Surgery is a mainstay of primary breast cancer therapy. Alterations in surgical technique have reduced normal tissue injury, yet pain and functional compromise continue to occur following treatment. A tenuous evidence base bolstered by considerable expert opinion suggests that early intervention with conventional rehabilitative modalities can reduce surgery-associated pain and dysfunction. Barriers to the timely rehabilitation of functionally morbid sequelae are discussed at length in this article. Barriers arise from a wide range of academic, human, logistic, and financial sources. Despite obstacles, expeditious and effective post-surgical rehabilitation is being regularly delivered to breast cancer patients at many institutions. This experience has given rise to anecdotal information on the management of common sequelae that may undermine function. The epidemiology, pathophysiology, and management of these sequelae are outlined in this article with an emphasis on the caliber of supporting evidence. Myofascial dysfunction, axillary web syndrome, frozen shoulder, lymphostasis, post-mastectomy syndrome, and donor site morbidity following breast reconstruction are addressed. A critical need for more definitive evidence to guide patient management characterizes the current treatment algorithms for surgical sequelae.


KEY WORDS: breast cancer; function; lymphedema; lymphostasis; myofascial pain; post mastectomy syndrome; mastectomy; lumpectomy; TRAM flap; axillary lymph node dissection; adhesive capsulitis; axillary web syndrome

INTRODUCTION

The therapeutic goal of breast cancer surgery is to completely excise the breast tumor, either by lumpectomy or mastectomy, and to assess axillary lymph node status, either by sentinel lymph node biopsy or axillary node dissection [1–3]. The paradigm for breast cancer treatment shifted during two significant time periods; in the early 1980s and again in the mid 1990s from radical mastectomy to breast conserving therapy, and from axillary node dissection to the minimally invasive sentinel node biopsy. Despite the adoption of more conservative surgical approaches, morbidity after surgery in the form of functional compromise and pain remains a significant clinical problem. Rehabilitation uses an interdisciplinary approach to address these issues. The goal of this article is to summarize common breast cancer surgery sequelae that require rehabilitation with a focus on the pathophysiology and treatment options.

The pathophysiological targets of rehabilitative interventions are limited to soft tissue fibrosis, deficits in muscle strength and flexibility, lymphatic insufficiency, muscle hypertonicity, and neural hypersensitivity. Despite the presence of algorithms that successfully address these problems, few breast cancer patients receive function-oriented treatments [4]. The reasons for this remain uncertain and are doubtless multifactorial. With increased emphasis on quality survivorship and post-treatment physiological integrity, function in cancer patients can be expected to emerge as an increasingly important public health issue.

*Correspondence to: Andrea L. Cheville, MD, MSCE, 200 First Street S.W., Rochester, MN. Fax: 507-266-1561. E-mail: cheville.andrea@mayo.edu

Received 8 January 2007; Accepted 9 January 2007
DOI 10.1002/jso.20782
Published online in Wiley InterScience (www.interscience.wiley.com).

© 2007 Wiley-Liss, Inc.
Rehabilitative concerns span the continuum of primary breast cancer treatment and interventions need not be administered by rehabilitation specialists. All oncologic clinicians can endorse a comprehensive, proactive approach to functional preservation. Preventive measures frequently obviate the need for formal physiatric evaluation. Stretching, gentle aerobic conditioning, low intensity resistive exercise, and postural modification should be integrated as early as possible after surgery, irrespective of the cancer treatment plan. Empowering patients to detect functional problems in their early, readily treatable stages is a critical treatment goal. Early diagnosis or, better still, empiric prevention of these problems significantly limits long-term functional and psychological morbidity [5]. Once initiated, the rehabilitation process requires the support of patients’ surgeons and continued emphasis on self-responsibility for optimal patient participation.

The limited group of primary musculoskeletal problems with established treatment algorithms will be the focus of this article. Barriers to breast cancer rehabilitation will be outlined. Extensive attention will be devoted to specific musculoskeletal problems; their incidences, clinical presentation, and management. Treatment discussions will emphasize classical rehabilitative and manual interventions with cursory mention of pharmaceutical and interventional management approaches.

**BARRIERS**

The absence of a robust evidence base has plagued rehabilitation medicine and represents a major barrier to its acceptance by clinicians of other disciplines and third party payors. Critics have remarked on the absence of double-blind, randomized, placebo controlled trials (RCTs), NCCN Category 1. However, careful consideration reveals the formidable challenges to accruing such evidence. Rehabilitation interventions are multi-factorial. Rather than administering a medication or performing a discrete procedure, rehabilitation involves multi-modality approaches that ideally evolve over time in response to patient progress, or lack thereof. The necessarily multi-factorial and time-varying nature of these interventions adds substantial variance. Variance is further compounded by the multi-factorial nature of rehabilitation outcomes (e.g., function, vocational viability, community re-integration). Function is inherently multidimensional, and remains challenging to accurately quantify despite the proliferation of assessment instruments. The sample size required to reject the null hypothesis is directly proportional to variance in the primary outcome measure. Trials in rehabilitation medicine are severely hampered by the fact that both interventions and outcomes are inherently variable necessitating unfeasible and unfundable sample sizes.

The statistical requirement for impractical sample sizes, limited generalizability, and deviance from the real-world clinical environment that characterize RCTs have been outlined [6]. Alternate methodologies, particularly large, prospective observational cohort studies that allow multi-variate regression analyses have been suggested as an alternative to the conventional “gold standard ” RCT. Large databases permit analyses of the multifactorial interventions and outcomes characteristic of rehabilitation medicine. Several recent methodological evaluations found the results of such observational cohort studies comparable to those of randomized controlled trials with similar aims, thus offering a possible alternative to the RCT [7]. Many research questions in rehabilitation medicine, even the most compelling, cannot be answered with RCTs in a financially responsible manner.

Additional barriers to rehabilitation arise from human, logistic, and financial sources. The dearth of clinicians, both physicians and therapists, specializing in cancer rehabilitation represents a significant barrier. At present, less than 50 physiatrists are specialized in cancer rehabilitation in the United States [8], though significantly more may contribute to the care of cancer patients. The shortage of specialists reflects the lack of a cancer emphasis in the physiatric literature and training. Until very recently, specialty training in cancer was unavailable to physical or occupational therapists. This situation has been somewhat remedied by the availability of 2- and 3-day didactic courses. Internships and fellowships with supervised treatment of cancer patients have yet to be established for physicians or therapists. As a consequence cancer patients may lack access to specialized rehabilitation services.

Lack of established relationships between the oncological and rehabilitation specialties has limited understanding on both sides regarding available services and potential benefits. Often physiatrists are sequestered in free-standing rehabilitation facilities. This situation precludes easy contact or familiarity with cancer specialists. Physiatry has not widely been integrated into cancer care. Therefore, most cancer specialists trained and continue to practice in environments lacking integration of rehabilitation specialists beyond their role in facilitating hospital discharges. Consequently oncological physicians may not be familiar with the skills of the physiatrist and physical/occupational therapist in approaching cancer-related functional loss.

Logistical barriers to receipt of cancer rehabilitation can be formidable. With few exceptions, cancer centers do not offer on-sight rehabilitation services, although this number appears to be gradually expanding. At present, only one National Cancer Institute designated

---

*Journal of Surgical Oncology DOI 10.1002/jso*
Comprehensive Cancer Center offers rehabilitation services dedicated specifically to cancer patients that span the full trajectory of need; inpatient consultation and liaison services, an inpatient acute rehabilitation ward, and outpatient physical and occupational therapy services with adequate specialization. In general, patients must travel, at times prohibitive distances, to receive specialized cancer rehabilitation services. The necessary time often poses an insurmountable barrier to patients’ already depleted reserves. Some health plans capitate patients to physical therapy (PT) facilities designated by their primary physician. These establishments may offer cost savings at the expense of high quality, individualized care. To minimize overhead, cancer patients may be treated with simplistic algorithms that at best, afford little benefit and at worst, are harmful (NCCN Category 2B). Obtaining approval for treatment at out-of-network or -capitation sites may involve time-consuming paper work and phone calls.

Fiscal barriers may also severely limit patients’ access to rehabilitation. In general PT and occupational therapy (OT) treatment sessions occur weekly, and more frequent visits are encouraged. Patients who must take time off from work and cover transportation costs may find this requirement prohibitive. Third party payers have steadily increased patient co-payments for PT and OT sessions to foster fiscal responsibility. Co-payments may be as high as 35 US $ per session. The cost of 3 weekly sessions may exceed the financial capacity of the average patient. In addition, rehabilitation supplies such as bandaging materials for lymphedema treatment may not be covered by conventional insurances. The requirement to pay for supplies renders treatment, in the absence of charity, financially untenable for many patients (NCCN Category 2A) [9].

Lastly, and perhaps most challenging, is that fact that PT and OT interventions are only as effective as patients’ willingness to adhere to their home exercise programs (HEPs). Consistent performance of an HEP requires far more time and effort than taking a pill. Adherence rates can be discouragingly low, particularly among patients without premorbid histories of regular exercise. In spite of supportive literature, emphasis on the critical importance of regular structured physical activity in mitigating the effects of anti-cancer treatments has yet to be integrated in cancer care. Until that time, we can anticipate that patient participation will be limited.

COMMON REHABILITATION PROBLEMS AND THEIR TREATMENT

Myofascial Dysfunction

Pathophysiology and epidemiology. Myofascial dysfunction is a painful condition characterized by the presence of a palpable nodules, “trigger points,” that respond to external pressure, stretch, or muscle recruitment with radiating pain [10]. Trigger points are normally quiescent but may become symptomatic when muscles are strained or traumatized. Breast cancer patients commonly develop trigger points in the scapular retractor muscles due to shortening of their pectoral muscles. Pectoralis tightness commonly develops during primary breast cancer treatment and pulls the scapula into a protracted and depressed position. Eventually, the retractor muscles become overused and strained in their effort to reestablish shoulder girdle symmetry [11]. This situation places patients at risk for subsequent myofascial dysfunction in the back and neck muscles.

The genesis of pectoral tightness among breast cancer patients is multi-factorial. Surgery may render the pectorals hypertonic through pain-induced contraction. Patients’ efforts to protect their surgical sights through thoracic flexion and scapular protraction may aggravate shortening. Radiation fibrosis of the pectoral tendons and muscle sheathes may produce further tightness [12]. Finally, when the pectoralis major is incorporated into the muscular pouch housing breast implants, muscle tension markedly increases and pulls the scapula anteriorly.

Abnormal scapular positioning forces shoulder girdle muscles to alter their length tension relationships. The scapular retractors, for example, must lengthen to accommodate forward migration of the scapula. Such accommodation requires muscles to relinquish their optimal length-tension relationships and become vulnerable to strain and myofascial pathology [10]. Factors other than muscle strain that are common among breast cancer patients favor the development of myofascial dysfunction; anxiety, pain and shoulder capsule tightness. The end result is generalized muscle overuse, irritability, and inhomogenous shortening which lead to trigger point formation. The precise incidence of myofascial pain following primary breast cancer surgery is not currently known. In a cohort of 163 Stage IV breast cancer patients, 21% developed moderate to severe myofascial pain [4].

Manual approaches. Treatment should be multi-modal with manual options explored first. Physical therapy emphasizes “myofascial release techniques;” sustained trigger point compression, gentle repeated stretching of involved muscle groups, and strategic recruitment of antagonist muscles [13](NCCN Category 2A). Once pain is controlled, patients may begin resistive activities to address strength deficits. Daily stretching of symptomatic muscles can begin immediately upon diagnosis. Ideally, PT should also include instruction in how to minimize stress in painful muscles, pacing strategies, and relaxation techniques.

It is impossible to overstate the importance of comprehensively evaluating patients with myofascial dysfunction.
pain for malignment, aberrant movement patterns, poor posture, and scapular protraction due to anterior chest wall tightness. Too often clinicians unfamiliar with the nature and potential sequelae of breast cancer treatment, focus exclusively on painful areas resorting too quickly to interventional approaches without identifying the inciting factors. Failure to adequately address these factors ignores the root cause of myofascial pain and places patients at needless risk from repeated invasive procedures that offer only transient relief.

**Pharmaceutical and interventional approaches.**
Analgesics choices should be made on a case-by-case basis. Antispasmodics such as lioresal, tizanidine, clonidine, and diazepam can be dosed continuously, as needed, or at bedtime depending on fluctuations in pain intensity (NCCN Category 2A). Nonsteroidal anti-inflammatory drugs may benefit patients during or after activity (NCCN Category 2A). Opioids are rarely required. However, the acute onset of severe pain or a substantial decrement in patients’ functional status may warrant the judicious use of opioids. Given the risk of shoulder and anterior chest wall contractures, patients should keep moving at all costs. The use of opioids is thoroughly defensible if patients remain active, vocally viable, and compliant with therapy (NCCN Category 3).

Invasive approaches offered by physiatrists and pain specialists have been extensively utilized to treat myofascial pain despite the absence of a strong evidence base. Trigger point injections with local anesthetic, the homeopathic agent Traumeel®, or steroids have been proposed as the standard of care [14] (NCCN Category 2A). Needle insertion into trigger points frequently elicits a “twitch response;” the brief, involuntary contraction of a small collection of adjacent muscle fibers. Thirty-five gauge acupuncture needles readily achieve this effect. It has been suggested that twitch responses underlie the therapeutic benefit of trigger point injections and that no injectate (e.g., lidocaine or corticosteroid) is required [15]. Botulinum toxin is on option for patients with refractory, highly symptomatic myofascial pain. However, the evidence is unconvincingly either for or against benefit [16–19](NCCN Category 3). The associated expense, questionable benefit, and difficulty in obtaining coverage for botulinum toxin, makes this option unfeasible for many patients.

**Axillary Web Syndrome**

**Pathophysiology and epidemiology.** Following surgical removal of axillary lymph nodes, patients may develop fibrotic bands or “cords.” Cords may be confined to the axilla or extend distally along the anterior, medial aspect of the arm as far as the palm. Pathological evaluation of four patients found the cords to be sclerosed veins and lymphatic vessels with surrounding fibrosis [20]. Flow ceases in axillary veins that are clipped and in lymphatics that terminate in resected nodes. Stagnant venous blood thrombosis leading to inflammation and gradual resorption of the now redundant veins. Presumably, a similar process occurs in lymphatic vessels though with significantly less inflammation.

The incidence of axillary web syndrome (AWS) and predisposing patient and surgical characteristics are ill-defined. Axillary webs generally develop between weeks 1 and 5 after axillary lymph node resection [20]. Among a cohort of 85 patients, AWS developed in 20% after sentinel lymph node biopsy and in 72% after axillary clearance [21]. Moskovitz reported a much lower incidence of 6% in a retrospective review of 750 mixed cases [20]. Seventy-four percent of patients in this latter cohort experienced shoulder abduction restricted to 90°. Inconsistencies among reported incidences presumably relate to varying diagnostic criteria. The natural history of AWS and long-term sequelae are inadequately characterized. In all 44 cases described by Moskovitz, symptoms and exam findings resolved irrespective of treatment in 2–4 months. Given the retrospective nature of this study and the absence of formal pain and functional assessments, its conclusions regarding the clinical course and treatment requirements of AWS should be interpreted with caution.

**Manual and pharmacological approaches.** Rehabilitation of AWS emphasizes education on the benign and non-progressive nature of the syndrome. Home exercises are critical and should be performed twice daily if tolerated. Gentle, gravity-assisted pendulum exercises for shoulder range of motion (ROM) (e.g., Codman’s exercises) offer a starting point for severely involved patients. Contingent on the degree of associated pain, pre-medication with NSAIDs and opioids may be required to enhance adherence. Less involved cases begin with wall-walking, active assisted forward flexion, and passive end-ranging of internal and external rotation (NCCN Category 2A). Manual fibrous release techniques break up cords and can be taught to caregivers (NCCN Category 2A) [22]. Whether such techniques afford lasting resolution of the cords has yet to be determined. Topical heat prior to manual treatments should be applied with caution (NCCN Category 2B). Heat renders collagen more supple and can enhance ROM [23], however prolonged exposure increases lymph production, potentially placing patients at risk for lymphedema [24]. In addition, patients who have compromised sensation from intercostal brachial nerve damage may be at risk of burns from excessive or prolonged heat application. The greatest threat posed by AWS is the potential for prolonged reduction in shoulder mobility.
necessitating altered movement patterns, particularly in irradiated patients. As in the case of myofascial dysfunction, aberrant biomechanical and neuromuscular recruitment patterns may develop.

Interventional techniques (e.g., surgical disruption of cords, injection of local analgesics, etc.) are contraindicated due to the risk of engendering lymphedema and the general success of non-invasive manual techniques.

**Frozen Shoulder**

**Pathophysiology and epidemiology.** Limited shoulder abduction is common following surgical removal of axillary lymph nodes. The pathophysiology of frozen shoulders after breast cancer surgeries is presumably no different than soft tissue contractures that develop in other conditions associated with decreased mobility. Two weeks post-operatively, incidences as high as 86% have been reported following axillary clearing, and 45% following sentinel lymph node biopsy (SLNB) [21]. Reports conflict regarding the role of SLNB in reducing the incidence of frozen shoulder. At 6 weeks post-operatively among 204 patients, the mean reduction in shoulder abduction was −24.7° after SLNB, and −26.4° after 2-level axillary clearing [25]. Long-term, 3 year, follow-up of an alternate cohort revealed that 34% of patients who underwent 2-level axillary clearing, and 15% of patients who underwent SLNB reported limited shoulder range of motion [26]. This latter study suggests that a minority of breast cancer patients, particularly after axillary clearing, develop sustained contractures. The prevalence and severity of functional limitations associated with restricted shoulder range of motion have yet to be characterized among breast cancer patients.

**Manual approaches.** Ideally, shoulder remobilization begins as soon as safely feasible after surgery, generally 7 days following mastectomy with axillary clearing (NCCN Category 2A) [27]. No increase in morbidity was noted if shoulder abduction and forward flexion were restricted to 90° for the initial 7 post-operative days, irrespective of drain status [27]. Early remobilization efforts may include wall walking, pendulum exercises, and active-assisted internal/external rotation with use of a cane. No definitive cut-off interval has been established beyond which persistent tightness should trigger referral to a physical therapist or physiatrist. Often patients with capsular tightness come to medical attention at the time of radiation simulation. The requirement for sustained abduction and external rotation during radiation simulation may cause intense discomfort for affected patients. Aggressive treatment is warranted prior to radiation to prevent progressive fibrosis of an already contracted shoulder capsule.

Manual techniques suffice to restore full ROM in most cases. Frozen shoulders are a common orthopedic problem and therapists need not have special training or experience to effectively manage ROM restrictions due to breast cancer treatment. No NCCN Class 1 evidence supports the use of PT for frozen shoulder [28], none-the-less PT remains a mainstay of treatment (NCCN Category 2A). Contingent on the severity of the contracture, mobilization approaches will vary. Some combination of the following specific ROM activities should be used: passive ROM using the unaffected arm to apply stretch in forward flexion, active-assisted ROM in all planes, wand exercises, and passive ROM in all planes with therapist-applied scapular stabilization. Comprehensive treatment may also include gentle resistive activities if strength deficits are detected in the shoulder flexors, abductors, or scapular retractors. Attention should also be paid to neuromuscular recruitment patterns. Patient adherence to an HEP is critical. Lasting improvement cannot be reasonably expected in the absence of daily shoulder ROM.

The costs and benefits of ultrasound use prior to ROM activities must be carefully weighed in cancer patients. Though entirely without an empiric evidence base, concern over the theoretical possibility of encouraging tumor growth and spread has severely curtailed all modality use in cancer patients. The problematic arguments against modality use have been outlined elsewhere [11]. In patients with refractory contractures, benign tumor characteristics, and low lymphedema risk, use of ultrasound prior to ranging activities can be trialed and continued if beneficial (NCCN Category 2B).

**Interventional and pharmacological approaches.** Pharmaceutical interventions should be used to support manual therapies, to minimize functional limitations, and to promote activity. NSAID and, potentially, opioid analgesic trials may be indicated for functionally significant pain. Helpful interventional procedures may include intraarticular or subacromial injection of anesthetic and steroid when pain interferes with therapy (NCCN Category 2A). For refractory cases, distension of the shoulder capsule may be attempted using volumes ranging from 25 to 35 ml normal saline (NCCN Category 2A) [29]. Capsular distension may be sufficiently painful to trigger severe post-procedure muscle spasms warranting the initial infusion of 3–5 ml lidocaine. Intraoperative shoulder manipulation under anesthesia should be restricted for refractory cases when the functional impact warrants such aggressive treatment (NCCN Category 2B) [30].

**Lymphostasis**

**Pathophysiology and epidemiology.** Lymphostasis develops from reduced lymph sequestration and transport. Transient lymphostasis is common immediately
following surgery and during radiation. Although in general, normal lymphatic homeostasis is unevenly restored. Post-operative lymphostasis may become chronic and progress to lymphedema involving the trunk, axilla, breast, or arm. The diagnosis and management of established breast cancer-related lymphedema has been addressed extensively. Readers are referred to several comprehensive reviews [31–33]. This section will confine its focus to persistent lymphostasis and early, mild lymphedema.

Lymphatics remove excess interstitial fluid and large molecular waste. When lymphatics fail to function normally, as in lymphostasis, large molecules accrue and alter the biochemical milieu in the interstitium [34]. Molecules may be vasoactive, pro-inflammatory, and pro-algesic including prostaglandins, serotonin, norepinephrine, bradykinin, histamine, etc. Progressive accumulation can lower the threshold for nociceptive impulse transmission leading to pain (NCCN Category 2A), hypersensitivity, and allodynia. Until normal lymph drainage is restored, patients may experience persistent pain leading to abnormal muscle recruitment, restricted shoulder range of motion and biomechanical malalignment (e.g. exaggerated kyphosis). Painful lymphostasis may aggravate all conditions previously discussed in this article.

Between 2.4% and 56% of breast cancer patients will develop lymphedema [35]. Risk depends on type of surgery, radiation status, and post-treatment weight gain [36,37]. The prevalence of chronic, symptomatic lymphostasis after breast cancer surgeries is unknown. The current absence of prevalence data reflects the fact that, until recently, sensitive and reliable metrics were not available to quantify interstitial fluid in the trunk and breast. It is assumed that all patients develop some lymphostasis from iatrogenic compromise. Sentinel lymph node biopsies remove lymph nodes draining the operated quadrant, if not the entire breast and surrounding tissue. Incisions and tissue resections can further compromise local lymph drainage. Patients undergoing more extensive resections, for example, 2-level axillary clearing or mastectomy, experience more severe, prolonged, and widespread lymphostasis. Resolution of lymphostasis is believed to occur through the development of collateral lymph drainage pathways [38].

Manual. Treatment of lymphostasis is benign, straightforward, and dominated by manual approaches. Manual lymphatic drainage (MLD); a gentle, highly specialized massage technique, represents the current standard of care (NCCN Category 2A) [39]. MLD is distinguished from conventional massage by stroke rhythm, orientation, sequence, and pressure [40]. MLD strokes stretch the dermis in parallel with lymph vessel orientation to encourage the flow. Different strokes have been developed to address variations in anatomic contour.

All MLD strokes are characterized by minimal pressure, proximal to distal sequence, and orientation along the lymph channels targeted for stimulation. MLD results are highly practitioner dependent and the effort to identify an experienced therapist is critical.

The evidence base supporting MLD has grown substantially over the past decade. MLD reduces lymphedema volume both independently and, potentially more effectively, in conjunction with other manual treatments such as exercise, ROM, and compression [33] (NCCN Category 2A). In addition, MLD promotes movement of radio-labeled tracer from congested territories to functioning lymph nodes in patients at risk for lymphedema [41]. A large randomized trial found shoulder ROM combined with massage to be superior to either treatment alone after breast cancer surgery [42] (NCCN Category 2A). The scant evidence on the utility of MLD in the post-operative setting is countered by extensive positive anecdotal reports.

Additional manual treatments are geared toward discouraging reaccumulation of interstitial fluid, enhancing lymph flow, and preventing adverse secondary effects such as deconditioning or contractures. Compression applied through garments or short-stretch bandaging minimizes refilling in decongested areas (NCCN Categroy 2A) [31]. Truncal compression garments are available through medical suppliers, however patients may derive equal benefit and save money by purchasing a snug exercise camisole. Discrete areas of lymphostasis may warrant focal compression achieved through the use of contoured foam inserts placed within bandages or garments. Progressive range of motion (ROM) activities in conjunction with deep breathing encourages lymph sequestration and flow [43]. ROM may be passive, active-assisted, or active depending on existing flexibility deficits and musculoskeletal morbidity. Aerobic exercise stimulates the lymphatic system, though it may also increase lymph production. Patients can benefit from exercise without risking worsening lymphostasis by compressing “at risk” territories while active (NCCN Category 2B) [44] Maintenance activities for lymphostasis include ROM activities, deep breathing, aerobic exercise, and MLD performed by the patient or a caregiver.

Pharmaceutical and interventional approaches. Pharmaceutical interventions may be indicated to enhance sleep quality and patients’ tolerance of manual therapies. Interventional strategies are contraindicated due to the potential for aggravating lymphostasis.

Post-Mastectomy Syndrome

Post-mastectomy syndrome (PMS) has been stripped of pathophysiological significance by imprecise use of
the term to describe any pain persisting beyond the period of “normal” healing after a mastectomy. It is now recognized that similar pains occur after lumpectomies and axillary surgeries. A collection of etiologically distinct conditions have been referred to as PMS despite the availability of alternate, more precise taxonomy. This article previously discussed several of these, namely myofascial pain, axillary web syndrome, and lymphostasis. The very reasonable suggestion has been made to confine the use of PMS to pain characterized by neuropathic descriptors, for example, “burning, tingling, pins and needles, lancinating, shock-like.” Such pains presumably arise from neural injury [45]. The precise mechanism(s) by which neural compromise occurs remains unclear. Neuroma formation, intercostal brachial nerve sacrifice, fibrotic entrapment, and intra-operative compromise of cutaneous innervation have been implicated.

The prevalence of PMS varies depending on the diagnostic criteria, whether a threshold for pain intensity is used, and the elapsed interval since surgery. Reported prevalences range from 4 to 56% [45–47]. Smith et al. included neuropathic descriptors among their diagnostic criteria and reported a PMS prevalence of 43%. This seems high in the authors’ experience and may reflect the fact that the investigators considered any pain, irrespective of intensity or functional impact, to reflect PMS. The literature lacks estimates of the relative prevalences of mild, moderate, and severe pain at progressive intervals after surgery. Smith’s cohort was resurveyed 6 years after the initial survey [48] in which 52% of the affected patients continued to experience pain.

Some patients unquestionably develop severe, unleashing pain after surgery for primary breast cancer. Thus far, no patient characteristics, aside from younger age, predict the development of PMS [45]. Validated treatment algorithms have not appeared in the literature. It remains speculative whether aggressive, pre-emptive analgesic approaches can reduce progression to chronic PMS. Growing awareness of sensitization within the peripheral and central nervous system following high levels of nociceptive activity has led to empiric multimodal management of other procedure-related neuropathic pain states (NCCN Category 2B) [49,50].

Manual approaches—Physical therapy is critical to preserve flexibility, strength, range-of-motion, and normal neuromuscular recruitment patterns during analgesic trials. Rehabilitation can reduce the adverse functional consequences of PMS at all time points after surgery (NCCN Category 2B). Patients’ efforts to reduce their pain through avoidance behaviors can severely undermine function if mobility, ADL performance, or vocational capacity are affected. PT may involve trials of analgesic modalities such as desensitization techniques, transcutaneous electrical nerve stimulation, and topical cold. Modality trials are rapid, relatively harmless, and inexpensive with the added benefit that patients can self-administer effective treatments. It must be acknowledged that a PMS-specific evidence base has not been established to support these modalities (NCCN Category 2B).

Pharmaceuticals and interventional approaches—Pharmaceuticals and interventional techniques are the mainstay of management. These treatments are increasingly being administered by physical medicine and rehabilitation specialists trained in pain management. Adjuvant analgesics including membrane stabilizing drugs (e.g., gabapentin, oxcarbazepine), serotonin, and norepinephrine reuptake inhibitors (e.g., paroxetine, duloxetine), GABA-agonists (e.g., lioresal) are first-line agents for neuropathic pain (NCCN Category 2A) [51]. Nonsteroidal anti-inflammatory drugs benefit neuropathic pain by virtue of their desensitizing central nervous system effects and should be trialed in PMS (NCCN Category 2A) [52]. Opioid trials may be warranted for intense or refractory PMS (NCCN Category 3). Patients’ candidacy should be assessed on a case-by-case basis. Interventional techniques including intercostal or paravertebral nerve blocks have the potential to afford abrupt pain relief. Initial diagnostic blocks with local anesthetic establish whether semi-permanent neurolysis with radiofrequency- or cryo-ablation is indicated. Successful nerve blocks may break the pain cycle sufficiently that repeat blocks are not needed [53].

Donor Site Morbidity

Autologous tissue transfer is an increasingly widespread approach to breast reconstruction. Skin, adipose tissue, and various muscles (predominantly the transverse rectus abdominis and latissimus dorsi) have been used to achieve remarkably natural breast reconstructions. Functionally significant sequelae rarely develop if the autologous transfers do not involve muscle. Post-transverse rectus abdominis muscle (TRAM) flap complications have received most attention. Isokinetic testing reveals weakness of the truncal flexors following TRAM flap harvesting [54–56]. Eventual recovery has been noted by some authors [55,56]. However, imbalance between truncal flexors and extensors persists [55]. The clinical significance of this imbalance remains unclear. Isokinetic testing in isolation fails to adequately characterize the range of deficits that may be precipitated by TRAM harvesting. TRAM-associated functional deficits are subtle but can significantly undermine patients’ quality of life [57]. Proprioceptive denervation of abdominal muscles may compromise patients’ balance; interfere with truncal “righting” reflexes; limit the...
small, ongoing muscle contractions required for dynamic balance; and increase risk of low back pain. Denervation may lead to neuropathic pain [58]. Lymph vessel damage may occur during separation of the rectus sheath from the overlying dermis engendering truncal lymphostasis. Trauma may produce fibrosis and tethering the dermis to the underlying tissue. This fibrosis limits truncal extension and may entrap small nerves producing chronic discomfort. Despite the potential for functional morbidity, a significant majority of patients endorse TRAM reconstruction and enjoy enhanced health-related quality of life following the procedure (NCCN Category 2A) [59,60].

Little information is available on function-related donor site morbidity following latissimus dorsi harvesting. Shoulder morbidity is a concern as the latissimus is an important shoulder adductor, internal rotator, and depressor. The risk of shoulder morbidity is substantiated by outcomes reported on a 43 patient cohort [61]. Diminished ROM was detected in 47%, and diminished strength in 33%.

**Manual approaches**—Rehabilitation following TRAM resection is designed to prevent subdermal fibrosis and adhesions, eliminate lymphostasis, modulate aberrant sensation, restore truncal alignment, minimize stress on the lumbar spine, optimize proprioceptive acuity in residual abdominal muscles, and encourage normal muscle recruitment patterns [62]. These goals are achieved through gentle progressive truncal ranging in all planes, instruction in body mechanics and back safety, strengthening of the thoraco-lumbar spinal extensors and residual abdominal muscles, application of fibrous release techniques to adhered soft tissue, postural alignment with visual cuing, progressive physioball activities, instruction in deep diaphragmatic breathing, and cutaneous desensitization techniques similar to those used in PMS rehabilitation (NCCN Category 2A). The relative emphasis on these different techniques must be individualized for optimal outcomes as deficits vary across patients. The requirement for individualization makes it essential to identify therapists familiar with post-TRAM rehabilitation.

Rehabilitation treatment algorithms have not been developed for the latissimus flap donor site. The heterogeneity of associated impairments contributes to the imprecise treatment recommendations. Though unstudied, some commonalities characterize post-latis-simus flap rehabilitation. All efforts attempt to correct abnormal motion at the scapulo-thoracic joint, restore adequate scapular stabilization for upper extremity activities, and prevent attrition of upper extremity function. Therapeutic techniques include shoulder ROM, normalization of scapulo-thoracic, and gleno-humeral joint mechanics, strengthening of residual shoulder depressors and adductors, and myofascial release techniques, as needed (NCCN Category 2A). Pain complaints associated with latissimus flap harvesting must be addressed on a case-by-case basis.

**Pharmaceuticals and interventional approaches**—Pharmaceuticals may be useful to facilitate participation in therapy and to achieve a level of analgesia that encourages normal functioning. NSAIDs, topical lidocaine, antispasmodics (e.g., tizanidine, clonidine, lioresal, and diazepam), and low dose opioids are reasonable options (NCCN Category 2A-3). Intense focal pain refractory to manual and pharmaceutical interventions is fortunately rare. In such cases, evaluation by a pain specialist is warranted to determine the utility of intercostal or paravertebral nerve blocks and serial analgesic trials.

**CONCLUSION**

Rehabilitation problems are common after breast cancer surgeries. The perception that problems gradually resolve without lasting sequelae may delay patient referrals at early stages when effective treatment may prevent long-term morbidity. Lack of familiarity with rehabilitation on the part of oncologic clinicians, and skepticism regarding the efficacy of rehabilitative interventions pose additional barriers to timely referrals. With the gradual accrual of a more robust and definitive evidence base, it is hoped that this situation will change. The paucity of rehabilitation clinicians expert in cancer is a significant problem. Greater emphasis on cancer is needed in training programs for physiatrists, PTs, and OTs. In addition, opportunities for specialized training (e.g., residencies and fellowships), must be developed. It is hoped that future efforts will forge a greater alliance between surgical oncology and rehabilitation medicine.

**SUMMARY POINTS**

1. Virtually all manual therapies are helpful in the rehabilitation of patients following breast cancer surgery (NCCN category 2A). Manual therapies that are categorized 2B lack robust evidence of benefit, but are not harmful.
2. Modalities (e.g., heat, cold, ultrasound) range substantially in evidence category due to their weak support and unassessed potential for fostering cancer growth and spread (NCCN category 2B-3).
3. With the exception of opioid use, which continues to be characterized by a conflicted literature, all analgesic use should be considered an integral approach to enhancing function (NCCN category 2A).
4. Little evidence in the literature addresses the efficacy of invasive procedures (i.e., injections) in the treatment of common sequelae associated with breast cancer. (NCCN category 2B-3).

REFERENCES
8. AAPMR., Cancer Special Interest Group Directory.