Effects of Breast Cancer Treatment on Shoulder Function: What to Expect and How to Treat?
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Abstract

Breast cancer treatment may lead to side effects such as shoulder pain, restricted shoulder mobility, fibrosis, breast cancer-related lymphedema, and anatomical and biomechanical changes of the shoulder, which will contribute to functional status limitations. Function of the upper limb requires adequate mobility of the shoulder, including the scapula, and an efficient neuromuscular coordination. Movement deviation patterns in women following surgery for breast cancer are similar to those seen in other known shoulder conditions. Exercise therapy and scapular stabilization exercises were found to be an effective approach for controlling pain, promote normal motor control and decreasing disability. The main purpose of the present paper is to review the shoulder movement dysfunctions after breast cancer treatment and to briefly characterize the main physical therapy intervention strategies to treat or prevent these dysfunctions.

Introduction

Cancer rehabilitation is a process that helps cancer survivors achieve and maintain the highest possible physical, social, psychological, and vocational functioning, within the limits created by cancer and its treatments [1].

Among women, breast cancer is the most commonly diagnosed cancer and the second leading cause of cancer death [2]. However, due to new treatments and early detection, breast cancer survival has improved over time [2]. Breast cancer treatment may lead to side effects such as shoulder pain, restricted shoulder mobility, fibrosis, breast cancer-related lymphedema [3-5], and anatomical and biomechanical changes of the shoulder [6], which will contribute to functional status limitations [7-9]. These disorders may manifest immediately after treatment of breast cancer or may present many years later [10]. Function of the upper limb requires adequate mobility of the shoulder, including the scapula, and an efficient neuromuscular coordination. Alterations of the scapulohumeral rhythm will cause microtrauma and long-term pain. It is suggested that subtle changes in this space may result in compression of the subacromial structures such as the bursa and rotator cuff during arm elevation [11]. The glenohumeral (GU) joint is a very mobile joint, and its stability depends largely on motor control. In this way the evaluation of this control and the directed treatment to achieve improvement should be a central part of the physical therapy approach [12]. Several types of functionally oriented exercises have been developed based on scapulohumeral kinematics and the kinetic chain beyond the shoulder range of motion (ROM) and strength [13]. Counseling exercises and scapula-oriented shoulder exercises may be effective with regard to pain and quality of life [14] as well improving shoulder mobility [15].

The main purpose of the present paper is to review the shoulder movement dysfunctions after breast cancer treatment and to briefly characterize the main physical therapy intervention strategies to treat these dysfunctions.

Shoulder Dysfunction after Breast Cancer Treatment

Women treated for breast cancer often complain of shoulder pain and decreased function post-surgery; 10-55% of women show restricted glenohumeral range of movement, 22-38% complains of shoulder pain, and 42-56% report difficulties with lifting the upper limb [16]. The surgical incisions through the skin and fasciae will result in scar tissue formation in the anterior chest wall region. This scar tissue may impair normal gliding between skin related structures, fasciae, and muscles that are necessary for free and normal motion of the shoulder girdle. That, associated with pain, protective postures and fear of complications, will promote a resting shoulder girdle mal-alignment and a decreased shoulder motion [17]. Soft tissue fibrosis secondary to radiation therapy would likely exacerbate decreased tissue flexibility and motion restrictions [18]. Pectoralis minor and major muscles lengths are believed to have an important effect on shoulder resting position [19].

Glenohumeral (GU) joint is the most mobile joint that relies heavily on mid-range stability on muscle control [12]. Arm elevation depends on interaction and coordination of both glenohumeral and scapulolothoracic movements which ensure that functional activities can occur without the head of the humerus impacting on the coracoacromial arch and placing the soft tissue structures across the shoulder joint, in risk of impingement. The absence of osseous stability at the GU joint means that the shoulder complex relies on the interaction of both static and dynamic structures to provide joint stability [20]. Muscles of the shoulder form the dynamic structures and can be divided functionally into stabilizers and prime movers [21]. Timed interaction between these two groups of muscles is essential to achieve a smooth and physiologic scapulohumeral rhythm [22-24].

Considering the kinematics of shoulder movement, shoulder tightness affects glenohumeral translation and scapulohumeral rhythm, and source are credited.
followed by changes in scapular motion [25,26]. In particular, shortened pectoralis major and minor covering the anterior part of the shoulder and chest can impose restrictions on upward rotation, external rotation, posterior tilt and elevation of the scapula [27] with changes for the scapulohumeral rhythm.

Some studies have highlighted, but have not quantified, scapula dyskinesia (e.g. winging of the scapula) in patients demonstrating limited shoulder movements. Its incidence varies widely between 0% and 74.7% [28-33]. Evaluation of the shoulder dysfunction in breast cancer patients have been based in clinical examination, including range of movement measures and functional activities. This might explain the high variability of these findings. Scapular winging is a condition in which the medial border and inferior angle of the scapula protrudes prominently from the thorax. It can arise from numerous pathologic processes, which lead to a deficiency of the muscles that play a central role in pulling the scapula towards the thoracic wall, like serratus anterior [34]. Post-operative pain, length and tightness of scars, neural damage and muscle atrophy, might be some of the causes [28]. Clinical observations have been reported for muscle morbidity of pectoralis major, serratus anterior and latissimus dorsi [28,29].

Shamley et al. suggests alterations to the normal biomechanics of the shoulder complex in patients treated for breast cancer. They found an increased internal rotation of the scapula during elevation and lowering of the arm, with significant pain levels for up to 6 years after surgery [35], supporting a real connection between soft tissue alterations and biomechanical changes at the shoulder. Borstad et al. [36] found the same changes after only two months of breast cancer surgery. Decreased scapula upward rotation and posterior tilting, and increased scapula internal rotation have all been associated with subacromial impingement syndrome [37]. Other studies [38,39] showed an increased upward rotation of the scapula following mastectomy for breast cancer. It is believed that this represents a compensatory mechanism for a dysfunctional motion of the GU joint. These results were similar in symptomatic [38] and asymptomatic [39] women in relation to shoulder pain.

Shamley et al. [40] found a decrease in the size of the pectoralis major and minor muscles and a decreased EMG activity in upper trapezius and rhomboid muscles during arm elevation, in contrast to other authors, who found an increased activity of the upper trapezius during a low-load upper limb functional task [41] and arm elevation [33]. Less activity in the serratus anterior and increased activity in the deltoid was also found in breast cancer patients [33]. These findings suggest that motor control impairments in the shoulder complex, which may persist for a long time, play an important role in the development of shoulder pain and dysfunction in breast cancer survivors. An association between altered muscle activity at the shoulder and functional limitation was also found in this population for up to 6 years after treatment [40].

Regaining upper-body function after breast cancer surgery seems to take significantly longer than women’s own or general expectations. Many women reported difficulties in simple day-to-day activities, such as, driving, sleeping, housework and gardening in addition to a reduced ability to do their usual occupations [42]. In a longitudinal investigation designed to assess the physical and psychosocial recovery of women 6 months following breast cancer, the range in the function/symptom scale - Disability of the Arm, Shoulder and Hand questionnaire (DASH) scores was 0-72, with approximately 50% of the group reporting upper-body function scores of 11 or lower, representing ‘good’ arm function [43]. Continuous upper-body problems, and therefore difficulties when performing everyday tasks, existed for many women after 1 year post-surgery [42].

Shoulder neuromuscular impairments commonly experience by breast cancer survivors, contribute to the development of shoulder pain and dysfunction. Given that the majority of these impairments can be addressed with appropriate rehabilitation interventions, it is crucial that physical therapists better understand these potential causes in order to develop specific evidence-based intervention programs to treat and prevent shoulder pain and dysfunction in breast cancer survivors.

Rehabilitation of Shoulder Function in Breast Cancer Survivors

The shoulder is a very mobile joint that relies heavily on mid-range stability on muscle control. Therefore, evaluation of such control and treatment directed at its improvement should form an integral part of management of all shoulder disorders [12]. The scapula has a major and pivotal role in normal shoulder function. Its position and motion provide the parameters to allow normal physiology and biomechanics of the shoulder to occur [22].

There is evidence of scapular kinematic alterations associated with shoulder and neck pain [44]. There is also evidence of altered scapular muscle recruitment patterns in these patients, with respect to changes in strength, flexibility, motor control and timing of the surrounding muscles [44]. In particular, lack of flexibility, in combination with muscle dysfunction of serratus anterior and lower trapezius, may be the clinical base for a treatment program given to these patients. The available evidence in clinical trials supports the use of therapeutic exercise in the rehabilitation of these patients [44]. In patients diagnosed with subacromial impingement syndrome and accompanying scapular dyskinesia, exercise therapy was found to be an effective approach for controlling pain and decreasing disability. However, adding scapular stabilization exercises to the exercise program produced slightly better results regarding scapular kinematics after 6 and 12 weeks of training [45].

From our knowledge until now, there is only one published study that has developed a scapula-oriented shoulder exercise program on upper limb dysfunction in breast cancer survivors, and compared with a general exercise and a non-exercise group. Their findings showed that pain, physical function, social function and quality of life improved significantly, and upper limb disabilities, range of motion and strength of the shoulder external rotation showed trends towards significance after the scapula-oriented exercise compared with baseline. The improvement in global quality of life and external shoulder rotation strength were significantly greater in the scapula-oriented exercise program than in the general exercise and control groups [14].

Other authors have studied the effects of general upper limb exercise interventions in this population. A systematic review on exercise interventions for upper limb dysfunction due to breast cancer treatment, has found that upper limb exercise (shoulder ROM and stretching) is helpful in recovering upper limb function following surgery for breast cancer; structured upper limb exercise program shows greater benefit in restoration of shoulder ROM; and exercise programs benefit quality of life and upper extremity strength through resistance exercise [46]. A structured weekly resistance training and
stretches a program improved ROM in both forward flexion and abduction and strength in abduction plane, and did not precipitate lymphedema [47]. Cavagnah [48] discuss the findings of four studies in which implementation of early exercise and activity after axillary node dissection was investigated. The results of this reviewed studies support the implementation of this approach, as opposed to restriction after axillary lymph node dissection.

Although exercise interventions have a positive effect on quality of life in cancer patients [49], in physical and psychosocial areas [50], have been associated with a lesser symptom experience for shoulder limitations, muscular chest wall pain, weight gain, lymphedema, and breathlessness [51].

Movement deviation patterns in women following surgery for breast cancer are similar to those seen in other known shoulder conditions [6]. Therefore we strongly recommend that the breast cancer patient's rehabilitation program should include a scapular motor control based approach.

One of the goals of any motor control rehabilitation is to gain awareness of, and the ability to activate the deep stabilizers of the region prior to activation of the, usually, more superficial torque prime movers and to maintain that activation during activity. Another is retraining of optimal movement patterns. Both involve motor program retraining and therefore, refined, controlled activation of the deep stabilizing force couples, using either strategies of isolation or controlled posture or movement facilitated by imagery [12].

Cools et al. [44] have suggested practical guidelines for the rehabilitation of scapular dyskinesia in patients with chronic complaints in the upper quadrant:

1. Conscious muscle control of the scapular muscles: In the early stage of scapular training, conscious muscle control of the scapular muscles may be necessary to improve proprioception and to normalize scapular resting position.
2. Muscle (re) training: Depending on the clinical examination results, the therapist may decide in the second stage of scapular muscle training to focus more on muscle control and co-contraction (advanced control during basic activities) or muscle strength. Scapular co-contraction may be trained in basic positions, movements and exercises. As the shoulder girdle works in both open and closed-chain activities, the muscles should be trained to respond to both situations, by challenging the maintenance of the new scapular position under load, using weight-bearing and non-weight-bearing tasks of the upper limb. These should be consistent with the functional needs of the patient.
3. General scapular strengthening exercises: Once muscle balance is restored, in the third stage of scapular muscle rehabilitation program, general scapular strengthening exercises may be used to increase muscle strength [44].

A common recommendation in rehabilitation is to limit the amount of weight used during glenohumeral and scapulothoracic exercises to assure that the appropriate muscles are being utilized and not larger compensatory muscles [52].

There is evidence that exercise and physical activity are effective, well-tolerated and rewarding complementary interventions to enhance the quality of life in women with breast cancer. Physical therapy have an important role in preventing further upper limb decline and restore function in breast cancer survivors.

Key Clinical Points

1. Breast cancer treatment may lead to side effects which will contribute to anatomical and biomechanical changes of the shoulder and functional limitations that may persist for many years;
2. Movement deviation patterns in women following surgery for breast cancer are similar to those seen in other known shoulder conditions- scapula dyskinesia - which means a motor control impairments in the shoulder complex;
3. Breast cancer patient's rehabilitation program should include a scapular motor control based approach.

Competing Interests

The authors declare that they have no competing interests.

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