*Review*

# Upper Limb Mobility after Breast Cancer Surgery: Pathoanatomical Changes and Physiotherapy Approaches

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**Abstract:**
Breast cancer often leads to functional impairments of the upper limb, manifesting as pain, reduced range of motion, muscle weakness, and lymphedema. These changes can significantly affect patients' quality of life and independence. The aim of this article was to present post-treatment pathoanatomical changes affecting the upper limb mobility following breast cancer surgery, and to evaluate modern physiotherapy approaches aimed at improving upper limb mobility and function. A literature review was conducted using scientific databases to analyze studies from 1990 to 2025, focusing on post-surgical upper limb complications and physiotherapy for breast cancer patients. Evidence was synthesized from systematic reviews, meta-analyses, and original research. The most common impairments following breast cancer treatment involve neuromuscular, musculoskeletal, and lymphovascular disorders of the ipsilateral upper limb, all of which may lead to reduced upper limb mobility. Physiotherapy represents a key component of comprehensive care for breast cancer survivors. Early initiation of structured and individualized physiotherapy interventions significantly improves range of motion, reduces pain, and enhances functional capacity of the affected limb, improving overall quality of life.

**Keywords:** Breast cancer, Pathoanatomical changes, Functional impairments, Range of motion, Physiotherapy, Rehabilitation

## 1. Introduction

Breast cancer accounts for one third of all new cancer diagnoses among women in the United States. As its incidence continues to rise, attention remains focused on improving survival through earlier detection and advanced treatments, which have already contributed to a decline in the breast cancer death rate. Current strategies focus on monitoring and addressing late effects of treatment, which is essential for managing the long-term health of a growing population of survivors with extended life expectancies (Siegel et al., 2024).

The treatment of breast cancer typically involves a combination of surgery, chemotherapy, radiotherapy, endocrine therapy, and targeted systemic therapies (Waks & Winer, 2019). While these approaches have substantially improved survival rates, the long-term management of cancer survivors has become increasingly important, as treatment-related sequelae can significantly affect patients' quality of life and functional independence (Cathcart-Rake et al., 2023).

Modified radical mastectomy was traditionally considered the standard surgical approach for early-stage invasive breast cancer (Clarke et al., 2005). In recent decades, however, breast-conserving surgery has increasingly become the preferred option due to comparable oncological outcomes and improved cosmetic results, particularly in women with early-stage disease (Kurtz et al., 1990; Clarke et al., 2005). Nevertheless, the status of the axillary lymph nodes remains a key determinant of adjuvant radiotherapy and systemic treatment decisions. Although axillary lymph node dissection is no longer routinely indicated in patients with clinically negative lymph nodes, it is still performed in cases of nodal involvement, thereby contributing to postoperative morbidity (Lyman et al., 2005).

Despite advances toward less invasive surgical techniques, interventions involving the breast and axilla remain closely associated with functional impairments of the ipsilateral upper limb, with a substantial proportion of breast cancer survivors experiencing shoulder and upper limb dysfunction following surgery (McCredie et al., 2001). Common complications include pain, restricted range of motion, muscle weakness, sensory disturbances, and lymphedema (Stubblefield & Custodio, 2006). These impairments are thought to result from a combination of surgical tissue damage, postoperative pain, scar tissue formation, and protective movement patterns, which promote shortening of the anterior chest wall muscles and lead to pathological alterations in shoulder biomechanics (Ebaugh et al., 2011). Lymphedema occurs as a consequence of axillary lymph node removal, which disrupts normal lymphatic drainage from the upper limb (Brahma et al., 2025).

Although objective shoulder mobility often improves within six weeks after surgery, many patients continue to report substantial upper limb disability during this period (Chan et al., 2020; Lee et al., 2019). This discrepancy between objective recovery and subjective functional impairment is largely attributed to persistent pain, numbness, and sensory disturbances, particularly in patients who undergo axillary lymph node dissection (Chan et al., 2020; Lee et al., 2019).

The purpose of this review is to analyze the pathoanatomical changes affecting upper limb mobility following breast cancer surgery and to evaluate contemporary, evidence-based physiotherapy interventions aimed at restoring mobility and functional capacity. By synthesizing current evidence, this review seeks to highlight the role of early and targeted rehabilitation in preventing long-term functional limitations in breast cancer survivors.

## 2. Design of the Review

A literature review was conducted to examine pathoanatomical changes following breast cancer surgery that affect upper limb mobility and functional capacity, as well as contemporary physiotherapy approaches for managing these complications. The analysis included peer-reviewed articles published in English between 1990 and 2025.

The literature search was performed using multiple scientific databases and a combination of the keywords "breast cancer" along with terms related to physiotherapy interventions, postoperative complications, and pathoanatomical changes after breast cancer surgery.

The review encompassed publications from the fields of oncology, surgery, physiotherapy, and rehabilitation. Systematic reviews, meta-analyses, clinical guidelines, and expert recommendations were primarily used to describe pathoanatomical changes and physiotherapy treatment strategies and to synthesize existing evidence. Original research articles

were included to present evidence-based physiotherapy interventions for upper limb rehabilitation and for the management of specific postoperative complications.

## 3. Pathological changes after breast cancer surgery

Due to breast cancer treatment, many patients experience ipsilateral upper limb and shoulder impairments, including reduced joint mobility, decreased muscle strength, pain, and lymphedema. The side effects of treatment make it difficult to perform daily activities, carry out work-related tasks, and participate in sports and other recreational activities (Tsai et al., 2009; Rietman et al., 2006; Land et al., 2010).

The most common side effect after breast cancer surgery is pain in the breast, axilla, or upper arm, which occurs in almost 50% of patients and may persist up to 3 months postoperatively (Chiu et al., 2014; Smith & Wu, 2012). Functional limitations are also reported in nearly 50% of patients, significantly affecting quality of life (Hauerslev et al., 2020). Pain and functional limitations are the main factors limiting return to work, affecting 48% of patients (Lee et al., 2017). Lymph node dissection or radiation therapy may additionally lead to secondary lymphedema, which can develop over months after treatment and become chronic in 17% of patients (Torgbenu et al., 2020).

Marco et al. (2023) classified postoperative functional limitations in patients after breast cancer surgery into 3 main categories: neuromuscular, musculoskeletal, and lymphovascular limitations.

A common neuromuscular functional limitation that occurs because of breast cancer surgery is postmastectomy pain syndrome (PMPS). This is a constant dull, burning pain in the chest, axilla, and upper arm on the side of the mastectomy, which is present for at least 3-6 months after surgery (Tait et al., 2018). The most common cause is injury to the cutaneous branches of intercostal nerves and the development of a neuroma. The risk is higher if axillary lymph node dissection is performed in addition to mastectomy (Chang et al., 2021). PMPS may also be associated with damage to other peripheral nerves, including the medial and lateral pectoral nerves, thoracodorsal nerve, and long thoracic nerve, and intercostal nerves II to VI (Kannan et al., 2022). Injury to motor nerves of the upper limb primarily results in muscle weakness and loss of function, leading to restricted movement and impaired upper limb mobility (Chang et al., 2021).

Movement may also be restricted due to musculoskeletal causes (Marco et al., 2023). Myofascial pain syndrome has been reported in up to 45% of breast cancer patients (Kalichman et al., 2019). This condition is characterized by the presence of myofascial trigger points, which elicit localized pain when palpated, stretched, or mechanically stressed. These trigger points may also restrict the available range of motion in specific joints (Kalichman et al., 2019; Chang et al., 2021). The underlying mechanisms contributing to myofascial pain syndrome and the associated reduction in upper limb mobility include muscle fibrosis secondary to inflammation, fascial dysfunction, and increased motor neuron excitability following breast cancer surgery (Kalichman et al., 2019; Chappell et al., 2021). Myofascial trigger points are frequently observed in individuals with postmastectomy pain syndrome (PMPS) (Chappell et al., 2021) and are commonly located in the latissimus dorsi, serratus anterior, pectoralis major, infraspinatus, and upper fibers of the trapezius muscles (Chang et al., 2021; Kalichman et al., 2019). Another cause of restricted upper limb movement is adhesive capsulitis of the glenohumeral joint. In this condition, limitations in both active and passive range of motion result from inflammation and subsequent fibrosis of the joint capsule. In the context of breast cancer surgery, recognized risk factors for adhesive capsulitis include breast reconstruction, lymphedema, and axillary lymph node dissection (Chang et al., 2021).

Marco et al. (2023) identify lymphedema as a functional limitation that adversely affects upper limb mobility. Although lymphedema is not typically associated with acute pain, it is frequently accompanied by sensations of heaviness and discomfort (Chang et al., 2021). Progressive fluid accumulation and subsequent fibrotic changes reduce joint mobility and alter muscle activation patterns, which in turn further impair lymphatic drainage (Manrique et al., 2022). This self-perpetuating cycle of reduced movement and compromised lymph flow contributes to the progression of lymphedema and ultimately results in increasing functional limitations (Mohamed et al., 2024).

Finally, reduced upper limb mobility may also be associated with axillary web syndrome (AWS). AWS is characterized by the presence of fibrous, cord-like structures within the

subcutaneous tissue of the axilla, which extend distally along the medial or anteromedial aspect of the upper arm and, in some cases, along the lateral chest wall. These cords become taut during movement and cause pain, particularly during shoulder abduction, thereby significantly limiting upper limb mobility. Although the pathogenesis of AWS remains incompletely understood, it is thought to result from injury to lymphatic vessels and surrounding soft tissues during surgical procedures such as sentinel lymph node biopsy and axillary lymph node dissection, which are frequently performed in conjunction with mastectomy (Stubblefield & Keole, 2014). Moreover, AWS is associated with an increased risk of subsequent lymphedema, further exacerbating impairments in joint mobility (González Rubino et al., 2022).

## 4. Physical therapy approaches to improve mobility after breast cancer surgery

Modern physiotherapy approaches aimed at improving mobility after breast cancer surgery emphasize the early implementation of structured rehabilitation programs, often commencing on the first postoperative day or within the first postoperative week (Bruce et al., 2022). These programs typically combine supervised physiotherapy sessions with individually prescribed home exercise programs, frequently supported by video-based materials and patient education on wound care, activities of daily living, physical activity, and nutrition. Interventions commonly include aerobic exercise, range-of-motion exercises targeting shoulder anteflexion, abduction, and external rotation, as well as daily stretching of the anterior chest wall musculature to prevent muscle shortening and contracture formation (Aydin et al., 2021; Bruce et al., 2022).

Progressive resistance training, often using elastic bands or body weight, is generally introduced gradually after the first postoperative month, once adequate tissue healing has occurred (Bruce et al., 2022). Evidence indicates that patients participating in structured exercise programs achieve significantly greater improvements in shoulder range of motion, muscle strength, and functional outcomes as assessed by the DASH (Disabilities of the Arm, Shoulder, and Hand) questionnaire compared with those receiving standard postoperative care (Min et al., 2024; Muñoz-Fernández et al., 2021; Bruce et al., 2022). Importantly, controlled early exercise, with few exceptions, does not increase the risk of postoperative complications such as seroma or hematoma formation, wound infection, or lymphedema, provided that arm elevation is initially limited to 90° (Bruce et al., 2022).

In addition to therapeutic exercise, manual therapy may be employed to alleviate postoperative pain and to address specific complications such as axillary web syndrome (AWS). Commonly used techniques include manual lymphatic drainage, manual scar mobilization, myofascial release, soft tissue mobilization, and transverse friction massage (González-Rubino et al., 2025; Meer et al., 2023). Acute postoperative pain may also be managed with the application of cold packs, particularly in the early postoperative phase (Emiroglu et al., 2023).

The combined application of therapeutic exercise, manual therapy, and soft tissue release techniques has been shown to produce significant and sustained reductions in pain intensity. These interventions not only relieve acute postoperative symptoms but also facilitate long-term recovery of upper limb function by improving tissue elasticity and preventing the formation of postoperative adhesions (Aydin et al., 2021; Bruce et al., 2022; González-Rubino et al., 2025).

If adhesive capsulitis develops after breast cancer surgery, physiotherapy intervention should primarily focus on its management. A home-based exercise program incorporating passive joint mobilization, stretching, and electrotherapy may enhance the effects of pharmacological treatment with nonsteroidal anti-inflammatory drugs, which are commonly used in the management of adhesive capsulitis (Chang et al., 2021). Progressive resistance training using elastic bands, when combined with scapular stabilization exercises, has been shown to effectively improve shoulder joint mobility and patients' quality of life (Aboelnour et al., 2023).

Development of lymphedema can be prevented or mitigated through the early initiation of manual lymphatic drainage, frequently combined with compression bandaging or compression garments to reduce interstitial fluid accumulation. In addition, low-intensity laser therapy may be applied to stimulate immune and macrophage activity and to promote the breakdown of fibrotic scar tissue, thereby facilitating lymphatic flow in the affected region

(Greenlee et al., 2017). The inclusion of behavioral strategies, such as motivational interviewing, setting of SMART (specific, measurable, achievable, relevant, and time-bound) goals, and the use of exercise diaries, increases adherence to the rehabilitation program (Bruce et al., 2022).

An important role of the physical therapist is to educate and reassure patients that movement during the postoperative period is both safe and beneficial. This educational component helps reduce kinesiophobia and supports patients in regaining a sense of control over their own bodies. Such comprehensive rehabilitation approaches have been shown to significantly reduce long-term disability, prevent muscle atrophy, and improve overall quality of life (Almagro-Céspedes et al., 2024; Bruce et al., 2022).

From an economic and healthcare system perspective, structured early rehabilitation represents a cost-effective strategy. These programs can be implemented at relatively low cost and are associated with reduced overall healthcare expenditures and improved quality of life by preventing the development of chronic functional limitations and facilitating a faster return to activities of daily living (Almagro-Céspedes et al., 2024; Min et al., 2024; Bruce et al., 2022).

In accordance with recommendations, physiotherapy treatment in Slovenia begins in the early postoperative phase (Bešić et al., 2019). An individually prescribed exercise program is initiated on the first postoperative day in combination with adequate analgesia. The rehabilitation protocol includes active stretching exercises, which are introduced one week after surgery with the aim of achieving full shoulder range of motion within 6–8 weeks. Resistance exercises are typically introduced 4–6 weeks postoperatively. Patients' progress is monitored through regular assessment of joint mobility and evaluation of functional performance during prescribed exercises, as well as overall functional improvement (Bešić et al., 2019). Lymphedema is managed using decongestive physical therapy, which includes manual lymphatic drainage, compression bandaging, therapeutic compression exercises, and skin care to prevent infections. The physiotherapy program also encourages aerobic activities such as walking, cycling, and swimming, as these activities enhance sympathetic nervous system tone and promote lymphatic flow. Appropriately dosed physical exercise has been shown not to exacerbate lymphedema (Bešić et al., 2019).

## 5. Discussion

Pathological changes following breast cancer treatment include neuromuscular, musculoskeletal, and lymphatic vascular impairments, which often occur simultaneously and interact to form a complex pattern of upper limb dysfunction. These alterations can significantly affect upper limb mobility, muscle strength, pain levels, and overall quality of life (Marco et al., 2023).

Nearly half of breast cancer patients undergoing surgical treatment report persistent pain and functional limitations for up to three months postoperatively, which substantially delays their return to work and daily activities. These findings highlight the considerable functional and social burden of breast cancer treatment and emphasize that successful oncological outcomes alone are insufficient to ensure full recovery (Chiu et al., 2014; Smith & Wu, 2012). Consequently, early, systematic, and targeted rehabilitation is essential (Tsai et al., 2009; Rietman et al., 2006; Land et al., 2010). Moreover, long-term follow-up studies demonstrate that upper limb impairments may persist for several years after treatment, further underscoring the need for extended rehabilitation and long-term monitoring rather than short-term postoperative care alone (Rietman et al., 2006).

Modern physiotherapy programs initiated on the first postoperative day or within the first postoperative week represent a logical and evidence-based response to the known pathoanatomical mechanisms of tissue damage associated with breast cancer surgery (Bruce et al., 2022). Early but controlled activation, with arm elevation initially limited to 90°, has been shown to be safe—even in the presence of seroma, hematoma, wound infection, or lymphedema—and significantly accelerates the recovery of upper limb mobility while reducing the risk of dense, poorly extensible scar tissue formation (Bruce et al., 2022; Chan et al., 2020; Lee et al., 2019).

The combination of aerobic exercise, targeted exercises for shoulder anteflexion, abduction, and external rotation, and daily stretching of the anterior chest wall musculature directly addresses the typical biomechanical consequences of surgery and radiotherapy, including pectoral muscle shortening and impaired scapulothoracic kinematics (Aydin et al.,

2021; Bruce et al., 2022). The effectiveness of these interventions is reflected in greater improvements in shoulder range of motion, muscle strength, and lower DASH questionnaire scores compared with standard postoperative care, confirming that early functional loading is critical for preventing permanent functional limitations (Min et al., 2024; Muñoz-Fernández et al., 2021; Bruce et al., 2022).

The added value of contemporary, individualized physiotherapy lies in the ability to tailor interventions to the predominant underlying pathological mechanism. In postmastectomy pain syndrome, where peripheral nerve injury and myofascial trigger points are common (Chang et al., 2021), manual therapy techniques combined with specific therapeutic exercises have demonstrated effectiveness in reducing pain and improving range of motion (González-Rubino et al., 2025; Meer et al., 2023). In adhesive capsulitis, physiotherapy interventions such as passive joint mobilization, stretching, and progressive resistance training using elastic bands directly address capsular fibrosis–related movement restrictions and serve as an effective adjunct to pharmacological treatment (Chang et al., 2021). In axillary web syndrome, where fibrous cords mechanically restrict shoulder abduction and provoke pain, manual lymphatic drainage, soft tissue mobilization, and myofascial release are biomechanically justified and clinically supported by evidence demonstrating pain reduction and faster functional recovery (Stubblefield & Keole, 2014).

The inclusion of behavioral strategies such as motivational interviewing, SMART goal setting, and the use of exercise diaries further addresses psychological factors, including kinesiophobia and pain hypervigilance, which are prevalent among breast cancer survivors and contribute to persistent functional limitations. This comprehensive, biopsychosocial rehabilitation approach not only improves mobility but also reduces long-term disability, prevents muscle atrophy, and enhances overall quality of life. Simultaneously, it represents a cost-effective strategy from a healthcare system perspective (Almagro-Céspedes et al., 2024).

## 6. Conclusions

Early, structured, and individualized physiotherapy is a key component in preventing long-term upper limb dysfunction following breast cancer treatment. Timely initiation of therapeutic exercise, combined with targeted manual therapy techniques and comprehensive patient education, effectively reduces pain, restores mobility, and facilitates a faster and safer return to activities of daily living.

From a clinical perspective, these findings support the routine inclusion of physiotherapy as an integral part of standard postoperative care for breast cancer patients, rather than as an optional or delayed intervention. From a healthcare system and policy standpoint, early rehabilitation represents a cost-effective strategy that reduces long-term disability, lowers overall healthcare utilization, and improves quality of life among breast cancer survivors. Therefore, systematic referral to physiotherapy and the implementation of standardized early rehabilitation pathways should be prioritized in breast cancer care to optimize functional outcomes and ensure sustainable, patient-centered survivorship care.

**Conflicts of Interest:** The authors declare no conflict of interest.

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