Axillary Web Syndrome, A Complication of Breast Cancer: What the Orthopaedic Physical Therapist Needs to Know

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ABSTRACT

Background & Purpose: One particular group of people accessing physical therapy services, and whose numbers are steadily increasing, are breast cancer survivors. Axillary web syndrome (AWS) is one complication of breast cancer treatment that can be easily misdiagnosed without an understanding of breast cancer treatment and its effects on the musculoskeletal and lymphatic systems. **Methods:** Literature search in PubMed and CINAHL yielded 25 articles on the topic of AWS. Fourteen articles met the authors' inclusion criteria. **Findings:** Axillary web syndrome was first reported in the literature in 2001 and the incidence rate among breast cancer survivors is 28% to 36%. The most significant impairment is limited shoulder abduction and several articles report positive results with physical therapy intervention. **Clinical Relevance:** With an understanding of breast cancer management and AWS, the orthopaedic physical therapist can properly differentiate AWS from other more commonly encountered conditions such as adhesive capsulitis and thoracic outlet syndrome as well as refer to a specialist if other complications, such as lymphedema, are present.

Key Words: shoulder, lymphedema, lymphatic cording, differential diagnosis

INTRODUCTION

Physical therapy has grown as a profession, with the Doctor of Physical Therapy degree now the standard for entry-level education. The American Physical Therapy Association has adopted *Collaboration and Access/Equity* among its Guiding Principles to Achieve the Vision Statement for the Physical Therapy Profession.[1] Collaboration can include referring to and co-managing patient care with providers, both inter-professionally and intra-professionally, for the optimum care and outcomes for the patient. The principle of access/equity speaks to resolving issues of health inequities and to physical therapy "serving as a point of entry to the health care system."[1]

Consistent with these principles is the growing role of physical therapists as the primary care provider for musculoskeletal and movement disorders. The literature supports this model as one in which quality care is less costly and more expeditious.[2-4] With this, of course, comes a responsibility for physical therapists to thoroughly examine patients/clients and to determine who can best deliver the needed interventions. Most of the time this is the examining physical therapist, but there are times when the patients/clients will be referred to a physician[5] or to another physical therapist with specialized or advanced training.

One such area of specialized services is lymphedema management provided by a certified lymphedema therapist (CLT). It is essential that the orthopaedic physical therapist understands the effects of breast cancer treatments on the musculoskeletal and lymphatic systems in order to determine whether a patient should consult a CLT. The intent of this paper is to provide a review of: (1) breast cancer epidemiology and related treatments, (2) the lymphatic system and lymphedema, and (3) axillary web syndrome (AWS), including differential diagnosis and management of persons with AWS.

BREAST CANCER

Epidemiology

According to the American Cancer Society (ACS), breast cancer is the most common invasive cancer in females accounting for 29% of all new diagnoses.[6] The ACS estimates 232,570 women will be diagnosed with invasive breast cancer while an additional 62,570 women will be diagnosed with noninvasive forms of breast cancer in 2014. In 2014, the ACS estimated there were 2.8 million women in the United States living with a history of breast cancer. Breast cancer in men is rare with an incidence rate of approximately 1% of all new cases.[6]

Following lung carcinoma, breast cancer is the second most frequent cause of cancer mortality in females with an estimated 40,000 deaths in 2014.[7] Fortunately, advancements in both early detection and cancer treatment have resulted in a modest, yet steady, decline in mortality rates between 1990 and 2010.[6,8]

Most breast cancers are initially diagnosed with imaging techniques including mammogram, breast MRI, and/or breast ultrasound followed by biopsy.[9] The staging of breast cancer uses the traditional TNM system. The TNM system is an acronym where **T** refers to tumor size, **N** refers to nodal status, and **M** refers to metastasis. Staging also generally requires tissue biopsies and additional imaging such as computed tomography scanning of the chest, abdomen, and pelvis, as well as bone scanning.[9] Breast cancers are then staged from 0, in situ disease, to IV, distant metastatic disease, according to the final results of the staging work-up.[9]

The pathologic diagnosis of breast cancer includes several different tumor cell types and histological grades ranging from low grade I, or well differentiated cells, to high grade III, or poorly differentiated cells.[9] The most common type of noninvasive breast cancer, or those tumor cells that have not left their initial location of origin, is ductal carcinoma in situ or DCIS, considered Stage 0. Ductal carcinoma in situ accounts for 83% of all noninvasive breast cancer diagnoses.[6] Invasive, or infiltrating, ductal carcinomas (IDC) have the ability to penetrate through ducts and lobules into the normal surrounding breast parenchyma and fatty tissue are characterized as Stage I-IV.[9]

Common non-modifiable risk factors that increase the risk for developing breast cancer include female gender, age, and

race/ethnicity.[6] Specific factors significantly increase the relative risk, or the risk ratio comparing those exposed to a risk factor with those without an exposure, of developing breast cancer. In women, those exposures which increase the relative risk to > 4.0 include age greater than 65, family history of two or more first degree relatives diagnosed with breast cancer at an early age, personal history of breast cancer onset at < 40 years of age, high breast density, a personal diagnosis of atypical ductal hyperplasia or lobular carcinoma in situ, and/or identifiable breast cancer genetic mutations.[9] Modifiable risk factors for breast cancer associated with a 1.1-2.0 increase in relative risk include alcohol consumption, nulliparity, recent and/or long term use of hormone replacement therapy, recent oral contraceptive use, and obesity in post-menopausal women.[6]

Invasive ductal carcinoma in women is typically diagnosed in the geriatric patient population with an average onset being age 65 or older.[6] When younger women are diagnosed with IDC, they often present with more aggressive cancers that can then require more aggressive treatment interventions, and ultimately, have a poorer prognosis.[6]

Breast Cancer Management

Surgery

Breast cancers are managed locally with surgical excision via either breast conserving surgery with a partial mastectomy, also referred to as lumpectomy, quadrantectomy, and/or wide local excision, or by means of simple or total mastectomy. The goal of surgical excision is to remove the cancer and sufficient tissue to demonstrate negative margins, and to assist in staging the breast cancer.[9] Negative, or clean, margins are considered to demonstrate an absence of cancer cells at the inked edge of the excised tissue. Most surgeons also prefer normal breast tissue free of cancer cells for a facility-defined distance from the border of the surgical margin.[9]

Considering breast cancers metastasize by way of either direct extension or through the circulatory or lymphatic systems, invasive breast cancers are staged radiographically and by lymph node sampling.[9] In patients with invasive breast cancer who would otherwise be appropriate candidates for systemic therapy due to reasonably good health, lymph node sampling is generally indicated. In patients with noninvasive breast cancers opting for mastectomy, axillary lymph node sampling is generally recommended.[9] This is accomplished by the sentinel lymph node biopsy (SLNB) technique that uses a radiolabeled colloid and a blue dye to allow the surgeon to properly identify the lymph node(s) responsible for the primary lymphatic drainage from the breast.[9] Once properly identified and excised, a pathologist examines the node(s) for cancer cells, often immediately, as a frozen section.[9] Historically, if a large deposit of cancer in one or more lymph nodes was found to be involved with cancer, the surgeon generally proceeded with a complete axillary lymph node dissection (ALND) where multiple additional nodes were surgically excised leading to a risk of greater postoperative complications.[10] Most recently, however, Giuliano et al[11] during the American College of Surgeons Oncology Group Z0011 trial found no survival benefit in patients with a positive SLNB followed by ALND if systemic therapy was used. Therefore, trends are towards more conservative treatment of the axilla in order to help to reduce arm morbidity.

Reconstruction

Surgical options for cosmesis following removal of breast tissue include several breast reconstruction techniques that may be either immediate or delayed. The most frequently used option includes saline or silicone breast implants, with or without the temporary placement of a tissue expander under the pectoralis major muscle.[9] This option may also be used with acellular dermal matrix or decellularized human tissue, to form a "sling" to allow for early expansion and provide inferior pocket protective support for the breast implant.[9]

Autologous breast reconstruction options include the use of a patient's own tissue, either adipose tissue, muscle tissue, or both.[9] These procedures offer the confidence in and benefits of using the patient's own tissue, but also result in additional surgical wounds, risk of infection, risk of graft/flap necrosis, and scar tissue.[9] Therefore, these procedures require additional consideration for the patient and physical therapist during the rehabilitation process. One option, reconstructive mammoplasty, involves the surgical repositioning of a patient's own ipsilateral breast tissue in order to fill in surgical deficits left behind due to wide local excision or partial mastectomy.[9] Myocutaneous flap procedures, either pedicle or free flaps, use muscles such as the rectus abdominis, the latissimus dorsi, gluteals, or gracilis, often with surrounding adipose tissue, to fashion a reconstructed breast.[9] Microsurgical free flap procedures use harvested skin, adipose tissue, and blood vessels to perform the reconstruction while leaving the muscles intact.[9] Reconstructive procedures can also be done to restore the nipple-areolar complex with harvested skin and/or the use of tattooing.[9]

Radiation Therapy

Since breast cancers that recur are most likely to do so within the immediate region of the original tumor site, radiation therapy techniques are often used for locoregional control to reduce this risk by treating the resected tumor bed and the normal surrounding tissue.[9] Radiation techniques used after surgical excision of breast cancer can include intraoperative brachytherapy with electric sources, brachytherapy used immediately postoperatively with radioactive sources, and/or most frequently, traditional external beam radiation therapy with a linear accelerator at approximately one month postoperatively or, if prescribed, after the completion of chemotherapy.[9] For those patients found to have positive axillary lymph nodes, expanding the radiation therapy treatment field to include the axilla and/or supraclavicular nodes is generally prescribed.[9]

Radiated skin and underlying soft tissues of the upper quadrant can present with fibrotic changes, which reduce flexibility and pliability, as well as altered circulation and texture due to damage to the superficial and deep anatomical structures when compared to nonradiated tissues.[9] In addition to radiation dermatitis in the treatment field, inflammation and irritation of the skin often seen during or immediately after radiation therapy, upper extremity symptoms can also present which may result in pain, paresthesias, and weakness, according to a systematic review by Lee et al.[12] These potential issues, in addition to monitoring for AWS, require close attention in the rehabilitation process with interventions including manual therapy, therapeutic exercise, and detailed home exercise prescription with an emphasis on ongoing range of motion after discharge.[9]

Chemotherapy

Chemotherapeutic, or cytotoxic, agents are used in breast cancer management to act systemically to destroy any residual cancer cells not addressed during surgical excision. Chemotherapy is commonly used postoperatively, or *adjuvantly*, in patients with positive axillary lymph node(s), in those with larger and/or more aggressive tumor types, and in those with genetic assay testing presenting with high recurrence scores.[9] In the

event of a large tumor at the time of diagnosis, chemotherapy may be used *neoadjuvantly*, or preoperatively, in order to attempt to shrink the tumor and make it more amenable to surgical excision.[9] Most regimens in early stages of breast cancer are anthracycline-based, whereas taxanes are generally added in instances of more aggressive tumors and/or node positivity.[9] The use of immunotherapy drugs such as the monoclonal antibody Herceptin (trastuzumab) provides targeted therapy to those patients with an over expression of the human epidermal growth factor 2 (HER2/neu) oncogene.[9]

The most common short-term side effects of chemotherapy include immunosuppression, anemia, mucositis, nausea and vomiting, alopecia, and fatigue.[9] In addition, anthracyclines are associated with potential cardiac toxicity, taxanes can cause chemotherapy induced peripheral neuropathy (CIPN) and Herceptin can cause or exacerbate pre-existing cardiac toxicity from anthracycline-based regimens.[9] These potential long-term side effects of chemotherapy deserve consideration in any breast cancer survivorship care plan.[13]

Endocrine Therapy

In addition to surgery, radiation therapy, and chemotherapy, those breast cancer survivors with breast tumors found to be positive for estrogen receptors (Er+) and/or progesterone receptors (Pr+) are good candidates for endocrine, or hormone, therapy.[9] This systemic technique allows for breast cancer risk reduction and/or tumor control by way of hormone manipulation to either block and/or lower levels of circulating estrogen.[9] The most common hormone therapies used in breast cancer include selective estrogen receptor modulators such as Tamoxifen, Aromatase Inhibitors such as Arimadex, and luteinizing hormone-releasing hormone analogs such as Lupron.[9] Ovarian ablation can also be achieved surgically by oophorectomy to induce menopause in premenopausal breast cancer survivors.[9]

Side effects from certain hormone therapies which are of a concern to rehabilitation include, but are not limited to, menopausal symptoms, myalgias and arthralgias, osteoporosis, blood clots, and an increased risk for cancers of the uterus in postmenopausal women.[9]

LYMPHATIC SYSTEM

Anatomy and Physiology

The lymphatic system, consisting of both superficial and deep layers separated by fascia, includes the components of lymph fluid, lymph vessels, and lymph tissues (Figure 1). Lymph fluid, or interstitial fluid within the lymph system, consists of proteins, water, cellular components, such as salts and white blood cells, fatty acids/fat compounds, and foreign substances.[10] Lymph vessels, including from the initial lymph capillaries to the precollectors and lymph collectors to the terminal lymph trunks, provide the major transportation channels for lymph fluid. Lymph tissues, comprised of reticular fibers either within connective tissue or encapsulated lymphoid cells forming organs, such as lymph nodes, the spleen, and thalamus, perform protective immune functions.[14] Lymph nodes both produce antigen-stimulating lymphocytes and filter harmful material, such as cancer cells, pathogens and debris from lymph fluid.[14] Lymph tissues also function to thicken lymph fluid as blood capillaries within lymph nodes absorb water to reduce the lymph load returning to the venous system.[14]

Several anatomic watersheds divide segments of the body into specific lymph drainage patterns based on directions of lymph flow.[14] These linear watersheds, including the sagittal or *median*, and lower horizontal or *transverse*, separate the body into 4 equal territories including right and left upper and lower quadrants.[14] In addition, the upper horizontal watershed divides the neck and shoulders from the arm and thorax while the inguinal watershed divides the lower extremities from the trunk.[14] In addition to these watersheds, several interterritorial anastomoses exist and may be used to redirect lymph flow preventatively in a particular territory or quadrant by the body's own protective mechanisms, or manually in the event of existing swelling.[14] These anastomoses usually promote lymph flow from anterior to and from posterior, from right

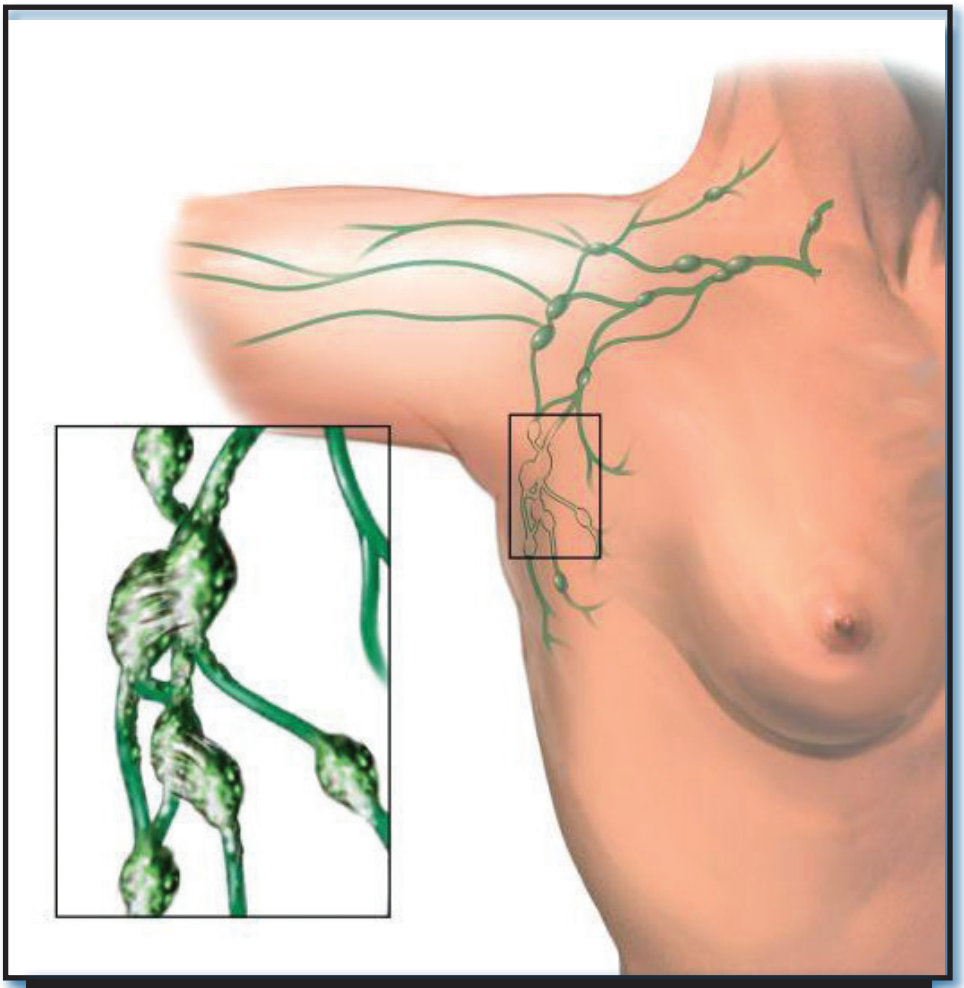

Figure 1. Lymphatic anatomy of the axilla with enhancement of the lymph nodes and lymph vessels. Photo courtesy of Nucleus Medical Media. Lymphedema. Smart Imagebase. April 3 2009 10:20 EDT. Available at: http://ebsco.smartimagebase.com/lymphedema/view-item?ItemID=7567. Accessed February 10, 2014.

to and from left and/or cephalad to caudad ipsilaterally.[14]

Lymphatic System Function

In addition to its immune system function, the lymph system is considered an accessory route for the transportation of lymph fluid from the tissues into the blood stream. In this role, the lymphatic system works with the cardiovascular system to maintain fluid balance throughout the body.[14] This delicate balance occurs when the filtration loads and pressures at the arteriole level are appropriately and equally offset by the reabsorption loads, pressures, and capacities through the lymph system on return to the venules.[14] Disruption in this balance, as a result of an anatomic malformation or a trauma, will result in lymphatic insufficiency that can result in local or generalized edema.[14] Lymphatic insufficiency can be either *dynamic*, where both active and passive edema protective measures fail, or *mechanical*, where transport capacity is reduced due to functional or acquired causes.[14] Mechanical insufficiency, also known as secondary lymphedema, is often due to causes such as surgery, radiation, trauma, and/or infection, and is most frequently experienced by cancer survivors.[10]

Lymphedema

Breast cancer survivors can present acutely with transient edema in the immediate postoperative period in the upper extremity, chest wall, axilla, and/or in residual breast tissue.[10] Closed–suction drains are used to reduce the accumulation of serous fluid in the ipsilateral trunk in the area of the surgical excision, known as seroma, considered a risk factor for the development of upper extremity lymphedema.[10] Patients with persistent or worsening edema should be examined for signs of infection and/or the differential diagnosis of chronic lymphedema requiring referral to a CLT.

Lawenda et al[10] examined the incidence of lymphedema as a consequence of cancer and cancer treatment techniques. Their review of upper extremity lymphedema studies included studies dealing with surgical and radiotherapeutic management of the axilla. Specific findings cited incidence rates as low as 2% by Mazeron et al[15] for individuals treated with lumpectomy and ALND to as high as 44% by Borup Christensen et al[16] for individuals treated with modified radical mastectomy, ALND, and axillary radiation.[15,16] Ahmed at al[17] looked at risk factors and related arm symptoms in 1,287 breast cancer survivors in the Iowa Women's Study. They concluded that tumor stage, number of excised nodes, tumor-positive nodes and adjuvant chemotherapy were cancer characteristics positively associated with lymphedema.[17] In addition, they found the lymphedema to be associated with greater baseline body mass index, greater waist and hip circumference and lower levels of general health. Arm symptoms were positively associated with higher numbers of excised nodes, axillary radiation and lower baseline general health.[17] A multivariable analysis by Norman et al[18] found ALND and chemotherapy in combination resulted in a 4 to 5 fold increase in hazard ratios for lymphedema compared with no treatment while radiation therapy and SLNB did not. In addition, O'Toole et al[19] found an arm volume increase of ≥ 5 % ($p = 0.028$) to be associated with the incidence of AWS in breast cancer survivors.

AXILLARY WEB SYNDROME

Axillary web syndrome is one complication of breast cancer that can be easily misdiagnosed without an understanding of breast cancer treatment and its effects on the musculoskeletal and lymphatic systems. Axillary web syndrome generally appears as taut cords in the axilla and can be a significant cause of pain and restricted mobility. Further description of the diagnostic criteria is included in the subsequent sections of the monograph.

Literature Review

Compared to lymphedema, AWS is a lesser known and less well understood postoperative complication associated with breast cancer. Like lymphedema, however, the incidence reporting varies widely, from 6% to 54% depending on the disease state and reporter.[20-25] The most recent studies of AWS and its relationship as a complication of breast cancer treatments report an incidence between 28% and 36%.[19,26] Axillary web syndrome has also been noted in individuals with melanoma who have had ALND.[21] The etiology and pathogenesis of AWS have not been definitively elucidated; however, several studies point to a hypercoagulation and fibrosis in and around the lymphatic vessels as the cause of the pathological symptoms.[27,28]

The following articles (Tables 1 and 2) were identified in a review of the literature conducted using a search of electronic databases including CINAHL, PubMed, and Cochrane Database of Systematic reviews. "Axillary" was used as the key word in combination with the following search terms: "web," "cording," and "syndrome." There were a total of 25 articles found in the CINAHL database and 28 found in PubMed. Date restrictions for literature published between 2000 up to 2014 were imposed, and only articles in English were considered. Titles and abstracts were reviewed according to merit of design, and only scholarly journal articles were included in this review. Fourteen articles met the authors' inclusion criteria.

Typical Presentation

Patients with AWS typically have significant limitations in shoulder abduction range of motion as the primary reason for seeking treatment.[20] Patients may also complain of pain that radiates down the arm,[31] "tautness" or numbness,[33] and/or paresthesias extending into the hand. It has been proposed that the term *Lymphatic Cording* is more appropriate than AWS because the lymphatic vessels may be affected throughout the entire limb, although symptoms usually begin in the axilla.[25]

Diagnostic criteria for Lymphatic Cording/AWS[20]:

1. Thickened fascial cord(s) running just under the skin, visible or palpable when the upper extremity is in a flexed and abducted end range position.
2. Subjective report from the patient includes the experience of "pulling" through area of cording and beyond.
3. Limited range of motion in area of cording.
4. Reports of discomfort or pain in area of cording.

Examination

While it is more common for the onset of AWS to be within weeks of the axillary node dissection, it is the authors' (McAuley & Litterini) experience that the onset can be up to several months later and the patient herself may not relate this onset to the surgery. In a retrospective review, Severeid et al[22] found that of those with AWS (n = 63), 22% had an onset of symptoms more than 3 months after lymph node biopsy. One individual in particular had an onset of symptoms more than 16 years after biopsy. It is imperative that the physical therapist understand that all persons with a history of lymph node dissection are at risk of developing AWS, regardless of how much time has passed since the initial medical treatment for cancer.

Table 1. Epidemiology of Axillary Web Syndrome

Author(s) Publication Date	Research Design	Findings
Moskovitz, Anderson, Yeung, Byrd, Lawton, & Moe (2001)[20]	Retrospective Cohort Study	This study was the first to define AWS, described a "typical" presentation of onset at approximately 2 weeks postsurgery and spontaneous resolution approximately 3 months postsurgery.
Leidenius, Leppanen, Krogerus, & von Smitten (2002)[21]	Randomized Control Trial	This study compared the incidence of AWS in patients who underwent Axillary Clearance to those who underwent SLNB. There was a significant decrease in the incidence of AWS in the patients who underwent SLNB.
Reedijk, Boerner, Ghazarian, & McCready (2006)[27]	Case Report	This study describes the case of a 41-year-old female presenting with AWS less than 7 weeks after a lumpectomy and ALND. The presentation of AWS in this case included nodules on the medial aspect of the elbow and upper arm with tightness extending into the patient's ipsilateral thumb. The patient's symptoms resolved spontaneously 15 weeks postsurgery.
Severeid, Simpson, Templeton, York, Hummel-Berry, & Leiserowitz (2007)[22]	Retrospective Cohort Study	The examination of 214 charts of patients who had been diagnosed with breast cancer and referred to physical therapy found an AWS incidence of 29.4%.
Lacomba, del Moral, Zazo, Sanchez, Ferrandez, & Goni (2009)[23]	Prospective Cohort Study	This study found a 48.3% incidence of AWS in a cohort of 116 patients 2 weeks after undergoing ALND. All but two incidences of AWS resolved by a 3-month postoperative examination.
Aydogan, Belii, Baghaki, Karabulut, Tahan, & Uras (2009)[26]	Case Study	AWS appeared approximately 8 weeks after a SLNB and spontaneously resolved 2 weeks after patient reporting. This case is a "typical" presentation of AWS.
Bergmann, Medes, de Almeida Dias, do Amaral e Silva, da Costa Leite Ferreira, & Fabro (2012)[24]	Prospective Cohort Study	This study found a 28.1% incidence of AWS in a cohort of 193 patients 45 days after surgery for a variety of breast cancers. AWS is associated with axillary lumpectomy and numbness in the ipsilateral upper extremity.
O'Toole et al. (2013)[19]	Prospective Cohort Study	This study showed a 36.2% incidence of AWS among 308 patients over the first 24 months post operatively, with 50% of those instances occurring within the first 3 weeks postoperatively.

Abbreviations: AWS, axillary web syndrome; SNLB, sentinel lymph node biopsy; ALND, axillary lymph-node dissection

The intent of the physical therapy examination is to establish whether the diagnostic criteria for AWS are met, and to rule out other potential causes for the patient's symptoms. A thorough history, including all treatments for cancer and/or lymph node biopsy, as well as the onset of the current complaint, should be obtained. The history and/or current presentation may include the report of some swelling or lymphedema into the affected upper extremity. Compared to the patient's complaint of shoulder girdle pain, the swelling may seem minimal, so it may be necessary to specifically inquire. If swelling is not subjectively reported, the patient may convey "heaviness" that is worse at the end of the day. O'Toole et al[19] also recommend specifically asking about possible cording, described to patients as "a thin cord or string in any of the following areas: in your armpit that extends into the inside of your upper arm, across the inside of your elbow, along your forearm and wrist, under your breast extending toward your abdomen, or none of the above," using the Lymphedema Evaluation Following the Treatment for Breast Cancer Questionnaire. According to O'Toole et al,[19] self-reporting using this questionnaire was ≥ 91.5% specific for cording.

The objective examination should include (1) posture assessment; (2) active and passive range of motion and mobility assessment of cervical spine, thorax, and shoulder girdle complex with special attention to the glenohumeral joint; (3) neurological screening of myotomes, dermatomes, deep tendon reflexes; (4) manual muscle testing of the scapular and glenohumeral muscles; (5) tissue movement and glide;[31] and (6) neurodynamic assessment of the median, ulnar, and radial nerves. The details of the full examination are beyond the scope of this paper. Special attention should be made to certain aspects of the examination that contribute to differential diagnosis (Table 3).

Differential Physical Therapy Diagnosis

Shoulder impairments have been reported following breast cancer treatment with restricted ROM in up to 50% of women.[34] Diagnoses typically associated with limitation of shoulder abduction, and more familiar to orthopaedic physical therapists than AWS, are adhesive capsulitis and thoracic outlet syndrome (TOS). Adhesive capsulitis affects the synovial lining and capsuloligamentous complex of the glenohumeral joint, and may be secondary to a

Table 2. Management of Axillary Web Syndrome

Author(s) Publication Date	Research Design	Findings
Kepics (2004)[29]	Expert Opinion	Expert opinion describing intervention options that she has used in the treatment of patients with AWS. Interventions include myofascial release techniques, manual lymph drainage, stretching, and soft tissue mobilizations that elicit a "pop" and an immediate increase in patient ROM.
Wyrick, Waltke, & Ng (2006)[25]	Retrospective Cohort Study	In this review of 180 physical therapy charts, 31 instances of AWS were documented with an average onset time of 36 weeks postoperative procedure. Overall, this study showed a significant shortening of AWS duration from 3 months to 10 weeks when physical therapy is regularly attended.
Craythorne, Benton, & Macfarlane (2009)[30]	Case Report	26-year-old female 2-weeks s/p wide local excision resolved after 2 months physical therapy including shoulder extension stretches, shoulder rotation stretches, and a light exercise program.
Fourie & Robb (2009)[31]	Case Report	47-year-old female 22-days post-mastectomy and axillary dissection. Utilizing soft tissue mobilization techniques, patient returned to pre-morbid ROM in 3 weeks and was symptom free in 16 weeks.
Tilley, Thomas-MacLean, & Kwan (2009)[32]	Case Report	37-year-old 1 week post axillary dissection and sentinel lymph node biopsy. With the application of moist heat, soft tissue mobilization, and stretching exercises the patient regained full ROM, but still had a palpable cord 7 weeks postoperatively.
Lattanzi, Zimmerman & Marshall (2012)[33]	Case Report	44-year-old female 10 days post wide excisional biopsy. Cording extended into the UE and into the ipsilateral breast tissue, making this a unique presentation. Soft tissue mobilization, stretching, and light exercise over the course of 40 days improved patient's Disability of Arm, Shoulder, Hand scores and provided motion within normal limits, but at one year follow up patient still reports occasional feelings of tightness in her thorax and breast during movement.

Abbreviations: ROM, range of motion; AWS, axillary web syndrome; UE, upper extremity

period of immobilization.[35] Adhesive capsulitis has been reported to occur in breast-cancer survivors due to pain and immobility following surgery.[3] It has been proposed that the negative effects of surgery (eg, pain) and radiation therapy (tissue fibrosis) can contribute to adhesive capsulitis in breast cancer survivors.[34] The ROM limitations associated with adhesive capsulitis follow a capsular pattern, and by definition include restriction of external rotation. Conversely, the physical therapist will note that restrictions of movement for persons with AWS are primarily shoulder abduction and flexion and do not follow a capsular pattern.

Thoracic outlet syndrome can be classified as vascular or neurogenic.[36] The majority of TOS is symptomatic neurogenic, meaning symptoms of pain and paresthesias, but not hard evidence of neurologic compromise.[36,37] Neurogenic TOS is typically caused by mechanical compression of the lower trunk (C8-T1) of the brachial plexus at one of 3 sites: (1) between the anterior and middle scalene muscles, (2) in the costoclavicular space, and (3) in the sub-coracoid tunnel.[36] According to Stubblefield and Keole,[34] although nerve entrapment syndromes are likely to occur in breast cancer survivors, there is no direct evidence that they are at greater risk of developing TOS than the general population. However, the scalene muscles and the pectoralis minor muscle are both susceptible to shortening and radiation fibrosis thereby causing a greater likelihood of nerve compression at these sites.[34] It is the author's (McAuley) experience that TOS is the most common incorrect diagnosis given for women with AWS. The symptom presentation is very similar, but the primary differentiating factor is the presence of cording. Additionally, the shoulder ROM restrictions present with AWS have a true tissue end feel while those with TOS are more typically due to muscle guarding or empty end feels.

Both adhesive capsulitis and TOS are more commonly diagnosed in women than men in the general population of persons without a history of cancer.[34] While either of these conditions may be present in the breast cancer survivor presenting to physical therapy, the clinician must recognize that more than one condition may be responsible for the patient's chief complaint. Axillary web syndrome should be strongly considered as contributory when the medical history is supportive. It can be confirmed by the visual inspection of the cording itself, visible crossing the axilla, and even extending distally to the antecubital fossa (Figure 2). In addition, therapists treating breast cancer survivors should be aware of the potential for the presentation of other painful conditions of the involved upper quadrant such as brachial plexopathy, postmastectomy pain syndrome, CIPN, and cellulitis.[34]

A discussion of differential diagnosis of upper extremity pain would not be complete without mention of complex regional pain syndrome (CRPS). There is no literature that demonstrates a greater likelihood of CRPS in breast cancer survivors. Complex regional pain syndrome, despite the controversy and variability regarding diagnostic criteria,[38] is viewed as a condition involving symptoms of diffuse pain as well as signs of vasomotor, sensory, motor impairments, and trophic

Table 3. Differential Diagnosis

Findings	Secondary Adhesive Capsulitis[35]	Thoracic Outlet Syndrome (TOS)[36, 37]	AWS / Lymphatic Cording
Symptom pattern	• May follow period of immobilization • Initially may experience some sharp pain at end ranges of motion • Progressive dull, aching symptoms • Sometimes reported to be worse at night / sleeping affected	• Insidious onset • Primary complaint of paresthesias in C8-T1 dermatome distribution • Secondary complaint of pain affects distal > proximal UE	• History of breast cancer • Primary complaint is of axillary pain; may extend into hand and have paresthesias
Glenohumeral range of motion	• Limitations are pronounced, especially ER, abduction, IR • AROM and PROM equally limited • Firm / capsular end feel • End range pain	• Limitations of overhead UE activity • AROM may be less than PROM for abduction and flexion • Typically these positions provoke symptoms & guarding (vs specific end feel)	• Limitations are pronounced for abduction and flexion • AROM and PROM most often are equally limited • Firm/tissue end feel • End range pain
GH joint mobility	• Joint glides/accessory motions restricted all directions, especially posterior & inferior	• Joint glides/accessory motions not limited (as compared to non involved GH joint)	• Joint glides/accessory motions not limited (as compared to non involved GH joint)
Neurodynamic assessment	• Negative (not associated with symptoms; equal to opposite UE)	• Positive findings with neurodynamic assessment (most commonly ulnar n., but may be median, radial n.)	• May have positive findings with neurodynamic assessment (may be median, ulnar or radial n.)
Swelling/Edema	• None	• Possible if vascular TOS and venous return is compromised; not common	• May have concomitant lymphedema
Cording	• None	• None	• Present in axilla and may extend along medial aspect of upper extremity, antecubital space, and into thumb[29]

Abbreviations: AWS, axillary web syndrome; UE, upper extremity; ER, external rotation; IR, internal rotation; AROM, active range of motion; PROM, passive range of motion; GH, glenohumeral; TOS, thoracic outlet syndrome

changes and edema.[38] One article was identified in which a 28-year-old man with CRPS following a distal radius fracture benefited from manual lymph drainage.[39] This does suggest that persons with AWS in which the lymphatics are compromised, would potentially be at greater risk for CRPS. It is important to note that CRPS is associated with spontaneous and diffuse pain, while persons with AWS experience end range pain associated with the presence of lymphatic "cords."

Axillary Web Syndrome Management

To date, there are no randomized controlled trials regarding the physical therapy interventions for persons with AWS. The available literature includes expert opinion, retrospective studies and case reports[25,29-33] (Table 2). Taken as a whole, however, we can glean meaningful information from the available literature. The most common interventions described can be classified as education, exercise, manual therapy, and manual lymph drainage (MLD).[25,29-33]

Education described in the literature is primarily related to anatomy, posture and diaphragmatic breathing.[29] Exercise encompasses ROM,[25,29] muscle contraction,[29] and progressive resistive exercise.[24] Manual therapy techniques are intended to increase shoulder ROM. It is important to note that joint mobilizations are not necessary as the capsule itself is not restricted. Techniques that target the soft tissue are to be prioritized. Specific techniques described in the literature vary from superficial soft tissue mobilization such as scar massage, cross-friction massage, skin rolling, skin gliding, skin traction, and myofascial release[29,31,33] to direct release techniques along the length of the cord that sometimes yielded audible "pops."[32,33] Physiologic ROM is also important once the superficial tissues are released, as well as to identify areas of restriction. Other methods of improving soft tissue mobility may also be effective, but were not found in the literature; examples include contract-relax techniques and proprioceptive neuromuscular facilitation. All authors emphasize the importance of starting gently and gradually increasing the intensity of all interventions. Two articles describe soreness within 24 to 48 hours after treatment, but the authors deemed this soreness acceptable.[31,33]

It is in the authors' (McAuley & Litterini) experience that neural mobilization of the upper extremity, as described elsewhere,[40] is very effective in treating the limited ROM and pain. The lymphatic system, like the nervous system, is continuous so many of the same principles can apply. Fourie and Robb[31] acknowledge increased shoulder mobility when the elbow is flexed, which is a clear example of the continuity of the lymphatic cords. Kepics[29] describes mobilizing the cords "distal to proximal" in a fashion that is very similar to neural mobilization techniques. Lattanzi et al[33] explicitly state inclusion of "nerve glides" in their case report; they reported the patient was having symptoms of paresthesias shortly after radiation therapy which responded well to the nerve glides.[3] It is likely the glides benefited the AWS as well.

Patients who are experiencing lymphedema, along with the AWS, should be referred to a CLT. A simple method to

Figure 2. A visible cord extending distally from the axilla across the antecubital fossa. Photo courtesy of Nancy Roberge, PT, DPT, MEd.

determine if the degree of swelling warrants referral is to obtain circumferential measurements along the limb. The National Lymphedema Network recommendation according to the Position Paper: Screening and Measurement for Early Detection of Breast Cancer Related Lymphedema, is to measure at 6-points: mid-hand, wrist, elbow, upper arm just below the axilla, and at 10 cm distal to and proximal to the lateral epicondyle on both arms. Criteria for referral is met if the involved limb is >1 cm at any point as compared to the non-involved limb.[41]

Manual lymphatic drainage is a specialized manual technique specifically designed to address the protein-rich lymphatic fluid. Manual lymphatic drainage has been defined as "a very light, superficial massage that facilitates the flow of lymph to drain."[41] Wyrick et al[25] report MLD as part of the intervention provided in their retrospective cohort study and found an average of 52° of improvement in shoulder abduction ROM over the course of 4 weeks. In this study, the average starting abduction ROM was only 84°. Given this initial restriction, 52° of improvement represents a substantial, functional increase.[25] Manual lymphatic drainage as a component of complete decongestive therapy has been shown to reduce edema, reduce pain, and improve function.[42]

Physical Activity and Rehabilitation for the Cancer Survivor

Recommendations for quality improvement in post-cancer treatment survivorship care were first emphasized in the 2005 Institute of Medicine (IOM) Report, *From Cancer Patient to Cancer Survivor: Lost in Transition*, where the importance of a comprehensive interprofessional team approach is considered critical.[43] From there, both the 2012 ACS *Nutrition and Physical Activity Guidelines for Cancer Survivors* and the 2013 National Comprehensive Cancer Network (NCCN) *Guidelines for Survivorship* recommended that rehabilitation and physical activity be the standard of care in cancer survivorship to help mitigate some of the many sequelae of cancer treatment.[44,45] Regarding the prevalence of fatigue in cancer survivorship, the 2014 NCCN Guidelines on Cancer-Related Fatigue also recognize as a standard of care that rehabilitation should begin at the time of diagnosis and physical activity should be encouraged.[46] Therefore, physical activity for overall strength and aerobic conditioning should be considered as part of any rehabilitation model for the cancer survivor.

In order to increase physical activity for cancer survivors, exercise prescription is best done on an individual basis by a skilled clinician for individuals in active cancer treatment and/or for those with advanced disease. In addition, cancer survivors with multiple co-morbidities should receive a formal exercise prescription to maximize patient safety. For those patients who have completed adjuvant cancer treatment and are otherwise considered appropriate for exercise by their physician, the recommended exercise dose by the ACS is for 150 minutes per week of moderate intensity exercise with the addition of strength training twice weekly.[43]

In addition to traditional referrals for the rehab management of breast cancer-treatment related diagnoses, Stout et al[47] and McNeely et al[48] advocate for prospective surveillance models of care to provide early identification of deficits and standardized processes for routine measurements and structured care for breast cancer survivors. Rehabilitation professionals should therefore be considered an integral part of every cancer survivor's initial cancer treatment plan, as well as their long-term survivorship care plan, in order to support and restore functional mobility, activity participation, and quality of life.

CONCLUSION

The expanding roles of physical therapists as the entry-point into the health care system for movement related impairments and as an integral member of the interprofessional team in oncologic rehabilitation necessitates that we be versed with (1) breast cancer epidemiology and related treatments, (2) the lymphatic system and lymphedema, and (3) AWS, including differential diagnosis and management of persons with AWS. This paper addressed each of these areas and serves to increase the knowledge of orthopaedic physical therapists, and in turn, the quality of care our patients deserve from a doctoring profession. For more information about oncological physical therapy, please visit the APTA's Oncology Section at www.oncologypt.org, Women's Health Section at www.womenshealthapta.org, and the Lymphology Association of North America at www.clt-lana.org.

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