program. Shoulder function is the most common complication post-surgery. This exercise program will be targeted at improving your shoulder function and to help you in your daily life activities.

Please be advised that by signing this page, you allow Claire Biafore to contact you to provide more information about the above study. This **does not** confirm your participation within this study. This is merely an opportunity to get more details or to ask any questions about your possible participation in this study. If you choose to not be involved in this study, this consent form will be destroyed immediately and no other follow up will be initiated by any researchers.

Questions About the Research? If you have questions about the research in general or about your potential role in the study, please feel free to contact Claire Biafore either by telephone at [redacted], or by e-mail [redacted]. If you have any questions about this process, or about your rights as a possible participant in the study, please contact Dr. R. Heslegrave, Chair, Mount Sinai Hospital, Research Ethics Board, (416)-586-4875.

Legal Rights and Signatures:

I_____, consent to be contacted by Claire Biafore regarding the study entitled "**The Effects of a Specific Exercise Program on Shoulder Function in Breast Cancer Survivors, 6-9 months Post-Surgery** conducted by Dr. Jaime Escallon, and Claire Biafore.
I am not waiving any of my legal rights by signing this form. My signature below indicates my consent to be contacted only to discuss my potential participation in this study, to receive more information about the study.

Signature_____ **Date**_____
Patient

Signature_____ **Date**_____
Dr. Jamie Escallon

Please contact me by:

1. Phone number: _____ and/or
2. Email address: _____and/or

Appendix I: Informed Consent Form

Informed Consent Form

Study Name: Effects of a Specific Exercise Program on Shoulder Function in Breast Cancer Survivors, 6-9 months Post-Surgery

Researchers: Dr. Jaime Escallon [redacted]
Claire Biafore [redacted]
Dr. Angelo Belcastro [redacted]
Dr. Loriann Hynes [redacted]

You are being asked to take part in a research study. Please read this explanation about the study and its risks and benefits before you decide if you would like to take part. You should take as much time as you need to make your decision. You should ask the study doctor or study staff to explain anything that you do not understand and make sure that all of your questions have been answered before signing this consent form. Before you make your decision, feel free to talk about this study with anyone you wish. Participation in this study is voluntary.

Purpose of the Research: The purpose of this study is to evaluate the effects of implementing a specific shoulder exercise program for breast cancer survivors between 6-9 months post-surgery. Research targeting exercise protocols for post mastectomy patients is limited and you may not necessarily have access to this type of active rehabilitation program. Shoulder function is the most common complication post-surgery. This exercise program will be targeted at improving your shoulder function and to help you in your daily life activities.

The study will ask you to participate in a basic and daily active exercise program. You will be asked to visit Mount Sinai Hospital or a private home based clinic multiple times over the course of the nine (9) week study. Each visit will be approximately 45 min to 1 hour and will include various assessments and/or an overview of your exercise program.

What You Will Be Asked to Do in the Research:
Your commitment will involve the following:

1. A commitment of nine (9) weeks.
2. Three assessments performed at the clinic: first assessment at the start of the study, second assessment at 4 weeks from the start of the study, and last assessment 8 weeks from the start of the study.
3. Assessments will include: Two (2) questionnaires, clinical observation of your posture, range of motion testing of your shoulders, measurement of swelling in your arm (lymphedema), (re)assessment of a resistance for your exercise program.
4. Your attendance will be dependent on what group you are randomly assigned to. The first group would consist of one exercise session and the other group would include three guided exercise sessions. Each session will be approximately one hour either once at the beginning of the study or three times spaced within the time-frame of the study. All assessments and exercise sessions will be performed at your breast cancer support clinic
5. You will be asked to perform the exercise program on a daily basis for the duration of the study.

Risks and Discomforts: The risks of your participation are low as an appropriate resistance will be determined for you. However, risks with your participation may include:

1. You may be uncomfortable in answering questions within a questionnaire. You may refuse to answer any questions that you feel are distressing to you.
2. Fatigue during or following the exercise program
3. Pain or stiffness in the shoulder or back region during your exercise program due to over-stretching or straining of the muscles
4. Pain or stiffness felt in the shoulder or back region during and following your exercise program
5. Muscle strains

If you feel pain or discomfort in your shoulder or back during or after your exercise regimen, stop all exercises immediately and contact Claire Biafore to discuss your concerns. In addition, your physician may be contacted for consultation.

In Case You Are Harmed in the Study: If you become ill, injured or harmed as a result of taking part in this study, you will receive care. The reasonable costs of such care will be covered for any injury, illness or harm that is directly a result of being in this study. In no way does signing this consent form waive your legal rights nor does it relieve the investigators, sponsors or involved institutions from their legal and professional responsibilities. You do not give up any of your legal rights by signing this consent form.

Expenses Associated with Participation in this Study: The only cost associated with your participation in this study is the expense of parking or public transit associated with your travel time to and from Mount Sinai Hospital.

Conflict of Interest: Although all of these people (Dr. Jaime Escallon, Claire Biafore, Dr. Angelo Belcastro, and Dr. Loriann Hynes) have an interest in the completion of this study, their interests should not influence your decision to participate in this study. You should not feel pressured to join this study.

Benefits of the Research and Benefits to You: An active exercise program tailored specifically to post surgical patients may be beneficial by helping improve shoulder movement during your daily life activities, leading to greater quality of life.

Voluntary Participation: Your participation in the study is completely voluntary and you may choose to stop participating at any time. Your decision not to volunteer will not influence the treatment you may be receiving.

Compensation for your participation: At this time, there is no compensation available for your participation, however, you will be receiving a complimentary exercise program that is normally a fee for service by Claire Biafore at $100 per session.

Withdrawal from the Study: You can stop participating in the study at any time, for any reason, if you so decide. Your decision to stop participating, or to refuse to answer particular questions, will not affect your relationship with the researchers, York University, or any other group associated with this project. In the event you withdraw from the study, all associated data collected will be immediately destroyed wherever possible.

Confidentiality:

Personal Health Information

If you agree to join this study, the study doctor and his/her study team will look at your personal health information and collect only the information they need for the study. Personal health information is any information that could be used to identify you and includes your:

- name,
- address,
- date of birth,
- new or existing medical records, that includes types, dates and results of medical tests or procedures.

The information that is collected for the study will be kept in a locked and secure area by the study doctor for 25 years. Only the study team or the people or groups listed below will be allowed to look at your records. Your participation in this study also may be recorded in your medical record at this hospital. The following people may come to the hospital to look at the study records and at your personal health information to check that the information collected for the study is correct and to make sure the study followed proper laws and guidelines:

- Representatives of the Mount Sinai Hospital Research Ethics Board or
- Representatives of the York University Research Ethics Board

Questions About the Research? If you have questions about the research in general or about your role in the study, please feel free to contact Claire Biafore either by telephone at [redacted], or by e-mail [redacted] If you have any questions about this process, or about your rights as a participant in the study, please contact Dr. R. Heslegrave, Chair, Mount Sinai Hospital, Research Ethics Board, (416)-586-4875. The REB is a group of people who oversee the ethical conduct of research studies. These people are not part of the study team. Everything that you discuss will be kept confidential.

Legal Rights and Signatures:

I_____, consent to participate in **The Effects of a Specific Exercise Program on Shoulder Function in Breast Cancer Survivors, 6-9 months Post-Surgery** conducted by Dr. Jaime Escallon, and Claire Biafore. I have understood the nature of this project and wish to participate. I am not waiving any of my legal rights by signing this form. My signature below indicates my consent.

Signature _____ **Date** _____
Participant

Signature _____ **Date** _____
Principal Investigator

Appendix J: Exercise Handout

Date Began Exercises: _____

Exercise Handouts

Please remember that these exercises are done on a daily basis

Researchers:

Dr. Jaime Escallon
[redacted]

Claire Biafore
[redacted]

Exercise Information

Thank you again for participating in this study! Your participation in this study is paving the way for future research for women recovering from breast cancer surgery.

Please adhere to the following rules for your exercises:

1. Please start with the resistance that was assigned to you. This will ensure that you do not injure yourself during the study.
2. Please only **add 5 repetitions per week**. For example, this week you will start with 10 repetitions of the necessary exercises. Next week, you will increase to 15 repetitions if you are able to complete the exercise without pain. The week after you will increase to 20 repetitions and continue until we meet in 4 weeks or 8 weeks.
3. Please perform all of the exercises in a pain-free range. There should be no pain during or after the exercise. It's common to feel tired after the exercise as your muscle strength is improving.
4. Again, please do not stray away from the specified resistance or repetition that you were advised to perform.

If you have any additional questions or concerns, please feel free to contact us using the contact information on the first page of this handout.

Thank you again!

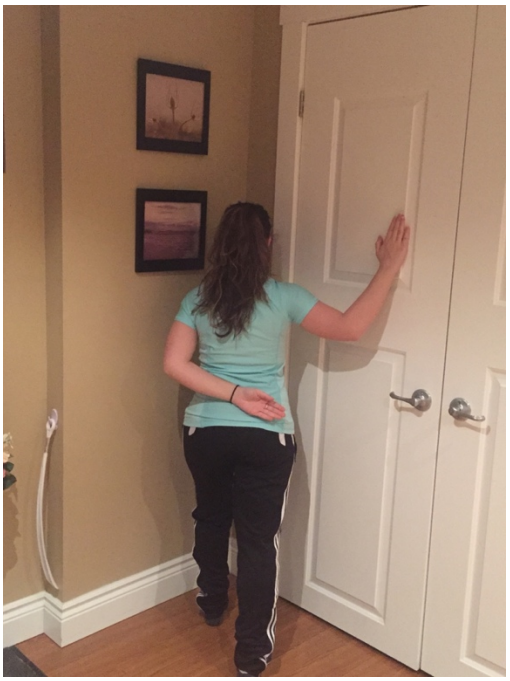
Sincerely,

Dr. Jaime Escallon and Claire Biafore

1. **Pectoralis major/minor stretch**

You will begin by facing a corner of a room. Next, bring one foot forward toward the corner of the wall at approximately 1-2 feet in front of your body and approximately shoulder width apart. Then, bring your arms to your sides to about 90 degrees with arms bent at the elbow with fingers toward the ceiling and palms facing in the direction of the wall. Then you will place your palm(s) on the wall in line with the foot that's in front and will lean your upper body into the wall focusing on bringing your chest to the wall. Next, you will begin with only one arm pectoralis stretch and then when you are able will move to two arms in the corner, followed by both arms on the inside of a door-frame.

This exercise is going to be performed up to three times per day and held for 30 seconds in the position closest to the wall.



2. Shoulder movement with internal rotation

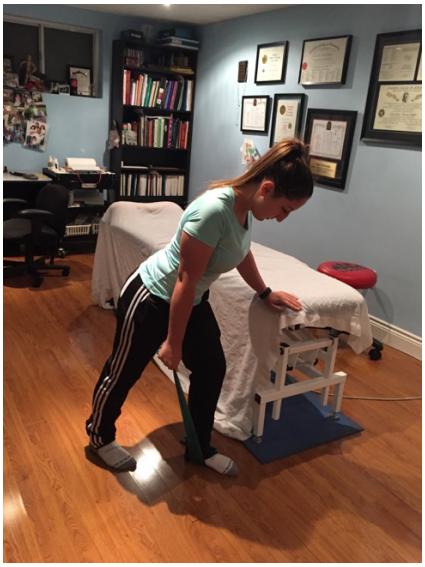
Description/Progression: You will stand with your arms at your sides. Next, rotate your arms at your shoulders so your elbows are straight, thumbs are closest to your legs and palms are facing behind you. While standing with your feet shoulder width apart, with shoulders down and away from your ears, raise your arms up to the ceiling and stop just below your shoulders or in a pain-free range. Then return to the starting position. **One set of 10 repetitions done daily.**

Below: Starting and Finished position with a band

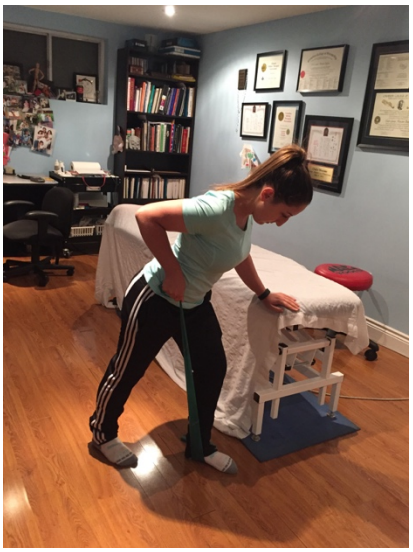
3. Single arm, bent over row

Description/Progression: You will begin by standing next to a table or a chair. Next, the begin by placing the foot closest to the table or chair in front of the other foot about 1-2 feet in front of the body and shoulder width apart. Next, bend forward from the hips and lean your upper-body forward while placing your hand closest to the table or chair in a push-up position. The upper body is maintained bent forward at a 45-degree angle, while the "working arm" is extended toward the floor with the palm facing you. Next, you will lift the wrist of the working arm toward the ceiling and will glide your arm close to your body making contact between the wrist and the side of your body and return to the starting position. **This exercise will be performed one set of 10 repetitions daily.**

Starting Position of the exercise:



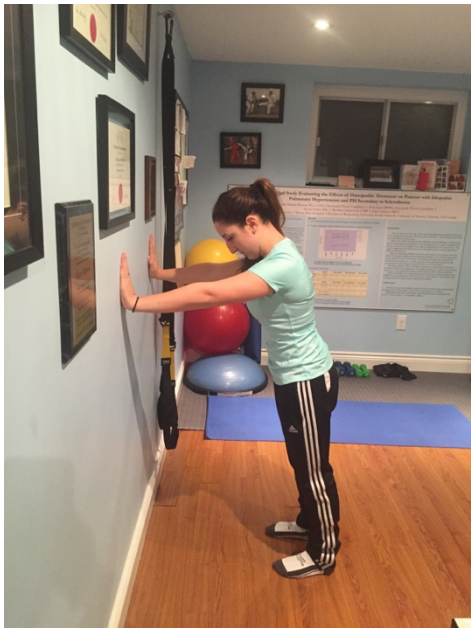
Finished position of the exercise:



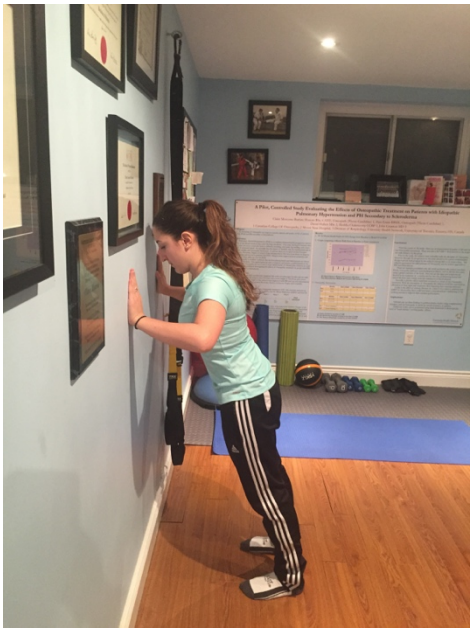
4. **Push ups with a plus**

   Description/Progression: You will begin in a push up position on the wall and will only progress to a chair when the primary investigator instructs you to do so. You start in a standing position about 1-2 feet away from the wall with arms extended in front of you in a push up position with palms touching the wall and arms shoulder width apart and just below their collarbone. Then you will bend your arms at your elbows in an attempt to touch your chest to the wall (or chair when instructed to). Next, push yourself up and away from the wall and at the position when your elbows are completely straight, you will accentuate your shoulder blades outward like the position of a cat. This is held for 1-2 seconds, next returning to the down position of the push-up. **The participant will begin with one set of 10 repetitions done daily.**

Starting Position for Wall push- ups

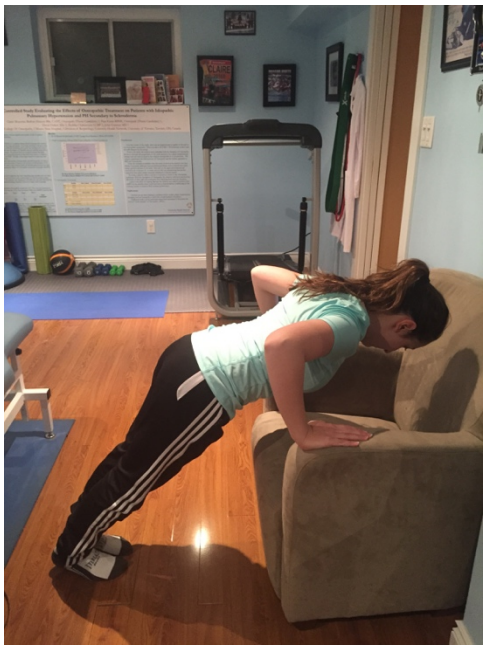


Finished position for Wall Push-ups



Starting Position for Chair Push-ups

Finished Position for Chair Push-ups



Daily Exercise Check-List

Please refer to the handout regarding exercise descriptions

Claire Biafore: cbiafore@yorku.ca

Days	Pectoralis Stretch	Shoulder Raise to the side	Bent Over Row	Push ups
1				
2				
3				
4				
5				
6				
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Appendix K: Clinical Observation Intake Form

Date: _____

Participant Number: _____ Baseline or Final Assessment

Affected Side: L or R

Questionnaires Complete Y or N

"Take a deep breath in and out and look straight ahead. Please don't move from your position."

ANTERIOR VIEW

Notes:

Arm Dominance	Right	Left	
Anteriorly Rotated Shoulder	Yes	No	
Guarding of the Shoulder Complex	Yes	No	
Muscle Atrophy			
Deltoid	Yes	No	
Upper Trapezius	Yes	No	
Pectoralis Complex	Yes	No	

SIDE VIEW

Head in Neutral	Right	Left	
Scapula Resting Flat Against the Rib Cage	Yes	No	
Spine has normal curves			
Cervical	Yes	No	
Thoracic	Yes	No	
Lumbar	Yes	No	
Pelvis in Neutral	Yes	No	
Knee Joints in Neutral Position	Yes	No	
Lower legs in Neutral Position	Yes	No	

POSTERIOR VIEW

Scapula the same height at superior border	Yes	No	
Scapula appear to be winging at the inferior border	Yes	No	
Winging Scapula Test	Yes	No	

Neurological Testing **Notes:**

Dermatomes			
C4	Positive	Negative	
C5	Positive	Negative	
C6	Positive	Negative	
T1	Positive	Negative	
T2	Positive	Negative	
T3	Positive	Negative	
T4	Positive	Negative	
T5	Positive	Negative	
T6	Positive	Negative	
Myotomes			
C4	Positive	Negative	
C5	Positive	Negative	
C6	Positive	Negative	
C7	Positive	Negative	

LYMPHEDEMA

Measurement **Notes:**

	Above	Below	
Right			
Left			
Lymphedema Noted			
Goniometer Measurements	Right	Left	
Flexion			
Extension			
Abduction			
Internal Rotation			
External Rotation			
Horizontal Abduction			
Horizontal Adduction			

RECOMMENDATION FOR EXERCISE INTERVENTION:

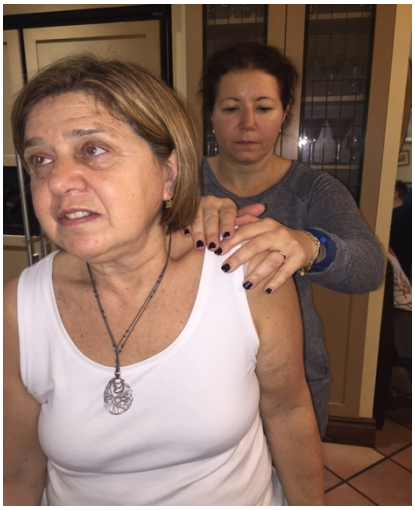
_____

_____

_____

Appendix L: Myotome Testing

C4: Shoulder Elevation



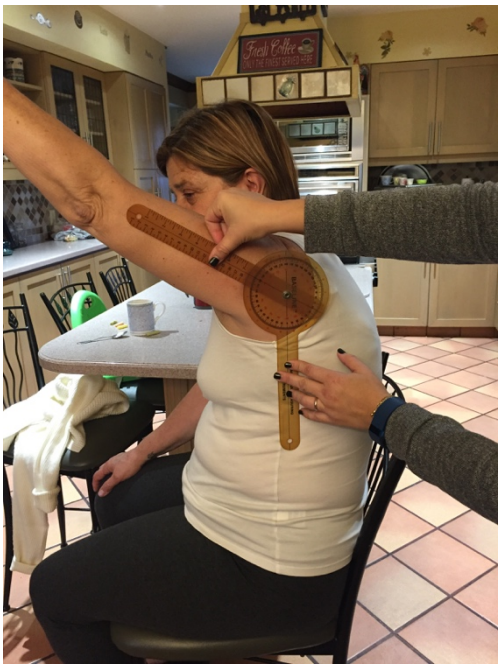
C5: Shoulder Abduction

C6: Elbow Flexion

C7: Elbow Extension

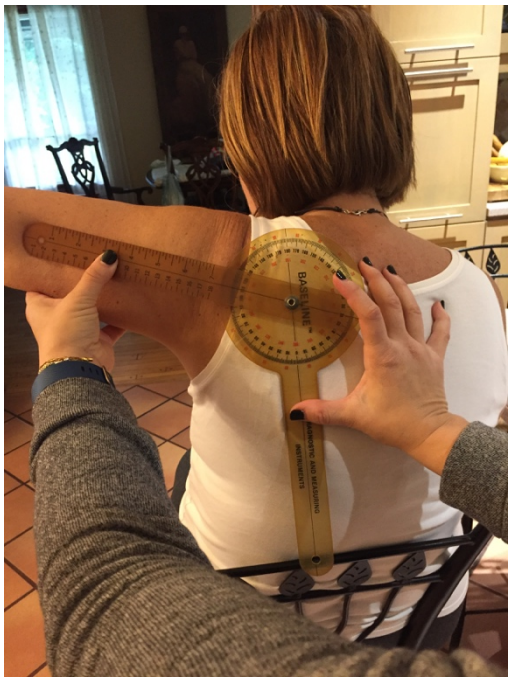
Appendix M: Goniometer Testing Positions

a) Shoulder Flexion



b) Shoulder Extension

c) Shoulder Abduction

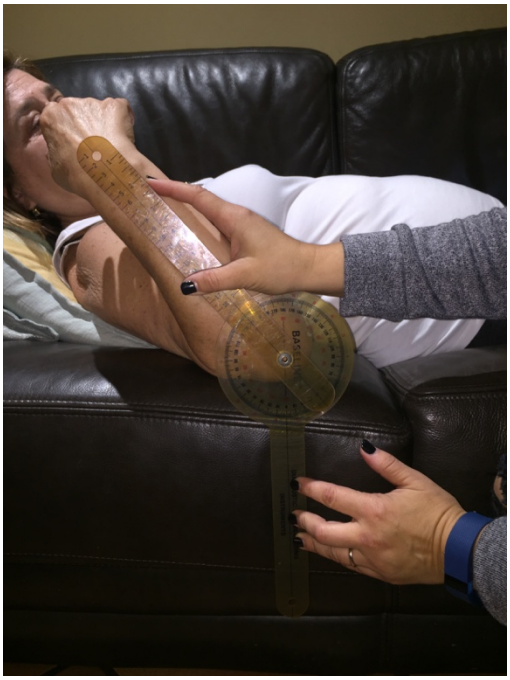


d) Shoulder Horizontal Abduction

e) Shoulder Horizontal Adduction

f) Shoulder Internal Rotation

g) Shoulder External Rotation



Appendix N: Letter of Appreciation

Date: April 21, 2017

Study Name: The Effects of a Specific Exercise Program on Shoulder Function in Breast Cancer Survivors, 6-9 months Post-Surgery

Researchers: Dr. Jaime Escallon [redacted], *Claire Biafore* [redacted] *Dr. Angelo Belcastro* [redacted] *: Dr. Loriann Hynes*

We would like to thank you for taking part in our research project. We really appreciated your contribution, your time and your effort.

The aim of the study was to evaluate the effects of implementing a specific shoulder exercise program for breast cancer survivors between 6-9 months post-surgery. Research targeting exercise protocols for post mastectomy patients is limited and you may not necessarily have access to this type of active rehabilitation program. Shoulder function is the most common complication post-surgery. The exercise program was targeted at improving your shoulder function and to help you in your daily life activities.

To date, this study is awaiting publication but if you have any additional questions or concerns, please feel free to contact me at [redacted] or via email at [redacted]

Thank you again for your help in this study!

Sincerely,

Dr. Jamie Escallon

Claire Biafore

Appendix O: EORTC QLQ-C30 Scoring

Scoring of the QLQ-C30 Summary Score

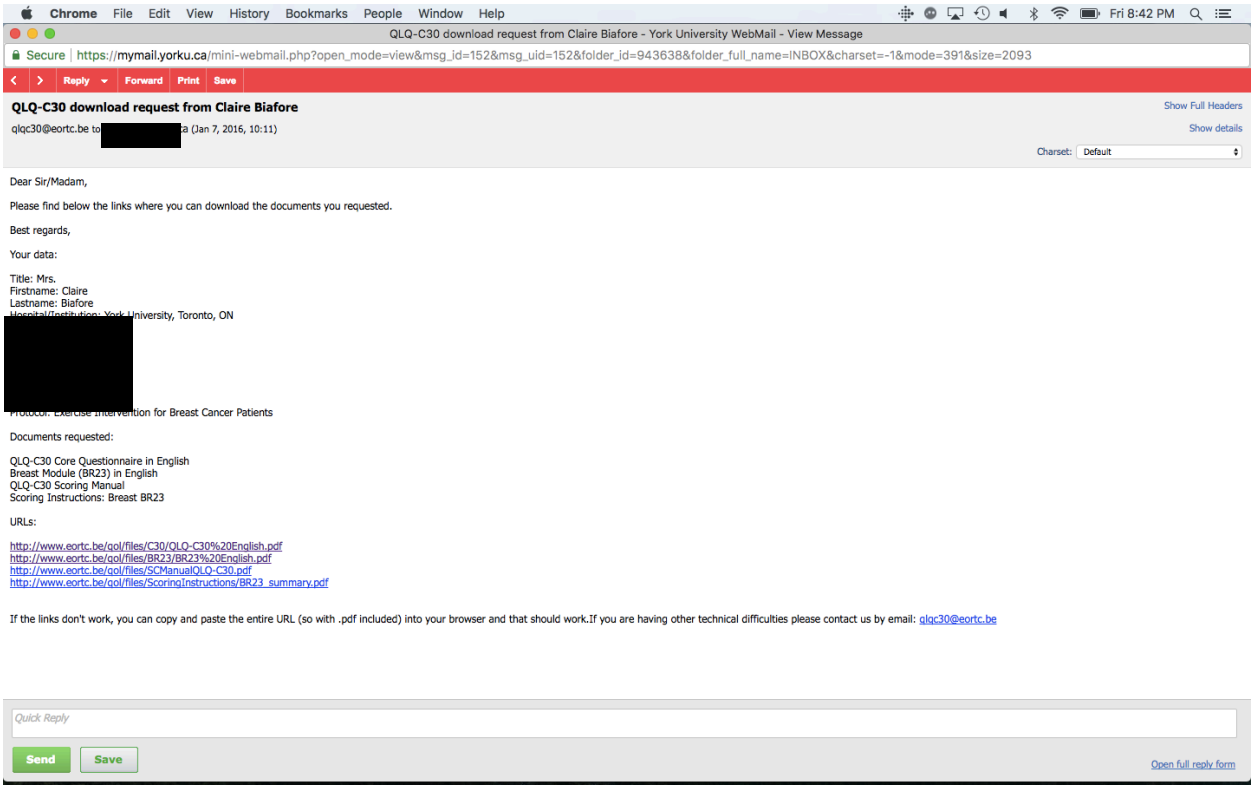
The EORTC QLQ-C30 Summary Score is calculated from the mean of 13 of the 15 QLQ-C30 scales (the Global Quality of Life scale and the Financial Impact scale are not included). Prior to calculating the mean, the symptom scales need to be reversed to obtain a uniform direction of all scales. The summary score should only be calculated if all of the required 13 scale scores are available (using scale scores based on the completed items, provided that at least 50% of the items in that scale have been completed (see Fayers et. al., The EORTC QLQ-C30 Scoring Manual (3rd Edition) 2001).

SPSS Syntax:

COMPUTE

QLQ-C30 Summary Score = (Physical Functioning+ Role Functioning+ Social Functioning+ Emotional Functioning+ Cognitive Functioning+ 100-Fatigue+ 100-Pain+ 100-Nausea_Vomiting+ 100-Dyspnoea+ 100-Sleeping Disturbances+ 100-Appetite Loss+ 100-Constipation+ 100-Diarrhoea)/13. **EXECUTE.**

Appendix P: Email Permission to Use EORTC QLQ-C30



Chrome File Edit View History Bookmarks People Window Help Fri 8:42 PM

QLQ-C30 download request from Claire Biafore - York University WebMail - View Message

Secure | https://mymail.yorku.ca/mini-webmail.php?open_mode=view&msg_id=152&msg_uid=152&folder_id=943638&folder_full_name=INBOX&charset=-1&mode=391&size=2093

Reply Forward Print Save

QLQ-C30 download request from Claire Biafore

Show Full Headers
Show details

qlqc30@eortc.be to [redacted]ca (Jan 7, 2016, 10:11)

Charset: Default

Dear Sir/Madam,

Please find below the links where you can download the documents you requested.

Best regards,

Your data:

Title: Mrs.
Firstname: Claire
Lastname: Biafore
Hospital/Institution: York University, Toronto, ON
[redacted]
Protocol: Exercise Intervention for Breast Cancer Patients

Documents requested:

QLQ-C30 Core Questionnaire in English
Breast Module (BR23) in English
QLQ-C30 Scoring Manual
Scoring Instructions: Breast BR23

URLs:

http://www.eortc.be/qol/files/C30/QLQ-C30%20English.pdf
http://www.eortc.be/qol/files/BR23/BR23%20English.pdf
http://www.eortc.be/qol/files/SCManualQLQ-C30.pdf
http://www.eortc.be/qol/files/ScoringInstructions/BR23_summary.pdf

If the links don't work, you can copy and paste the entire URL (so with .pdf included) into your browser and that should work.If you are having other technical difficulties please contact us by email: qlqc30@eortc.be

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