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I. Introduction

In the United States, approximately 12% of women will develop breast cancer in the course of their lives.[1] Globally, it is the most commonly diagnosed cancer in women.[2] While many effective breast cancer treatments have been researched and successfully applied to patients, they are not without complication and functional implications. Physical therapists might assume that basic upper extremity dysfunction is the most common issue arising from surgical and radiation treatment of the breast, but various soft-tissue impairments can also occur that lead to decreased functional mobility and pain.[3] Furthermore, in the event that mastectomy takes place, reconstructive surgery is a common consideration of patients that unfortunately may lead to soft-tissue and functional complications as a result of the autogenous tissue techniques typically utilized.[3,17] Considering the significant incidence of breast cancer in the population, as well as the various potential complications that accompany treatment, it is quite clear that physical therapy has a role to play in the prevention and rehabilitation of the various dysfunctions that may result from breast cancer treatment measures. This paper will examine common soft-tissue and muscular complications stemming from breast cancer treatment and surgery: axillary web syndrome, lymphedema, and muscular disruptions due to reconstructive techniques. Furthermore, bone health will be discussed in relation to hormonal treatments utilized during chemotherapy, which place women at increased risk for decreased bone mineral density, osteoporosis, and potential fracture.

II. Axillary Web Syndrome

One breast cancer-specific tissue pathology that commonly results from lymphadenectomy and sentinel node biopsy is axillary web syndrome, presenting as a visible and palpable rope-like tissue structure extending distally down the surgical upper extremity into the medial arm, antecubital space, and forearm.[4,8] While both lymph node dissection and sentinel node biopsy are considered standard treatment for early-stage breast cancer management, they can result in a detrimental disruption of the lymph tissue which ultimately leads to this condition.[5] The pathophysiological causes of axillary web syndrome are only moderately researched, with varied evidence suggesting that sclerosis of the lymphatic and venous structures, as well as inflammation of the neurovascular bundle and even myofascial restrictions, leads to the characteristic cord of tissue beneath the axilla.[5,6] In a situation of surgical trauma and inflammation, lymphatic fluid coagulates at a relatively rapid rate due to exposure to thrombokinase, an enzyme released in lymph after tissue damage and cell death.[9] This ultimately leads to formation of “fibrotic bands” composed of sclerosed veins and fibrosed lymphatic vessels.[7,9]

Also known as “cording,” axillary web syndrome can lead to various restrictions on an individual’s use of their surgical arm, due to pain, decreased ROM, and swelling.[4,6] Aydogan et al cite approximately 74% of these patients present with pain and limited shoulder abduction ROM, while Black et al also commonly had patients present with limitations in shoulder extension and functional overhead activity.[6,7]

An exploratory study by Black et al found that first signs of cording present 10 days after surgery, with resolution of symptoms highly varied (based on physical therapy intervention, overuse, or further trauma).[5] However, they did find very similar

approaches to treatment from physical therapists interviewed in the study. All reported emphasis on gentle stretching, soft tissue massage, and ROM, while no highly aggressive approaches were taken due to presence of inflammation.[5] In fact, all therapists interviewed in this study advocated for a gentle approach due to inflammation's primary role in the pathophysiology of cording; of course, aggravating an already inflamed tissue would lead to further inflammation and regression from the ultimate goal of improved tissue mechanics and restored ROM.[5]

A fascinating randomized controlled trial published in *Support Care Cancer* examined the effectiveness of physical therapy on shoulder function, pain, lymphedema, and quality of life in patients with axillary web syndrome.[8] It gives a very detailed and comprehensive overview of standard treatment for axillary web syndrome in the physical therapy setting. Intervention involved upper extremity stretching and pulley exercises for shoulder flexion, abduction, and elbow flexion.[8] Manual therapy was performed by a PT, who applied longitudinal stretching to the tight cords, within the patient's highest range of shoulder abduction.[8] Scapular mobilization was also applied based on patient ROM limitations.[8] Finally, lymphatic drainage was performed by certified physical therapists to address another highly common result of lymph node surgery: lymphedema.[8] Upon conclusion of the four-week intervention period, Cho et al found significant improvement in shoulder flexion strength, decreased pain, improved quality of life, and a restoration of full shoulder ROM.[8]

III. **Lymphedema**

As mentioned briefly as a comorbidity often found with axillary web syndrome, lymphedema is the most common complication of breast cancer surgical intervention

and adjuvant chemotherapy.[8] Due to the disruption of lymph nodes during axillary lymph-node dissection and the inherent inflammation produced by radiation therapy and surgery, protein-rich interstitial fluid is not sufficiently controlled by the now-impaired lymphatic system, resulting in immense swelling, pain, diminished strength, and decreased ROM of the affected upper extremity.[10,13] As a chronic condition, lymphedema must be consistently managed in order to maintain functional mobility of the upper extremity and to prevent tissue fibrosis.[10]

Physical therapy management of this condition has traditionally involved a combination of methods, including wrapping and manual lymphatic drainage.[10,11] However, evidence supporting the effectiveness of these modalities is sparse. A 2013 systematic review of manual lymphatic drainage for the treatment of lymphedema actually concluded that there is simply not enough evidence to support use of this manual treatment for resolution of lymphedema symptoms.[11] Another earlier review also had similar results, finding inconsistencies among the various randomized-controlled trials reviewed, with varying levels of significance in support of manual drainage.[12]

This lack of empirical evidence calls to question what, exactly, a physical therapist should do when a patient presents with this condition. As Tambour et al point out, without regular management of lymphedema, impaired ROM, decreased quality of life, and development of scar tissue in that limb will result, ultimately leading to a feed-forward chronic upper extremity impairment.[10] A multi-modal approach, therefore, would seem most appropriate in the absence of definitive evidence to support one specific intervention. Devoogdt et al found that those patients receiving combined physical therapy had significantly greater reductions in upper extremity edema than those who

had just manual drainage or exercise alone.[12] A study published in Lymphatic Research and Biology examined the effects of combined physical therapy on post-mastectomy lymphedema over the course of five years.[14] Ochalek et al found that women receiving regular combined physical therapy were significantly more likely to maintain upper extremity function and regular limb size than those who did not follow physical therapy nor adhere to any compression sleeve guidelines.[14] The combined physical therapy protocol that was utilized included regular use and fittings of compression sleeves, manual lymphatic drainage techniques, wrapping, and individualized upper extremity exercise programs (catered to the individual's deficits and functional needs).[14] The five-year success of these patients is a testament to the effectiveness of combined physical therapy, but should also be treated with some reservation as patient education certainly plays an enormous role in management of a chronic condition such as lymphedema. In fact, Ochalek et al point out that the control group had received intensive physical therapy immediately after mastectomy but simply did not follow up for any more physical therapy appointments during those five years.[14] If better education and perhaps more intense emphasis on the chronic nature lymphedema had been applied, the control group may also have had better success.

IV. **Reconstructive Techniques & Muscular Involvement**

Both axillary web syndrome and lymphedema can result from minimally invasive breast surgeries, but there is also a large patient population that will undergo mastectomy and more invasive reconstruction. Two specific reconstructive techniques can result in functional complications for the patient, due to their use of autologous

musculature for reconstruction of the breast: the transverse rectus abdominis myocutaneous (TRAM) flap and the latissimus dorsi flap.

The TRAM procedure utilizes two different approaches to reconstruction. A “free” TRAM flap involves complete removal of the rectus abdominis and accompanying fat, skin, and blood vessels, which are then transferred to the chest for reconstruction.[15] There is also a variation on this method that uses only the medial portion of the rectus abdominis muscle in an effort to reduce recovery time and potential core stability complications later on.[15] Meanwhile, the “attached” TRAM flap does not completely remove the muscle and tissue from the abdominal wall but instead leaves some blood vessels attached to their original blood supply in the abdomen.[15] This technique uses a much larger portion of the rectus abdominis and is sometimes called a muscle-transfer flap.[15]

Of course, the primary question that comes to mind regarding this highly common reconstructive procedure is the loss of core stability that would inevitably result from disruption of the abdominal wall and removal of an abdominal muscle. Some surgeons will proactively place an artificial mesh material in place of the removed rectus abdominis to provide some stability.[15] Not surprisingly, 46% of patients undergoing the more invasive “attached” TRAM procedure report higher rates of abdominal weakness and decreased exercise ability.[16] Additionally, 30% of these patients reported low back pain after surgery.[16] A systematic review of abdominal wall function after breast reconstruction, assessed via isometric dynamometry, found that attached TRAM patients experienced an overall 23% deficit in abdominal wall function, while free TRAM patients experienced an overall 18% deficit.[17] Trunk flexion and oblique function was

most impaired in attached TRAM patients, with 40% and 53% impairment, respectively.[17]

Physical therapy implications for the TRAM approach to reconstruction should initially focus on posture and body mechanics to reduce tensile stress on sutures of the abdominal wound closure.[16] Additionally, attention should be paid to the horizontal post-surgical scar, and use of taping and potentially cross friction massage should absolutely be considered to prevent hypertrophic scar formation.[30,31] Consideration of muscular healing processes would also be of immense benefit in the weeks after surgery.[32] In a review published in the *Physical Therapy Journal*, Monteiro recommends that patients position the head of the bed at a 45-degree angle and lying on their uninvolved side in a slightly flexed position when sleeping.[16] She emphasizes the importance of maintaining trunk flexion during transfers and during regular activity in order to reduce tensile strain on the healing incision across muscular tissue.[16,32] Monteiro recommends that trunk strengthening should involve co-contraction of the oblique, transfers abdominis, and multifidus muscles.[16] Exercises that may facilitate this goal include hook-lying lower trunk rotation, isometric trunk rotation, and bridging.[16] Finally, great attention should be paid to preservation of upper extremity range of motion and strength after surgery, through use of active and active-assistive exercise, as well as gentle stretching.[16]

The latissimus dorsi flap is another method that has potential complications for patients undergoing breast reconstruction surgery, for, as its name implies, it uses the latissimus dorsi to reconstruct the breast.[18] This technique does not completely remove the latissimus dorsi but instead excises the tissue needed and “tunnels” it to the other side of the torso for reconstructive use.[19] It is often used as an alternative to the TRAM

flap in individuals who have had prior abdominal surgeries or in those who not have sufficient tissue to spare.[18] Furthermore, it has an overall complication rate of just 9%.[18] Despite this low rate of complication, however, this procedure has potential to impact shoulder function and merits physical therapy attention. A three-year observational study by Button et al examined shoulder function of 58 patients who had undergone latissimus dorsi reconstruction.[20] All patients in the study received physical therapy intervention that included shoulder flexion and abduction exercises, as well as scapular mobility exercises.[20] In general, they found that the majority of patients experienced immediate post-operative shoulder dysfunction and highest DASH scores 2-3 weeks after surgery; however, mean DASH scores fell to functional levels by 3-6 months, with a normal return to ADLs and work at 3 months.[20] Button et al also found that those patients with high pre-operative DASH scores had higher post-operative DASH scores, indicating potential benefit of pre-operative strengthening intervention.[20] In fact, Butten et al assert that these higher-scoring DASH patients should be identified as “at risk” for shoulder dysfunction.[20] Regarding the absence of a functioning latissimus dorsi muscle, there are virtually no recent studies examining this specific implication of the surgery. However, a 1986 study by Russel et al found that synergistic muscles are recruited and eventually “replace” the lost latissimus dorsi’s functional action of shoulder adduction, IR, and extension.[21] Another 1985 study by Laitung et al states that the latissimus doris muscle is “totally expendable” and that there is “no significant functional loss at the shoulder” after this surgery; perhaps such blatant disregard for the muscle’s functional importance should be avoided in physical therapy intervention, but it is interesting to

note the synergistic response of surrounding musculature to aid in the functional deficits from a lost latissimus dorsi.[22]

As with physical therapy intervention of a TRAM flap patient, approach to rehabilitation after latissimus dorsi reconstruction is similar. Considering the potential loss of range of motion, strength, function, and increased pain, treatment would initially address these problems.[33] A study by Glassey et al found that lost range of motion, strength, and function was abnormal up to six months after surgery, with return to normal values occurring around one year post-surgery.[33] They are unclear about physical therapy interventions that subjects may have received. As mentioned previously, some evidence shows that surrounding musculature will respond to the complete or partial absence of the latissimus dorsi; thus, isometric and eventual concentric strength training focused on internal rotation, adduction, and extension would be beneficial in “replacing” lost function.[21]

V. Bone Health in the Breast Cancer Patient

While chemotherapy has an intended goal of eradicating cancerous cells from the body, it is not without negative side-effects that influence function, quality of life, and general health in the patient. Since 70% of breast cancers express an estrogen and/or progesterone receptor, typical breast cancer treatment will utilize chemotherapeutic agents that lower estrogen levels in the patient, with the intent of eradicating presence of those hormone-responsive tumors.[23,25] Unfortunately, estrogen’s important presence as an osteoclast inhibitor is lost in this process, leading to increased rates of bone resorption and an ultimate decrease in bone mineral density.[23,24] Compounding this complication is the influence of increased age on bone health and even chemo-induced

early menopause in women, further decreasing estrogen levels and its bone-protecting benefits.[24] Radiation therapy has also demonstrated detrimental effects on bone structure, though there is a dose-dependent relationship between radiation and risk of fracture.[24]

Physical therapy treatment of breast cancer patients, whether they are currently receiving treatment or simply have history of treatment, should consider bone mineral density and potential increased risk of fracture with all selected interventions. Both the American Society of Clinical Oncology and the National Comprehensive Cancer Network encourage monitoring of bone-mineral density, increased weight-bearing exercise, and adequate intake of calcium and vitamin D in these patients.[25,26,27] There is an overwhelming abundance of evidence supporting the effectiveness of physical activity in reducing the detrimental side-effects of chemotherapy, such as fatigue, and it is well known that weight-bearing activity can also increase bone-mineral density.[25,26,27,29] Thus, PT intervention should include weight-bearing exercise with appropriate duration and intensity, as well as attention to posture and core stability. Referral to a nutritionist may also be appropriate for those patients who are not consuming enough calcium and vitamin D, in addition to those patients who seek to improve their eating for cardiovascular health and weight loss.

VI. Conclusion

Physical therapy undoubtedly has a role to play in the management of breast cancer-related dysfunctions. Due to its significant prevalence in the female population, it is highly likely that the practicing clinician will encounter a patient who has had breast cancer or is currently undergoing treatment for it.[1,2] Thus, an all-encompassing

awareness of breast cancer treatment techniques and potential side-effects will be of practical benefit to both the treating PT and the patient, with an overall potential for improved outcomes. Physical therapy-specific evidence is varied in this realm, with seemingly higher quality research dedicated to management of lymphedema and axillary web syndrome. Research continues to be lacking in the realm of functional mobility after muscle-harvest reconstruction, especially related to physical therapy treatment implications. However, knowledge of these common procedures and the involved structures serves as a useful guide to approaching treatment. Until more effective treatments or even a true cure for breast cancer is reached, these surgical and soft-tissue complications will continue to impact patients in their daily lives. Fortunately, the physical therapy profession can make an impact in improving functional mobility and quality of life in all who are affected.

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