MANUAL THERAPY TECHNIQUES IN LYMPHEDEMA TREAMENT

A Case Report

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The final copy of this Case Report has been examined by the signatories and we find that both the content and the form meet acceptable presentation standards of scholarly work in the above mentioned discipline.
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Abstract

Background and purpose: This case presentation describes the physical therapist examination, evaluation, and interventions for a patient with left upper extremity lymphedema. The patient received complete decongestive therapy with an emphasis placed on the utilization of a home exercise program with self-manual lymph drainage. Case description: The patient was a 55-year-old female who developed left upper extremity lymphedema approximately three months after surgery and chemotherapy for breast cancer. The patient presented with pain and swelling in the left upper extremity, as well as decreased range of motion, and decreased ability to reach overhead and complete functional tasks. Interventions: An intervention program was designed that consisted of manual lymph drainage techniques, compression, skin care education, and therapeutic exercise. The patient received treatment 2 to 3 times a week instead of the recommended 5 times per week, for a total of 9 visits. Outcomes: The outcomes related to lymphedema were measured using the sum of the circumference of each limb. Upon discharge, the patient had a 9% reduction of lymphedema in the left upper extremity. Range of motion was increased back to functional limits, and she was able to resume all normal functional activities. This case presentation demonstrates the effectiveness of a home exercise program with a focus on self-manual lymph drainage.
**Case Description**

The patient is a 55-year-old woman who was referred to physical therapy in May 2014 with lymphedema of the left upper extremity. The patient reported that she was diagnosed with breast cancer in late 2013, and had undergone a bilateral mastectomy in January 2014. A single lymph node was removed from the left axilla, which tested negative for cancer. The patient then underwent four rounds of chemotherapy, but did not undergo any radiation therapy. The patient noticed increased swelling, pain, and difficulty reaching overhead in April 2014, causing her to seek medical attention from her oncologist, who referred her on to physical therapy.

**Literature Review**

Lymphedema is described as an accumulation of protein and excess lymph fluid within the interstitial space (Lacomba et al., 2010). The lymphatic system is composed of vessels that collect and drain lymph fluid from skin, tissue, muscle, and bone. After draining the fluid, the lymphatic system will return it to circulation (Morrell et al., 2005). However, lymphedema occurs when there is some sort of disruption to this system. In most cases, there is a backup of protein that leads to a collection of lymph in the distal vessels. This protein back-up leads to swelling of the breast or, more commonly, the extremities, especially the upper extremities. This swelling can often be quite extreme and debilitating to the patient (Lacomba et al. 2010). If left untreated, lymphedema can progress, leading to other damaging conditions, such as skin infections, functional impairment, lymphangiosarcoma, deep vein thrombosis, and many more (Gautam, 2011).

Lymphedema is one of the most common side effects of any cancer, but especially breast cancer. It occurs in 71% of breast cancer survivors within the first
twelve months after surgery. Some studies suggest that this number is underreported due to a variety of factors, such as variations in definition and measurement of lymphedema, as well as patients who do not seek or are unable to receive treatment for lymphedema (Bicego et al., 2006). This number is slated to increase as approximately 12% of all women are affected by breast cancer, resulting in at least 226,870 new diagnoses per year in the United States alone. Additionally, rising advancements in medical technology and treatment are causing the breast cancer survival rate to rise, increasing the number of new cases of lymphedema (Lacomba et al., 2010). Lymphedema is very debilitating for the patient, significantly reducing their quality of life (QOL) due to changes in their appearance and functional status (Kim et al., 2010). Many patients complain of limb heaviness, paresthesia, achiness, skin-tightness, poor-fitting clothing, decreased range of motion, adverse skin changes, and many limitations in their daily activities (Myers, 2012). In fact, many breast cancer survivors find lymphedema more physically and emotionally challenging than breast cancer, since hiding the loss of function and the physiological changes that occur with lymphedema are much harder (Gautam et al., 2011). However there is a specialized set of treatments for lymphedema patients called Complex Lymphedema Therapy or Complete Decongestive Physical Therapy (CDP or CDT) performed by Certified Lymphedema Therapists (CLTs). This type of therapy generally involves four interventions: manual lymph drainage, fastidious skin care, compression bandaging, and exercise. CDP is recommend to be performed five days per week and lasts approximately four weeks on average for the first phase of clinic-heavy treatment, generally in the outpatient setting (Holtgreve, 2006; Morrell et al., 2005). These therapeutic interventions are able to increase patients’ QOL, by decreasing the size
of the limb, increasing their range of motion, and increasing their ability to complete activities of daily living. These are available to treat patients with breast, upper extremity, and lower extremity lymphedema, and often include compression sleeves the patient is required to wear for the rest of their lives (Degnim et al., 2012).

Manual lymph drainage involves light, gentle massage strokes in order to improve circulation of the lymphatic system. This improved circulation is important to remove fluid from the interstitial place by improving reabsorption (Lacomba et al., 2010). Skin care is incredibly important in order to avoid skin infections that come about from the excess skin and stagnant fluid (Gautam et al., 2011). Compression bandaging helps to passively encourage circulation and filtration of the lymphatic system when used in conjunction with elevation. Finally, exercise is important as skeletal muscle movements help to actively encourage circulation of the lymphatic system, helping to return the limb to a normal size (Kim et al., 2014).

A study by Gautam et al. looked at the effectiveness of a home exercise program on lymphedema and the QOL in female postmastectomy patients. The program was individualized, and as accompanied by telephone calls to monitor their progress weekly. Statistically significant differences were found in both QOL and volume reduction in the upper limb following the 8 week program. However, this study did not include any self-manual lymph drainage as only exercises were included in the home program. A case report by Holtgrefe looked at a decreased frequency of CDP, with the patient only receiving the treatment 2 times per week instead of the recommended 5. The report showed that the patient still had a reduction in the bilateral lower extremity lymphedema volume equivalent to that of a traditional 5 days per week program, however a longer
time frame was needed to achieve these results-8 weeks versus 4 weeks. The aim of this study was to look at the effect of the emphasis on self-manual lymph drainage as part of a home program, to determine the efficacy of such an intervention when the number of clinic visits were reduced.

This study utilized manual lymph drainage techniques from the Vodder method, which aims to increase the effectiveness of lymphatic pumps by moving and/or stretching the skin using high pressure (working phase) and zero pressure (resting phase). Light pressure is used for acute onset lymphedema, but increased pressure can be used with more fibrotic tissue, as long as it does not cause redness (Struble, 2001). It employs 4 different strokes, chosen based on the area of the body. The strokes are performed in 2 phases, a working and a relaxation phase. For this case patient, the strokes were applied to the trunk, neck, and left upper extremity, according to the Vodder method.

**Normal Anatomy**

The lymphatic system is made up of two interconnected drainage systems: a superficial drainage system and a deep drainage system (Morrell *et al*., 2005). The superficial drainage system is located in and drains the skin and subcutaneous tissues. It generally run with veins, whereas the deep drainage system drains muscles, tendons, nerves, periosteum, joints, and internal organs, and generally runs with arteries (Myers, 2012; Struble, 2012). These two drainage systems are connected by perforating vessels to help drain lymph throughout the body. The lymphatic system also contains lymphatic capillaries (also called initial lymphatics), which are a two-dimensional network composed of millions of open-ended vessels. These are housed in the reticular dermis, which helps to form more of a three-dimensional drainage system. Lymphatic capillaries
are highly permeable due to an incomplete basement membrane, and their 100µm
diameter, which makes them wider than blood vessels (Goodman & Fuller, 2009; Myers,
2012). These capillaries are connected to collagen and elastin fibers within the
extracellular matrix by anchoring filaments. When pressure increases within the
interstitium, the filaments get pulled, which then opens the lymphatic channels.
Additionally, due to their large diameter and increased permeability, these lymphatic
capillaries are able to absorb larger particles such as proteins and bacteria from within the
interstitium (Myers, 2012; Struble 2012). Once the fluid is absorbed into the lymphatic
system, it is now called lymph fluid or simply lymph. Lymph fluid is made up of water,
proteins, dead or dying cells and their cellular components, fatty acids, foreign material,
and debris (Morrell et al., 2005). All of these parts together are collectively known as the
lymphatic load (Myers, 2012).

The lymphatic capillaries lead into slightly larger vessels called precollectors,
which measure about 150µm in diameter. Precollectors have a tight endothelial junction,
a few unidirectional valves (to direct lymphatic flow), and three underdeveloped layers of
smooth muscle. These precollectors then flow into larger lymph collectors, which range
from 100-600µm in diameter. Lymph collectors are similar to veins in the sense that they
have well-developed muscular walls, consisting of the tunica intima, tunica media, and
tunica adventitia (Goodman & Fuller 2009; Myers, 2012). Within the lymphatic system,
there are valves that divide it into functional units, which are called lymphangions. On
average, typical arm lymph collectors have 60-80 lymphangions whereas typical leg
lymph collectors have 80-100 lymphangions (Myers, 2012). These lymphangions are
considered the ‘lymphatic microhearts’ because they have peristaltic contractions that go
along with valves opening and closing to prevent backflow of the lymph fluid (Struble, 2001).

Figure 1: Lymphatic capillaries


Lymph flows through this series of progressively larger vessels towards clusters of regional lymph nodes, which can be round, oval, kidney-shaped, or spindle-shaped, and can range in size from 0.2-3cm. Typically, an adult has 600-700 lymph nodes. However, the greater the size of the lymph node, the fewer nodes there will be in that region. They are arranged in a string-like fashion, and serve as filter stations in which lymphocytes (specialized white blood cells) identify and destroy foreign material, as well as assisting in normal immune function. When lymph nodes have to be surgically removed, such as is the case with cancer, the filtration capacity is decreased, possibly impeding lymph transport and increasing the risk of local infection. However, there are some collateral lymph collectors that skip over regional lymph nodes, which can be a
very valuable drainage mechanism if nodes are surgically removed or have become damaged (Myers, 2012).

The last two pieces of the lymphatic system are the right lymphatic duct and the thoracic duct. All of the lymph fluid eventually will have to pass through all the aforementioned lymph nodes and territories, where it will end up in one of these two ducts (Goodman & Fuller, 2009). The right lymphatic duct drains lymph from the right side of the head, upper extremity, and thorax. It drains approximately 25% of the body’s lymph, and ends in the right subclavian vein to allow the lymph to join venous circulation. The thoracic duct is much larger, draining the remainder of the body (the left upper quadrant, and lower extremities), ending by moving the lymph fluid into the left subclavian vein, enabling it to join with venous circulation (Struble, 2001).
A lymphatic territory is an area of skin that is made up of several adjacent lymph node collectors draining into the same regional lymph nodes. These lymphatic territories are separated by watersheds, natural boundaries between the territories. Generally, the lymph will flow from the periphery of a watershed towards the regional lymph nodes (Myers, 2012). The sagittal watershed divides the body into right and left sides, whereas the horizontal watershed, which is located near the umbilicus, divides the body into superior and inferior portions. In a healthy individual, most lymph flow will flow within one quadrant as these watershed regions prevent drainage from one quadrant to another. Nonetheless, the anatomy of the lymphatic capillaries and anastomoses allows flow from an ineffective quadrant or watershed to a healthy one in the case of a disruption, such as
lymphedema (Struble, 2010). Firstly, because there are no valves in the lymphatic capillaries, lymph fluid is able to flow in any direction, so it will naturally flow from an area of higher lymphatic pressure to an area of lower lymphatic pressure. This is a local phenomenon, and generally only occurring with a two to three centimeter overlap due to the small size of the lymphatic capillaries. Secondly, there are interterritorial anastomoses, which allow regional lymph nodes from one area to use regional lymph nodes from another area as an alternate or supplemental drainage system. These anastomoses are generally located when there are short distances between regional lymph nodes (Myers, 2012; Struble, 2001).
Figure 3: Lymphatic watersheds, lymphatic anastomoses, and lymphatic territories

Normal Physiology

The movement of fluid in the lymphatic system is governed by osmotic and hydrostatic pressure gradients, according to Starling’s Law of Capillaries, forcing fluids to flow from high pressure areas to low pressure areas (McClure et al., 2010; Struble, 2001). Essentially, arterial pressure is greater than the pressure in the interstitial space, which causes water to push into the interstitium on arterial ends of capillary beds. However, the opposite is the case at the venous end of capillary beds, where interstitial pressure is greater than the intracapillary pressure, and 80-90% of fluid is reabsorbed into the capillary. The basement membrane of the capillaries is semi-permeable, which allows about 50% of the circulating plasma to enter into the interstitium every day (Myers, 2012). Under normal circumstances, slightly more fluid gets filtered out of the capillaries and into the interstitial space than gets reabsorbed from the interstitial fluid back into the plasma (Struble, 2001). When interstitial pressure is greater than intralymphatic pressure, water and proteins flow into the lymphatic system, producing lymph. In a healthy individual, lymph will move centrally in a number of different ways. Firstly, the contraction and relaxation of skeletal muscles allow for alternate compression and decompression of the lymphatic vessels. This allows for the lymph to flow centrally through the unidirectional valves. Secondly, a respiratory pump assists in moving fluid through the chest by way of alternating pressures. Thirdly, the pulsating aorta assists with movement of lymph through the lymphatic duct due to their close proximity to each other. Fourthly, the smooth muscle within the lymphangions spontaneously contracts, propelling the lymph centrally. This is called lymphangiomotoricity and happens approximately three to twelve times per minute, which is key in decreasing edema.
overnight while patients are supine and the lower extremity lymphatics are in a position of decreased gravity. This lymphangiomotoricity is also very important in patients who are immobile or who have had motor neuron damage. Additionally, the rate of lymphangiomotoricity can elevate to twenty times per minute with exercise, and can increase with sympathetic stimulation (Myers, 2012).

**Edema and its Types**

**Non-Pitting Edema**

![Edematous ankle](http://www.atlanticpodiatry.com/blog/tag/ankle+trauma.html)
Edema is an excessive and abnormal accumulation of interstitial fluid, due to a temporary inability of the body to remove excess fluid. This occurs as the rate of capillary filtration surpasses the limits of the lymphatic drainage. This results in a noticeable enlargement of the affected body area, as well as other clinical signs and symptoms. Traditional edema (also known as non-pitting edema) contains mostly water and is relatively acute, whereas lymphedema is an accumulation of a protein-rich fluid and is longer-lasting (Myers, 2012; O’Brien et al., 2005; Trayes et al., 2013). Non-pitting edema can occur in a generalized or localized form, and is treated based on the underlying cause (Goodman & Fuller, 2009). Major causes of edema include: venous obstruction (which is quite common in the lower limbs), increased capillary permeability, pregnancy and increased plasma volume secondary to sodium and water retention, which is a common side effect of medication. These are often due to heart, liver, or kidney failure, as well as an infection. Edema will persist due to compensatory mechanisms geared towards maintaining plasma volume until the body is able to return to its homeostatic state (O’Brien et al., 2005; Trayes et al., 2013). Generalized edema is often bilateral and characterized by shortness of breath, ankle swelling, changes in blood pressure, an increased respiratory rate, and/or abnormal laboratory findings (including electrolytes, serum creatinine, blood urea nitrogen, and hemoglobin) (Goodman & Fuller, 2009).
Pitting Edema

Figure 5: Pitting edema

Pitting edema is a form of edema that, when pressed with the thumb, leaves a dent in the skin for several seconds due to the fluid in the tissues. This dent will slowly fill back, and the pitting edema is scored based on the depth of the pitting and the length of time taken to re-fill the compressed area (Goodman & Fuller, 2009). It is essential to document the location (as well as unilateral versus bilateral), re-fill time, and the depth of the pitting in order to determine the cause and appropriate treatment response (Trayes et al., 2013). In the ambulatory patient, pitting edema generally begins distally in the foot or ankle, and ascends up the leg(s). It is most remarkable at the end of the day, and will decrease after a night’s rest or a period of prolonged elevation. However, in the bed-
bound or recumbent patient, this pitting edema presents initially in the pre-sacral area, and will advance to the medial thigh(s) and genital area (Goodman & Fuller, 2009). In the lower extremities, pitting edema is most often associated with venous disease, and commonly affects the medial malleolus, the bony portion of the tibia, and/or the dorsum of the foot (Trayes et al., 2013).

Myxedema

Figure 6: Pretibial myxedema

Myxedema is a form of edema, due to hypothyroidism or hyperthyroidism. If due to hypothyroidism, it will present with a dry, thick skin and non-pitting periorbital edema. The skin over the knees, elbows, palms, and soles of the feet will appear yellow to orange in discoloration (Trayes et al., 2013). If associated with hyperthyroidism, it is termed
pretibial myxedema, and is a rare autoimmune manifestation of Grave’s disease, occurring in approximately 4% of cases (Gopie et al., 2011). While associated with Grave’s disease, myxedema generally doesn’t present until one to two years after the initial diagnosis, and generally presents with severe Graves’ opthalmopathy. This form presents with diffuse non-pitting edema on the shins, looking similar to lymphedema. It also can present with nodules or plaques on the shins. Pretibial myxedema is generally asymptomatic and self-limiting, but severe cases can be treated with corticosteroid injections, topical corticosteroids, and compression therapy with good outcomes (Kim et al., 2014).

**Lymphedema**

![Figure 7: Leg affected with lymphedema](http://www.riversideonline.com/health_reference/Disease-Conditions/DS00609.cfm)
Lymphedema will occur whenever one portion of the lymphatic system fails, therefore disrupting the flow and balance of the lymph fluid. This disruption can be an acquired interruption occurring when the system is stressed, thus showing an inadequacy in the system due to anatomical abnormalities, or it can occur after various medical interventions, such as radiation therapy or surgery. Once the damage has occurred, proteins lead from the capillaries and into the surrounding tissues, causing edema as they no longer can be removed by the lymphatic system (Lacomba et al., 2010; McClure et al., 2010; Struble, 2001). Lymphedema can occur in all four limbs, the trunk, and the breasts. However, it is more common to affect the extremities, with the upper extremity being substantially more common than the lower extremities (Degnim et al., 2012).

Primary Lymphedema. Lymphedema is classified as either primary or secondary, with secondary lymphedema being substantially more common (Holtgrefe, 2006). Primary lymphedema is classified as a dysplasia of the lymphatic system, and can either be a hypoplasia or hyperplasia. Hypoplasia involves an incomplete development of lymph vessels and/or a decreased diameter of vessels. Hyperplasia involves larger diameter lymph collectors, which can lead to lymphatic reflux (Zuther et al., 2013). This becomes evident either immediately following birth (congenital lymphedema), or later in life, during puberty or during a hormonal change (lymphedema praecox) such as pregnancy. Lymphedema tarda is extremely rare, occurring after age thirty-five, and very little is known about this condition (Holtgrefe, 2006; Struble, 2001; Zuther et al., 2013). It is believed to be attributed to a degeneration of smooth muscle in the lymphatic system, although more research is needed on the subject to confirm this hypothesis (Kim, et al., 2010).
Many researchers dispute the idea of anatomical abnormalities as the cause of lymphedema (Holtgrefe, 2006; Struble, 2001; Zuther et al., 2013). This is likely due to the fact that although people may be born with these abnormalities, there are many patients who never have any overt signs of lymphedema as the reduced transport capacity of the lymphatic system may still be able to meet their needs. However, some studies have shown that minor traumas, such as a sprained ankle or insect bite, may trigger lymphatic system fatigue or overload with these patients (Myers, 2012; Zuther et al., 2013). While these traumas may trigger lymphedema, it occurs almost exclusively in the lower extremities and affects females more than males. Regardless of the cause of primary lymphedema, it is still treated the same as secondary lymphedema (Zuther et al., 2013).

**Secondary Lymphedema.** Secondary lymphedema can arise from a variety of causes, such as tumor compression or obstruction of a lymphatic vessel, but it most notably arises from cancer treatments (Morrell et al., 2005; Taylor et al., 2006). It does not always develop immediately following treatment, but has been documented as occurring up to thirty years post-treatment, with most occurrences in the first twelve months (Lacomba et al., 2010; Struble, 2001). It is characterized by incompetent valves that allow lymph to flow towards the skin, in a phenomenon called “dermal backflow” (Struble, 2001). These treatments include radiation, chemotherapy and lymph node removal. Although it can arise following a battle with any type of cancer, breast cancer has the highest subsequent lymphedema rate (Taylor et al., 2006). This is especially true with upper limb lymphedema, as nearly all upper limb lymphedema cases are related to breast cancer and its subsequent treatments (Kim et al., 2010). This is likely due to the
fact that metastatic spread to the axilla and axillary lymph nodes is the strongest 
prognostic factor in breast cancer cases, and occurs in about 30% of all breast cancer 
cases (Morrell et al., 2005).

Cancer diagnosis and treatment can disrupt lymph flow leading to lymphedema, 
especially the treatments for breast cancer, such as radiation therapy. A disruption in 
lymphatic flow can also come from the surgical resection of axillary lymph nodes that is 
used to stage and/or control breast cancer. This disruption creates a build-up of pressure 
within the vessel walls, which leads to distention. Eventually, this distension leads to a 
blockage in fluid transport, obstructing the main route for lymph fluid to exit the upper 
extremity, which results in lymphedema (Myers, 2012). It is estimated that 
approximately 80% of patients who have undergone an axillary lymph node resection 
will suffer from lymphedema at some point in their lifetime (O’Brien et al., 2005). There 
have been numerous studies showing a correlation between the severity of lymphedema 
and the number of lymph nodes removed, with more aggressive surgeries taking more 
nodes having a higher incidence of lymphedema (Struble, 2001). However, newer 
surgical methods, such as sentinel lymphadenectomy and lymphatic mapping are 
becoming more frequent, and have been shown to minimize negative effects of the 
surgery. Radiation therapy also can lead to lymphedema, most commonly in the upper 
extremity or breast (Morrell et al., 2005). Lymph nodes are especially susceptible to 
radiation, as the radiation generally leads to vessel wall fibrosis, which impedes their 
ability to filter fluid normally (Bicego et al., 2006). The risk of lymphedema with 
radiation increases as treatment is directed closer to the regional lymph nodes (Morrell et 
al., 2005). Additionally, since lymph is not flowing properly in these areas, a breeding
ground for bacteria is created, making these patients increasingly susceptible to infection (Bicego et al., 2006).

A review by Meek found that patients who have undergone axillary radiation therapy without resection tend to develop lymphedema later than patients receiving a combination of radiation therapy and axillary lymph node resection (Meek, 1998). Unfortunately, many patients today receive a combination of these treatments, which can increase their risk for lymphedema by at 7-8% (Struble, 2001). However, education of patients and caregivers on the early signs of lymphedema and earlier treatment of lymphedema has been shown to more effective than starting treatment in the latter phases of lymphedema (Lacomba et al., 2010).

**Diagnosing Lymphedema**

While lymphedema is not curable, it is treatable with proper diagnosis and treatment (Struble, 2001). At the current time there is not just one single diagnostic criterion to determine whether or not a patient has lymphedema, which has led to variations in incidence rates (Lacomba et al., 2010). However, all of the diagnostic tests compare the affected limb against the unaffected limb (Kim et al., 2010). The most common diagnostic criterion for lymphedema is a patient showing a difference of two cm or greater at any measurement point on a limb compared with the contralateral upper limb. However, critics of this criterion cite the fact that this difference may not even be noticed in overweight or obese women, and therefore they may be dissuaded from seeking treatment. Additionally, some studies have classified this difference as clinically significant, whereas other studies have classified this as only mild lymphedema (Bicego et al., 2006). Another diagnostic set point is a difference of 200cm, or, a greater than 10%
increase in the volume ratio between arms (Lacomba et al., 2010; Gautam, 2011). This is an area that requires more research, which will help lead to better diagnoses and treatments for future patients. Research is needed to determine what is the most accurate determinant of lymphedema, whether it is a two cm difference between limbs, a 10% or greater increase in volume ratio, or another criterion yet to be discovered. Additionally, research is needed to determine if a diagnosis of lymphedema is necessary to initiate treatment, or if treatment can still be successful without a concrete diagnosis, as the degree can vary greatly between individuals (Kim et al., 2010; Taylor et al., 2006).

Measurement of Lymphedema

Currently, there are many different ways used to measure the extent of a patient’s lymphedema. Some of these methods include circumferential measurement, water displacement, bioelectrical impedance spectroscopy, perometry, tonometry, lymphoscintigraphy, and other self-report tools. Circumferential measurement is the most commonly used method in the clinical setting, however others will also be discussed in detail. Due to the fact that patients can have varying degrees of lymphedema, it is more important to measure the degree of lymphedema as opposed to having a concrete diagnostic set point. It is for this reason there are many different ways to measure lymphedema (Bicego et al., 2006; McClure et al., 2010; Perdomo et al., 2014; Taylor et al., 2006).

Measurement of lymphedema: circumferential. The most commonly used and clinically practical way to measure differences in arm circumference is by using a tape measure at various positions on the arm. In this method, the therapist would take measurements on both sides of the body, the same distance away from a designated
anatomical landmark using a flexible, retractable tape measure. Then, the clinician will compare the affected and unaffected limbs to determine the extent of the swelling (Kim et al., 2010; Lacomba et al., 2010; Taylor et al., 2006). By using the ratio comparing the affected and unaffected limbs, there is a reduction in errors that could be correlated with patient characteristics, such as body mass index (Lacomba et al., 2010). These objective measurements taken at each visit help to quantify the recovery for patients, providing an additional source of motivation for patients (Struble, 2001).

There are two common ways to ensure the measurements can be replicated as the patient progresses through therapy. The first bases the circumferential measurements on their distance from the fingertips, with various set points between fingertips and 30-60cm from the fingertips. Opponents state the problems with this method include different arm lengths among women as positions related to anatomy would be different, and having to cross the elbow joint. These problems lead to implications of the validity of this method. However, Taylor et al., has found the interrater reliability of this measurement to be 0.98-0.99 (Taylor et al., 2006).

The other commonly used method bases the circumferential measurements on their distances from anatomical landmarks, such as the olecranon process or the styloid process. Taylor et al. found the interrater reliability of this to be 0.97-0.99, and to be more valid than circumferential measurement based on distances from fingertips, likely due to the fact an anatomical landmark is used for each measurement, instead of just a body length (Taylor et al., 2006).

**Measurement of lymphedema: volumetric.** Volumetric measurement of the affected versus unaffected limb is widely considered as the most accurate measurement
technique, as Megens et al. and Sander et al. found an intraclass correlation coefficient of 0.99 for intrarater reliability (Taylor et al., 2006). These volumetric measurements are taken using a volumeter filled to a set point with water. The patient then submerges their affected arm, and the clinician measures the amount of water displaced. As with circumferential measurement, the process is repeated on the contralateral limb to determine a control measurement (Struble, 2001). However, it is difficult to ensure arms are submerged to the same level with each measurement, creating some intrarater reliability difficulties. Additionally, due to the fact that it is time consuming, not portable, and isn’t necessarily convenient for practitioners, it is not widely used in the clinical setting (Taylor et al., 2006). Another way that is infrequently used to measure the volume of the limbs is to use geometric equations based on the assumption that the limb is shaped like a cylinder, truncated cone, rectangular solid, or a trapezoidal solid. The clinician takes measurements of the limb and inputs them into one of the aforementioned shapes, with the truncated cone showing the greatest accuracy, with the smallest standard error of measurement. However, this method is generally time consuming and may require the use of computer programming to determine volumes. Therefore, this method is rarely used in the clinical setting (Taylor et al., 2006).

**Measurement of lymphedema: other.** Other ways to take lymphedema measurements involve perometry, lymphoscintigraphy, or using a bioelectrical impedance analysis system (Morrell et al., 2005). Perometry is the use of a frame with an infrared light. The arm is positioned in the frame, and readings are taken every 0.4cm. Then, the volume is computed using specialty software by computing the summation of elliptical segment volumes. This method has been proven reliable, easily (and highly)
reproducible, as well as convenient with only a few seconds required for each measurement. However, the software used to compute the volumes is still very specialized and costly, therefore is not widely used in the clinical setting (Taylor et al., 2006).

Lymphoscintigraphy is the use of a radiotracer, such as technetium Tc99m-filtered sulfur colloid, to determine if there have been changes to the flow of the lymphatic system, and can also be used to determine the extent of the spread of metastases if they have invaded the lymphatics. Additionally, this method of diagnosis has been shown to be effective in distinguishing lymphedema from other causes of edema, such as lipedema or venous edema. However, due to the technical nature of this method as well as the time and equipment required, this method is generally only used for research purposes (Morrell et al., 2005; Struble, 2001).

Bioelectrical impedance uses the measurement of the amount of extracellular fluid in the arm, by reporting the resistance level to a low-frequency electrical current. Low-frequency currents travel outside cells through extracellular fluid, thus the resistance is related to the amount of extracellular fluid, which includes lymph fluid. This method has been shown to be a more sensitive measure than manual girth measurements, or volumetric measurements taken by the use of a truncated cone formula. However, it is not used often in the clinical setting due to the time and equipment required to use this method (McClure et al., 2010).

All of these techniques are as accurate as circumferential measuring, however they have many clinical limitations—they are time consuming to use, involve injections, or are expensive to purchase. For these reasons, circumferential measurements made with
a tape measure are the most common clinically used measurements. This is also an area in which more research is needed. Research is needed to determine if circumferential measuring is accurate across subsequent treatments due to changing limb volumes. It is also needed to determine if there is a different cost- and time-efficient way to accurately measure limb volume as treatment progresses (Taylor et al., 2006; McClure et al., 2010; Bicego et al., 2006).

**Negative Effects of Lymphedema**

Lymphedema is a debilitating disease including both physical and emotional symptoms, with the emotional symptoms often worse than the physical symptoms (Gautam et al., 2011). Some of the most prevalent physical symptoms reported by patients are heaviness, tightness or fullness, pain and swelling in the affected limb (Kim et al., 2010; Morrell et al., 2005). For many women, the first sign of lymphedema is that rings or clothing has become tighter in the affected arm, or socks are constricting on the affected leg (Struble, 2001). Most patients report arm heaviness and inflammation, and may also have other musculoskeletal damage such as muscle, tendon, or ligamentous damage as a result of breast cancer treatment (Taylor et al., 2006). As the lymphedema progresses, increases in pain, decreases in joint mobility, as well as skin changes are noted frequently (Morrell et al., 2005). This swelling, tightness, and pain often translate to decreased range of motion and mobility for the patient (McClure et al., 2010). Patients also need to worry about recurrent skin infections due to decreased fluid flow and changes in skin for the affected extremity (Bicego et al., 2006). It is shown that the stagnant, excess protein in the interstitial space serves as a readily available food source
for bacteria if there is a break in the skin, quickly allowing small skin breaks to become larger and more problematic if left untreated (Myers, 2012).

Emotional symptoms include a large decrease in QOL due to changes in their appearance and self-esteem (Kim et al., 2010). Also, a large percentage of patients also report depression and emotional distress due to being unable to hide their physical disfigurement when participating in social activities (Holtgrefe, 2006; Lacomba et al., 2010). In many cases, these emotional symptoms can be comparable to a patient receiving the actual diagnosis of breast cancer, and can last long after the affected limb has been restored to its original size and function (McClure et al., 2010).

Negative Effects of Lymphedema: Functional. Patients suffering with breast cancer related lymphedema often report a wide range of functional impairments, most relating to the upper extremity. The most common of these include the feeling of heaviness in the limb, breast, or trunk; and a decreased range of motion, strength and/or coordination of the limb that creates difficulties with functional tasks (Davies et al., 2014). As the lymphedema progresses, joint range of motion is decreased, leading to an inability to complete activities of daily living (Morrell et al., 2005). Many women report being unable to hook/unhook their bra, wash or style their hair, as well as performing cleaning or other household chores (Struble, 2001). Most patients report that the increase in swelling leaves them with difficulties in pushing, pulling, twisting, carrying, and grasping (Zuther et al., 2013). Furthermore, for decades strenuous activity has been discouraged for lymphedema patients, and many physicians still discourage patients from using the affected limb, despite research indicating otherwise. This lack of use leads to weakness, and predisposing the limb to further injury, even from a small household task. This fear of
use is also a barrier to exercise, which can also decrease quality of life scores (Gautam et al., 2011).

One way clinicians are able to assess functional disability is by using functional outcome measures. One commonly used outcome measure in upper limb lymphedema is the Disability of Arm, Shoulder and Hand questionnaire (DASH). Since this questionnaire takes an average of five to ten minutes to complete and is easy to score, it is widely used in the clinical setting, as it allows patients to self-report their difficulties with functional tasks using the shoulder, arm, and hand. It has been validated and rated as ‘highly recommended’ for use in this population by the Breast Cancer Evaluation Database Guide to Effectiveness Task Force (or Breast Cancer EDGE Task Force). The other questionnaire rated as ‘highly recommended’ by the Breast Cancer EDGE Task Force is the Functional Assessment of Cancer Therapy-Breast (of FACT-B +4), as it has excellent reliability, sensitivity to change among patients with breast cancer, and internal consistency. This tool measures five domains: physical well-being, social/family well-being, emotional well-being, functional well-being, and arm morbidity, with questions within the arm morbidity domain pertaining to swelling and tenderness (Davies et al., 2014).

The musculoskeletal system is affected greatly during the course of lymphedema and its treatment. Due to the large limb volume, additional strain is placed on the joints, which could lead to muscular or ligamentous damage. A large intramuscular imbalance is also very common in this population. Additionally, range of motion is lost in the joints due to this additional strain as well as a lack of use. This leads to decreased strength, flexibility, and endurance in the musculature. Patients then struggle often struggle with
daily tasks, creating compensatory strategies that may not be biomechanically correct, leading to additional problems. Therapeutic exercise is often used during the treatment phase to combat these difficulties—to increase strength, endurance, and flexibility, as well as help restore intramuscular balance and normal biomechanics (Struble, 2001).

**Negative Effects of Lymphedema: Neurological.** One of the risks associated with surgeries and radiation therapy to treat malignancies is the risk of injury to peripheral nerves or the spinal cord. If any nerves are damaged with the cancer treatment, it can be detrimental for the patient during lymphedema treatment, as immobility decreases lymphatic return. Additionally, exercises may have to be modified due to the lack of motor control of limbs during certain movements (Zuther et al., 2013).

Lymphedema patients are also at risk for reflex sympathetic dystrophy (RSD), which is due to a disturbance in the sympathetic nervous system, and affects all tissue layers. While this generally is caused by a traumatic injury to a nerve, neural plexus, bone, or soft tissue, it can also be caused by the excess protein-rich fluid that can be present in the muscle tissues, tendons, and joint cavities present in lymphedema. RSD can have components of pain, edema, autonomic dysfunction, movement disorder, and trophic changes, although pain is the common denominator among patients with RSD. Clinicians must treat the RSD with a goal of controlling/minimizing pain in order to prevent progression and restore full function to the limb, while they use manual lymph drainage to increase lymphatic drainage to remove lymph. Compression bandaging or compression sleeves are contraindicated in the RSD patient (Zuther et al., 2013).

**Negative Effects of Lymphedema: Psychological.** As noted above, many breast cancer survivors find lymphedema more physically and emotionally challenging than
breast cancer (Gautam et al., 2011). Taylor et al. (2006) concluded that “Quality of life may be affected by disfigurement, discomfort, and disability associated with arm and hand swelling” (p 206). This is due to the fact that hiding the loss of function and the physiological changes that occur with lymphedema is much harder than with cancer and its associated treatments (Gautam et al., 2011). In fact, breast cancer survivors who suffer from lymphedema suffer depression, anxiety, and emotional distress much more often than survivors without lymphedema do (Lacomba et al., 2010). Patients with higher levels of edema and larger limbs report higher levels of distress, and lower scores on quality of life indexes, likely due to decreased social interaction and self-esteem (Degnim et al., 2012; Kim et al., 2010). While the lymphedema symptoms may be under control, patients are never able to fully put it out of their mind. Several precautions they will have to take for the rest of their life include: no blood draws, injections, or blood pressures on the affected limbs; wearing gloves when completing housework, gardening, or any activity that could result in an injury; avoiding manicures to avoid the risk of infection; wearing compression garments while traveling by air, and many more. Furthermore, many patients must wear a compression sleeve every day, which often makes them feel self-conscious and hesitant to go out (Struble, 2009). Additionally, the psychological morbidities appear to remain even after the lymphedema has been decreased and treatment is discontinued (McClure et al., 2010).

**Treatment of Lymphedema**

Currently, there is a specialized set of treatments for lymphedema patients called Complex Lymphedema Therapy or Complete Decongestive Physical Therapy (CDP or CDT) performed by Certified Lymphedema Therapists (CLT’s). This type of therapy
generally involves four interventions: manual lymph drainage, fastidious skin care, compression bandaging, and exercise. CDP is recommend to be performed five days per week and lasts approximately four weeks on average for the first phase of clinic-heavy treatment, generally in the outpatient setting. However, the longer lymphedema goes undiagnosed, the longer the treatment time will be as the tissue is generally more fibrotic by this time (Holtgrefe, 2006; Morrell et al., 2005). Manual lymph drainage involves light, gentle massage strokes in order to improve circulation of the lymphatic system. This improved circulation is important to remove fluid from the interstitial place by improving reabsorption (Lacomba et al., 2010). Skin care is incredibly important in order to avoid skin infections that come about from the excess skin and stagnant fluid (Gautam et al., 2011). Compression bandaging helps to passively encourage circulation and filtration of the lymphatic system when used in conjunction with elevation. Finally, exercise is important as skeletal muscle movements help to actively encourage circulation of the lymphatic system, helping to return the limb to a normal size (Kim et al., 2010).

A study by Liao et al. (2012) showed that the longer a patient has had lymphedema before obtaining treatment also affects how well treatment interventions work in treating the symptoms and causes of lymphedema, as increased chronicity decreases the effectiveness of CDP. Furthermore, increased age also contributes to decreased efficacy of CDP (Liao et al., 2012). Additionally, when patients are able to receive all four interventions simultaneously there are greater improvements made than when three or fewer interventions are used (Holtgrefe, 2006; Struble, 2001). More research is needed in this area to determine if it is ever too soon to begin lymphedema
treatment in order to offset any potential symptoms that may occur after breast cancer treatments.

Unfortunately, symptoms can recur at any point during the patient’s lifetime. Successful maintenance of the initial self-care program, which includes the home self-manual lymph drainage, compression bandaging or use of a compression sleeve, skin care, and individualized therapeutic exercises, will determine the long-term effectiveness of the CDP. Therefore, it is essential for clinicians to successfully teach all components of the home program to ensure understanding of patients (Lasinski & Boris, 2002).

The presence of infection is currently the only portion of treatment where pharmacological treatment is indicated, as diuretics or other classes of medications have shown no significant benefit to patients in the treatment of lymphedema (Morrell et al., 2005). Rather, diuretics have actually been shown to cause further damage in some cases by concentrating protein in the tissues since they remove water from the tissues (Struble, 2001).

**Treatment Interventions: Manual Lymph Drainage**

Manual lymph drainage involves light, gentle strokes in order to improve circulation of the lymphatic system. This improved circulation is important to remove fluid from the interstitial place by improving reabsorption (Lacomba et al., 2010). The three main types of manual lymph drainage were created by Drs. Emil and Estrid Vodder, Professors Michael and Etelka Földi, and Drs. John and Judith Casley-Smith. Each method is named for the researcher who pioneered the treatment. While they all have similar goals (improving circulation of the lymphatic system), they all have different methods. These methods will be detailed below.
**Treatment Interventions: Compression Bandaging**

The compression portion of the treatment includes several types of compression—compression bandages, compression garments (or compression sleeves), gradient compression devices, and/or pneumatic compression devices to help mobilize lymph fluid (Morrell et al., *et al.*, 2005). Compression bandages are used to initially reduce the limb volume in order to fit the patient for a custom compression sleeve. These bandages are a short-stretch (or low-stretch) elastic compression stocking (Lasinski & Boris, 2002). When applying these bandages, clinicians (and patients in their homecare program) begin at the distal end of the limb (Struble, 2001). They begin with applying a gauze sleeve and some padding (Casley-Smith *et al.*, 1998). Then, the bandages are wrapped so as to create more compression at the distal end without simply pulling the bandages tighter. This is accomplished by increasing the amount of overlap and/or increasing the number of layers. While range of motion will be diminished with compression bandages in place, the patient should still be able to complete their exercise regimen and activities of daily living with these bandages in place (Struble, 2001).

A study by Casley-Smith, Boris, Weindorf, and Lasinski (1998) has shown that most of the reduction in limb volume occurs in the first seven to ten days of treatment (Casley-Smith *et al.*, 1998). Clinically, most patients will utilize compression bandages during this time frame, then will order a compression sleeve as their reduction plateaus (Struble, 2001). Compression sleeves come in standard sizes or can be custom-made to fit the patient’s limb measurements, however custom-fit garments are generally very costly with a long production time. These sleeves range in pressure from 20-60mmHg, depending on the limb(s) and severity of the lymphedema, as well as other medical
Factors for that patient (Lasinski & Boris, 2002; Zuther et al., 2013). Compression sleeves generally last for four to six months, and need to be replaced at that time (Struble, 2001). They come in a wide variety of styles for the hand, arm, and leg, to ensure that the sleeve will stay in place during exercise or activities of daily living (Zuther et al., 2013).

Compression devices (or compression pumps) are most commonly used in more severe cases of lymphedema, as they have several risks involved with their use. These risks include possible damage to the vasculature, and they can be arduous for patients with physical or emotional difficulties. Furthermore, they are contraindicated in patients with congestive heart failure, active infection, or a deep vein thrombosis (Morrell et al., 2005). There are two types of pumps, single chambered and multiple chambered. Single chambered pumps inflate all at once then release, whereas multiple chambered pumps will generally inflate distally to proximally, and thus are tolerated better. Research has not shown that one is more beneficial than the other, so patient tolerance is a key factor when deciding between the two (Struble, 2001). They are generally used for thirty minutes to several hours, and they are still in addition to other treatments (compression sleeves, manual lymph drainage, etcetera) (Morrell et al., 2005).

Treatment Interventions: Fastidious Skin Care

Skin care is a vital part of lymphedema therapy, as the skin is the first line of defense against infection. Patients who suffer from lymphedema are at an increased risk of skin infections due to the stagnant increased protein concentration and temperature of the affected limb. This static protein-filled fluid creates a breeding ground for bacteria so even a minor cut or injury (such as a nick to the cuticle during a manicure or a sunburn) can have dire consequences as patients have decreased wound healing capabilities.
(Struble, 2001). Additionally, many lymphedema patients present with various skin changes, such as scarring, dry or scaly skin, or skin hyperplasia or plaques. These create challenges for the clinician, as they must be dealt with during CDT (Zuther et al., 2013).

Patients also must learn prophylactic measures to avoid integumentary complications. Some of these measures include maintaining clean, resilient skin, avoiding trauma, and learning to dry skin thoroughly (Struble, 2001). Patients are taught how to properly clean and moisturize the skin, inspect the skin for any wounds, and what ointments are suitable for their skin in its fragile state (Zuther et al., 2013). These prophylactic measures are important, as the rates of cellulitis and lymphangitis are high in this population, as simply having lymphedema predisposes patients to these infections due to the stagnant nature of the protein-rich fluid in the limbs (Gautam et al., 2011).

**Treatment Interventions: Exercise**

Therapeutic exercise is also a vital component to complex lymphedema therapy, as it can aid in reducing the stasis of lymph fluid by increasing lymphatic fluid clearance (Gautam et al., 2011). The exercises used are chosen to aid lymph flow through the repeated contraction and relaxation of muscles, as well as to help mobilize joints, prevent muscle atrophy, and enhance overall daily function (Morrell et al., 2005; Struble, 2001). Each contraction of skeletal muscle provides the primary pumping mechanism for both lymphatic and venous drainage, stimulating the contraction of lymph vessels as they are innervated by the sympathetic nervous system (Bicego et al., 2006). Each clinician creates an individualized program, to maximize benefits for the patient, but the exercises are generally performed three times a week. The patient is to complete these exercises while the limb is compressed (whether with bandages or a compression sleeve), and is to
complete exercises at home as part of their home activities (Morrell et al., 2005). By having the limb compressed with exercise, lymphatic and venous return has been shown to improve, as well as fluid leaking into the interstitial space is minimized (Bicego et al., 2006). While each program will vary, they generally have a slow progression and also include a stretching program, with stretching exercises for the levator scapulae, upper trapezius, pectoralis major, as well as other internal and external rotators of the shoulder if necessary. Proprioceptive neuromuscular facilitation is also widely used in this population, with rhythmic initiation moving from passive to active-assisted to active moments in the diagonal patterns (Lacomba et al., 2010; Zuther et al., 2013).

In a study by Kolden et al. in 2002, it was shown that after completing their therapeutic exercise portion of treatment, patients showed statistically significant improvements in resting systolic blood pressure, flexibility, aerobic capacity, and strength (Bicego et al., 2006). This is very important for lymphedema patients, as many have lost significant amounts of strength and range of motion due to treatments, pain, and lack of use. Gains made in these areas aid in returning the patient to activities of daily living, such as lifting a bag of groceries with ease (Gautam et al., 2011). Additionally, scores on the Cancer Rehabilitation Evaluation System, Global Assessment Scale, and Life Functioning Scales all increased with exercise programs (Bicego et al., 2006). Additional studies quoted by Bicego et al. all reported statistically significant increases of quality of life, which were sustained at one- and three-year follow ups (Bicego et al., 2006). The individualized nature is important in this population, as individualized home exercise programs have been shown to significantly decrease circumference and pain, while increasing quality of life in lymphedema patients in eight weeks or fewer.
Standardized programs, while generally showing a decrease in limb circumference, don’t show the same significant decrease (Gautam et al., 2011; Kim et al., 2010).

While exercises used in clinical studies have been performed both in sitting and while standing, studies have shown that isotonic exercises with muscle shortening are best for increased lymph flow, with anywhere from fifteen to thirty repetitions at a lower weight being recommended (Gautam et al., 2011; Kim et al., 2010; Zuther et al., 2013). Isometric exercises are not recommended for this population, but flexibility and aerobic exercises are effective in this population for increasing endurance as well as aiding in decreasing the amount or degree of soft tissue contractures (Gautam et al., 2011; McClure et al., 2010). Regardless of the exercises chosen, it is important to ensure proper form is used with each of the exercise motion, especially for exercises chosen for the home exercise program to increase effectiveness and decrease the risk of injury (Gautam et al., 2011).

Diaphragmatic breathing has also been utilized effectively in this population, due to the fact that the thoracic duct traverses the diaphragm (McClure et al., 2010). The diaphragm controls breathing involuntarily, allowing for efficiency and a low oxygen consumption by muscles of ventilation. If the diaphragm isn’t functioning, individuals rely on the accessory muscles of inspiration, thus greatly increasing the work of breathing while decreasing the efficiency. However, patients can be taught diaphragmatic breathing to increase the efficiency of respiration (Kisner & Colby, 2007). Diaphragmatic breathing also creates a vacuum in the thoracic cavity, which aids in the drainage of lymphatic vessels (Gautam et al., 2011). This has been evidenced by numerous manual lymph drainage studies, as it is commonly used as a part of manual lymph drainage (McClure et
Diaphragmatic breathing is taught with the patient in a relaxed position, which allows gravity to assist the diaphragm. Patients are told to relax their accessory inspiration muscles, which can include shoulder rolls or shoulder shrugs. The practitioner or patient’s hand is placed on the abdomen, just caudal to the anterior costal margin. The patient is instructed to breathe in through their nose, slowly and deeply. The patient’s shoulders and upper chest should be relaxed, allowing their abdomen to rise minimally. The patient is then instructed to relax and exhale through their mouth slowly (Kisner & Colby, 2007). Additionally, clinicians should use ensure that breathing is completed correctly, with the ‘work’ phase of the exercise utilizing an exhalation, and the ‘rest’ phase of the exercise utilizing an inhalation (McClure et al., 2010).

Various exercise types involving relaxation techniques, such as yoga, tai chi, and qigong have also been shown to be effective in this population, as well as aerobic exercise. Cohen et al. and Ryu et al. showed that exercise programs focused on relaxation techniques aid in initiating improvements in emotional areas, as well as decreasing emotional stress (McClure et al., 2010). Aerobic exercises should be stressed in the lymphedema patient, even if patients have never exercised before, as physical activity aids in improving the flow of lymph fluid. Aquatic exercise is a good choice in this population as the water provides additional compression, however patients should ensure the temperature is less than 94°F. In patients who have been inactive, most clinicians recommend starting with walking for twenty minutes. However, regardless of the mode chosen, it is imperative for patients to complete their aerobic activity with compression applied, through short-stretch bandaging or a sleeve, to ensure maximum benefit is achieved (Zuther et al., 2013).
Manual Therapy Schools of Thought

While all researchers agree on the four fundamentals of lymphedema therapy (manual lymph drainage, compression bandaging, therapeutic exercise, and fastidious skin care), various researchers have come up with different methods of manual lymph drainage. The main methods are known as the Vodder Method, Földi Method, and the Casley-Smith Method (Struble, 2001).

Vodder Technique

One of the major contributors in the field of lymphedema therapy was Dr. Vodder Schule who coined and copyrighted the term ‘manual lymphatic drainage’ and created the Vodder Technique as a means of teaching other therapists his lymphedema treatment techniques. The goal of the Vodder technique is to increase the effectiveness of the lymphatic pumps. This is done by using high pressure (a process known as manual pushing) and zero pressure (a process known as manual contact). The therapist will employ the use of their hands to move skin in the direction of lymphatic flow, either by pushing or stretching the skin. Using this technique, physical therapists use light pressure for acute onset lymphedema, whereas more chronic lymphedema, especially cases with fibrotic tissue, requires the use of greater pressure, as long as it does not cause redness. After the pressure phase, the therapist begins a relaxation phase. During this phase, the therapist maintains manual contact with the skin but doesn’t apply any pressure. In fact, so little pressure is used that Vodder technique teachers are famous for saying “The weight of a fly is too much” when teaching this technique (Struble, 2001, p.10). It is important to note that there can be a visible reduction in volume after two weeks while using this technique if the patient is able to receive the therapy five times per week.
However, if the patient is only able to attend two sessions per week, the gains are substantially slower, often requiring four weeks instead of two before seeing a noticeable decrease in limb volume (Holtgreve, 2006).

The Vodder technique employs four basic strokes: “stationary circles”, “pumps” “ rotary”, and “scoop” in various patterns as deemed appropriate for the patient by the provider. Stationary circles use an oval-shaped stretching of the skin, using the entire hand or the palmar surface of the fingers. This is accomplished by using radial or ulnar deviation to create the half-circle shape. These strokes can be used on the entire body, but are most commonly applied on the neck and face. During the working phase, the stretch is originally applied perpendicularly to the lymph collectors, and finishes parallel to the collectors. After the working phase, the resting phase occurs, where the hand relaxes but still maintains contact with the patient’s skin. The elasticity of the skin then moves the hand passively to the starting position. It is good to note that stationary circles can be applied with one or both hands, and can be either alternating or simultaneously. They can be termed dynamic stationary circles if they are used in succession with one another across an area of the body (Zuther et al., 2013).
The next stroke Vodder used was called the pump. This stroke utilizes the entire palm as well as the proximal phalanges, and is performed almost exclusively on the extremities. This is a dynamic stroke, therefore moves distally to proximally, and can also be applied with one or both hands. However, if applied with two hands pumps need to be completed with alternating hands. The pump working phase starts with the hand on the extremity with ulnar deviation, wrist flexion, with the fingers extended and the thumb in opposition to the fingers. During this stroke, the pressure will increase and then decrease gradually as the wrist makes the transition to radial deviation and extension. The maximum stretch is accomplished when the entire palm has made contact with the extremity. The rest phase then begins, and once again, the elasticity of the skin carries the clinician’s hand back to the starting position. However, the next stroke is then completed.
by gliding the hand up one-half hand width proximally, without any pressure being applied while moving (Zuther et al., 2013).

Figure 9: Pump stroke

The third stroke created by Vodder was the scoop, which is a spiral-shaped movement generally performed on the distal extremities. This too is a dynamic stroke, being applied with one hand, or two hands in an alternating fashion. During the working phase, the hand begins being ulnarly deviated and pronated onto the skin, in a direction perpendicular to lymph collectors. To begin, the web space between the thumb and pointer finger is in contact with the skin. The clinician then glides over the skin in a spiral-like motion, moving in a proximal direction. As the hand glides, pressure will gradually increase, and the palm/palmar surfaces of the hands will come in contact with the skin. Finally, the fingers then glide over the skin so they are parallel to the extremity being worked on. The resting phase then commences, however the hand does not return to the position it started in. Rather, the next stroke begins approximately one-half hand width further proximally (Zuther et al., 2013).
The last of the four main strokes is the rotary stroke. This is generally employed on large surfaces, such as the trunk, but can be adapted for use on the extremity, generally using only one hand as opposed to the two hands used on the trunk. The clinician’s hand begins with the wrist in flexion, hand elevated, the fingers in a neutral position, and the thumb abducted about $90^\circ$. The working phase begins as the palm is placed on the skin over the ulnar side in an elliptical-type movement. While this is occurring, the thumb is also abducting so that the subcutaneous tissues are being stretched against the fascia and perpendicularly to the flow of lymph fluid. Once full contact is achieved with the hand, the skin is stretched further toward the drainage area, with increasing pressure. During the resting phase, the hand moves back into wrist flexion so that it is elevated again, and the fingers slide, maintaining contact with the skin but without applying pressure. The stroke is then repeated in this position (Zuther et al., 2013).
Figure 11: Rotary stroke

<table>
<thead>
<tr>
<th>Stroke:</th>
<th>Hand Placement:</th>
<th>Resting Phase:</th>
<th>Working Phase:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stationary Circles</strong></td>
<td>The entire hand or palmar surface of fingers can be used. The hand is radially or ulnarily deviated to create a half-circle shape.</td>
<td>The hand is relaxed, but maintains contact with the skin. The skin elasticity moves the hand back to the starting position where the stroke is repeated.</td>
<td>Stretch is applied perpendicularly to the lymph collectors, and finished parallel to the lymph collectors.</td>
</tr>
<tr>
<td><strong>Pumps</strong></td>
<td>The entire palm and proximal phalanges are used. The wrist is flexed and ulnarily deviated, fingers extended, and the thumb in opposition to the fingers.</td>
<td>The elasticity of the skin moves the hand back to the starting position. Without applying any pressure, the hand glides up one-half hand width proximally to begin the next stroke.</td>
<td>Pressure increases then gradually decreases as the wrist moves into radial deviation and extension. Maximum stretch is accomplished when the entire palm has made contact with the extremity.</td>
</tr>
<tr>
<td><strong>Scoops</strong></td>
<td>The wrist is ulnarily deviated and pronated onto the skin, with the thumb and pointer finger starting in contact with the skin, ending with the palm/palmar surfaces of the hands will come in contact with the skin.</td>
<td>The elasticity of the skin moves the hand back to the starting position. The elasticity of the skin moves the hand back to the starting position. Without applying any pressure, the hand glides up one-half hand width proximally to begin the next stroke.</td>
<td>The stretch is applied perpendicularly to the lymph collectors. The clinician guides the hand in a spiral-like motion, moving in a distal to proximal direction. Pressure gradually increases as more of the hand comes in contact with the skin. To end this phase, the fingers glide over the skin so they are parallel to the extremity being worked on.</td>
</tr>
<tr>
<td><strong>Rotary</strong></td>
<td>The wrist is flexed with the hands elevated, fingers in a neutral position, and the thumb abducted 90°. The palm is placed on the skin over the ulnar-side.</td>
<td>The wrist moves back into flexion so the hand is elevated. The fingers slide across the skin, maintaining contact with the skin but not applying pressure. The stroke is repeated in this position.</td>
<td>The palm is contacting the skin on the ulnar side in an elliptical-type movement, while the thumb is abducting perpendicularly to the flow of lymph fluid. Pressure increases as full contact is achieved with the hand and the skin is stretched closer to the drainage area.</td>
</tr>
</tbody>
</table>

Table 2: Sample arm sequence with patient positioned in supine

<table>
<thead>
<tr>
<th>Step:</th>
<th>Stroke:</th>
<th>Location:</th>
<th>Repetitions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. “Short Neck”</td>
<td>Effleurage</td>
<td>Sternum to acromion</td>
<td>2-3</td>
</tr>
<tr>
<td></td>
<td>Stationary Circles</td>
<td>Supraclavicular fossa</td>
<td>5-7</td>
</tr>
<tr>
<td></td>
<td>Stationary Circles</td>
<td>Earlobe to supraclavicular fossa (draining auricular lymph nodes)</td>
<td>5-7</td>
</tr>
<tr>
<td></td>
<td>Stationary Circles</td>
<td>Lateral cervical triangle (rework)</td>
<td>5-7</td>
</tr>
<tr>
<td></td>
<td>Stationary Circles</td>
<td>Submandibular area—from the tip of the chin in the direction of the angle of the jaw</td>
<td>5-7</td>
</tr>
<tr>
<td>2. “Arm &amp; Hand”</td>
<td>Stationary Circles</td>
<td>Axillary lymph nodes</td>
<td>5-7</td>
</tr>
<tr>
<td></td>
<td>Effleurage</td>
<td>Dorsal aspect of the entire arm</td>
<td>2-3</td>
</tr>
<tr>
<td></td>
<td>Pumps &amp; Stationary Circles (alternating; Pumps with head hand, stationary circles with inferior hand)</td>
<td>Lateral aspect of arm, beginning at lateral epicondyle, working superior to deltoid region</td>
<td>5-7</td>
</tr>
<tr>
<td></td>
<td>Dynamic Stationary Circles</td>
<td>Antecubital fossa with 3 hand placements (from one hand-width below to one hand-width above)</td>
<td>5-7</td>
</tr>
<tr>
<td></td>
<td>Scoops and Pumps (alternating)</td>
<td>Anterior and posterior forearm from the wrist to the elbow</td>
<td>5-7</td>
</tr>
<tr>
<td></td>
<td>Thumb Circles (using 1 or both thumbs)</td>
<td>The palm and over each individual fingers</td>
<td>5-7</td>
</tr>
<tr>
<td>3. “Arm Rework”</td>
<td>Scoops and Pumps (alternating)</td>
<td>Wrist to shoulder</td>
<td>2-3</td>
</tr>
<tr>
<td></td>
<td>Stationary Circles</td>
<td>Axillary lymph nodes</td>
<td>2-3</td>
</tr>
<tr>
<td></td>
<td>Stationary Circles</td>
<td>Supraclavicular fossa</td>
<td>2-3</td>
</tr>
<tr>
<td></td>
<td>Effleurage</td>
<td>Dorsal aspect of the entire arm</td>
<td>2-3</td>
</tr>
</tbody>
</table>

Table 3: Sample leg sequence with patient positioned in supine

<table>
<thead>
<tr>
<th>Step:</th>
<th>Stroke:</th>
<th>Location:</th>
<th>Repetitions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. “Anterior Leg”</td>
<td>Bimanual Stationary Circles (both hands at once)</td>
<td>Inguinal lymph nodes</td>
<td>5-7</td>
</tr>
<tr>
<td></td>
<td>Effleurage</td>
<td>Entire leg, beginning at the foot</td>
<td>2-3</td>
</tr>
<tr>
<td></td>
<td>Pumps</td>
<td>Anterior thigh, from patella to the ASIS</td>
<td>5-7</td>
</tr>
<tr>
<td></td>
<td>Scoops and Pumps (alternating)</td>
<td>Lateral thigh, from patella to the ASIS</td>
<td>5-7</td>
</tr>
<tr>
<td></td>
<td>Dynamic Stationary Circles (alternating hands)</td>
<td>Medial thigh, from medial aspect of knee to the groin</td>
<td>5-7</td>
</tr>
<tr>
<td></td>
<td>Pumps</td>
<td>Knee with 3 hand placements (from one hand-width below to one hand-width above)</td>
<td>5-7</td>
</tr>
<tr>
<td></td>
<td>Stationary Circles</td>
<td>Medial and lateral knee</td>
<td>5-7</td>
</tr>
<tr>
<td></td>
<td>Pumps (alternating hands)</td>
<td>Anterior calf, from ankle to knee</td>
<td>5-7</td>
</tr>
<tr>
<td></td>
<td>Dynamic Stationary Circles</td>
<td>Simultaneously behind the medial and lateral malleoli</td>
<td>5-7</td>
</tr>
<tr>
<td></td>
<td>Stationary Circles</td>
<td>Dorsum of the foot</td>
<td>5-7</td>
</tr>
<tr>
<td>2. “Anterior Leg Rework”</td>
<td>Scoops and Pumps (alternating)</td>
<td>Anterior leg, from ankle to ASIS</td>
<td>2-3</td>
</tr>
<tr>
<td></td>
<td>Bimanual Stationary Circles</td>
<td>Inguinal lymph nodes</td>
<td>2-3</td>
</tr>
<tr>
<td></td>
<td>Effleurage</td>
<td>Anterior leg, from ankle to ASIS</td>
<td>2-3</td>
</tr>
<tr>
<td>3. “Posterior Leg”</td>
<td>Effleurage</td>
<td>Posterior leg and gluteus muscle, from ankle to gluteus muscle</td>
<td>2-3</td>
</tr>
<tr>
<td>Position patient in Prone if able</td>
<td>Pumps (alternating hands)</td>
<td>Posterior thigh, from popliteal fossa to gluteus muscle</td>
<td>5-7</td>
</tr>
<tr>
<td></td>
<td>Dynamic Stationary Circles</td>
<td>Medial thigh, from medial aspect of knee to groin</td>
<td>5-7</td>
</tr>
<tr>
<td></td>
<td>Pumps and Stationary Circles (alternating hands)</td>
<td>Posterior thigh, from knee to gluteus muscle</td>
<td>5-7</td>
</tr>
<tr>
<td></td>
<td>Pumps and Stationary Circles (alternating hands)</td>
<td>Lateral thigh, from lateral knee to gluteus muscle</td>
<td>5-7</td>
</tr>
</tbody>
</table>
### Table 3: Sample Leg Sequence Continued

<table>
<thead>
<tr>
<th>Step:</th>
<th>Stroke:</th>
<th>Location:</th>
<th>Repetitions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pumps (alternating hands)</td>
<td>Popliteal fossa with 3 hand placements (from one hand-width above to one hand-width below)</td>
<td>5-7</td>
<td></td>
</tr>
<tr>
<td>Pumps (alternating hands)</td>
<td>Posterior calf, from Achilles tendon to popliteal fossa</td>
<td>5-7</td>
<td></td>
</tr>
<tr>
<td>Thumb Circles</td>
<td>Between Achilles tendon and malleoli</td>
<td>5-7</td>
<td></td>
</tr>
</tbody>
</table>

#### 4. “Posterior Leg Rework”

<table>
<thead>
<tr>
<th>Step:</th>
<th>Stroke:</th>
<th>Location:</th>
<th>Repetitions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pumps and Stationary Circles (alternating hands)</td>
<td>Entire posterior leg, from Achilles tendon to gluteus muscle</td>
<td>2-3</td>
<td></td>
</tr>
<tr>
<td>Pumps and Stationary Circles (alternating hands)</td>
<td>Entire lateral leg, from Achilles tendon to gluteus muscle</td>
<td>2-3</td>
<td></td>
</tr>
<tr>
<td>Entire posterior leg, from Achilles tendon to gluteus muscle</td>
<td>Entire lateral leg, from Achilles tendon to gluteus muscle</td>
<td>2-3</td>
<td></td>
</tr>
<tr>
<td>Effleurage</td>
<td>Entire posterior leg, from Achilles tendon to gluteus muscle</td>
<td>2-3</td>
<td></td>
</tr>
</tbody>
</table>

#### 5. “Final Anterior Leg Rework”  
Position patient in supine

<table>
<thead>
<tr>
<th>Step:</th>
<th>Stroke:</th>
<th>Location:</th>
<th>Repetitions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pumps and Stationary Circles (alternating hands)</td>
<td>Entire anterior leg, from ankle to ASIS</td>
<td>2-3</td>
<td></td>
</tr>
<tr>
<td>Bimanual Stationary Circles</td>
<td>Inguinal lymph nodes</td>
<td>2-3</td>
<td></td>
</tr>
<tr>
<td>Effleurage</td>
<td>Entire anterior leg, from ankle to ASIS</td>
<td>2-3</td>
<td></td>
</tr>
</tbody>
</table>


**Földi Method**

The Földi Method is another manual lymph drainage technique, essentially a modified version of the Vodder technique. The goal of this technique is to stimulate the
lymphangiomotoric activity in order to move the fluid and decrease the size of the limb. With the Földi Method, the therapist uses mild strokes on the drainage area that surround the affected region, and heavier strokes when on the limb to force fluid from the region (Struble, 2001). These techniques have been shown to have average lymphedema limb volume reductions that range from 15% to 68.6%. This large range is due to the varying limbs that can be affected by lymphedema, as well as how quickly the lymphedema was diagnosed (Lasinski & Boris, 2002; Liao et al., 2012).

**Casley-Smith Method**

Another technique for decreasing the size of the limb in patients who suffer from lymphedema is called the Casley-Smith method. This is a special type of massage that aims to “open new drainage pathways across the watershed areas, through an enlargement of the superficial lymphatic drainage paths, and to increase the drainage of the adjacent normal lymphotome through its normal lymphatic system” (Struble, 2001, p.10). There are no specific strokes that the Casley-Smith method employs, but rather short, light, sequential hand strokes, are used, with larger strokes used on the larger areas of the body. In fact, it is so gentle it should not cause redness or pain to the patient (Casley-Smith et al., 1998). However, there are times where heavier pressure is indicated: when the therapist is pushing lymph fluid across a watershed area, softening a fibrotic area, or performing a lymph node massage (Struble, 2001). One of the most important parts of the training is learning the correct pressures for the variations that occur in the lymphatic system with lymphedema (Casley-Smith et al., 1998). Another important part of this method is that one hand follows the other hand to prevent any backflow of the lymph, and that gentle massage pressure is employed so as to avoid worsening any
damage to the already fragile lymphatic vessels. The Casley-Smith method also uses a very specific massage sequence to increase the effectiveness of the lymphatic massage (Struble, 2001).

In the Casley-Smith method, clinicians are instructed to first clear the trunk, as this creates an empty space. This allows an area for the lymph fluid to go as the affected limbs are drained, as it is futile to push fluid into an area that is already full. Once the lymph is in the trunk, if it is necessary to move the lymph across the body to a normally draining set of lymph nodes, then the functioning nodes must also be cleared as well, prior to moving the lymph there. It is good to note that as clinicians continue to clear various areas, additional time may need to be taken to clear proximal areas a second time, to ensure lymph will continue to have a location to flow to and so as to not overload the area. This is especially true if the limb is extremely large, or if the lymphedema extends into the breast, trunk, or groin regions (Casley-Smith et al., 1998).

Finally, it is very important with this method that it is used in conjunction with compression bandaging to prevent excessive back flow of fluid that has been cleared. This is especially true in areas that are more fibrotic. The Casley-Smith method teaches that in these fibrotic areas, in addition to heavier amounts of pressure being used with the massage, the clinician must ensure the patient is bandaged firmly in these areas. This helps to prevent additional leakage from the superficial lymphatics if their endothelial junctions were accidentally opened during the massage (Casley-Smith et al., 1998).

**Billing and Compensation for Lymphedema Treatment**

Billing and compensation for lymphedema treatment poses challenges for the physical therapist, as in many ways billing practices have not caught up with the scope of
treatment. One such example is the fact that therapists often perform manual lymph drainage and then reinforce it by applying compression bandages, forcing therapists to bill both for manual therapy techniques (97140) and compression techniques (29581 for leg (below knee), including ankle and foot; 29582 for thigh and leg, including ankle and foot; 29589 for upper arm and forearm; or 29584 for upper arm, forearm, hand and fingers). However, up until 2012, the Current Procedural Terminology manuals had a parenthetical statement indication that the compression codes could not be billed on the same date of service as manual therapy techniques. The American Physical Therapy Association successfully advocated on behalf of lymphedema therapists and patients, and was able to get this parenthetical statement removed, allowing therapists to bill for manual therapy and compression techniques on the same date of service starting in 2013.

While ICD-10 codes do exist for lymphedema, they are not often used due to the narrow nature of their scope and the lack of a common diagnostic set point to determine whether or not the patient has lymphedema. The most commonly used lymphedema codes are I89.0 (Lymphedema, not elsewhere classified) and I97.2 (Postmastectomy lymphedema syndrome). It is not uncommon to see clinicians use codes involving pain at the joint (such as M25.51, Pain in shoulder, or M25.5, Pain in joint) as these diagnosis codes allow for more freedom with additional procedural codes as treatment progresses. Procedural codes are often the same used in traditional therapy, with the addition of a few more. The more traditional procedure codes include 97001 (initial evaluation by a physical therapist), 97110 (therapeutic exercise), and 97140 (manual therapy techniques). Other codes that are more specific to lymphedema treatment include 97016 (vasopneumatic pump) and 97535 (self-care home management training—such as
Manual Therapy Techniques in Lymphedema Treatment

bandaging or self-MLD instruction). It is important to note that all of these codes are payable by Medicare, but that they only include instruction in the clinic, not the actual pump or bandages. Medicare will eventually cover a vasopneumatic pump for lymphedema therapy, but only after conservative lymphedema therapy has been tried for at least four weeks, and included compression (bandages or stockings), exercise, and elevation. After the four-week trial if symptoms still remain, a physician must certify that there has been no significant improvement or if significant symptoms still remain. Unfortunately, compression bandages and compression sleeves are generally not covered. However, legislators are working towards getting these covered in the coming years as The Centers for Medicare and Medicaid Services have recently approved compression garments for the treatment of venous stasis ulcers (Cms.org; Zuther et al., 2013).

Current research indicates that CDP should be performed five times per week for the acute, clinic-heavy phase of treatment, which usually lasts four weeks. After the acute phase, the number of visits per week is slowly decreased to ensure the patient is able to maintain the volume reduction and manage the condition on their own (Holtgrefe, 2006; Morrell et al., 2012). Unfortunately however there are many patients that are unable to attend therapy at this frequency due to a wide variety of factors. Currently, some research has been done on the results of CDP with a decreased frequency, however they are few in number, and none include self-manual lymph drainage as part of the therapy program. The following case study looks at a decreased frequency with an emphasis on self-manual lymph drainage as a part of the home exercise program.
Case Presentation

Examination

The following findings were obtained at the first physical therapy visit, in May 2014.

Past medical history. The patient’s past medical history included non-insulin dependent diabetes mellitus (controlled), hypertension, pneumonia, chronic kidney disease, lipidemia, chronic obstructive pulmonary disease with asthma, hysterectomy, cardiac catheter, and migraines.

Observation. The patient had a bilateral mastectomy with implanted breast expanders (she was scheduled to have breast reconstruction in June 2014), and a port on the right side of her chest. She also presented with increased left upper extremity lymphedema as well as left upper quadrant edema.

Range of motion (ROM) of the upper extremities. Bilateral active range of motion was taken, with the right upper extremity having a full 180° of shoulder flexion, and 180° of shoulder abduction. Her left upper extremity AROM was restricted, with 153° of shoulder flexion, and 141° of shoulder abduction. Passive range of motion of the left upper extremity was also restricted with 154° of shoulder flexion, and 160° of shoulder abduction. Bilateral elbow flexion and extension, as well as bilateral wrist AROM were all within functional limits.

Girth measurements. Girth measurements were taken using a plastic, flexible tape measure. Measurements were taken at seven locations with varying distances from anatomical landmarks. The right upper extremity acted as a control measurement to the affected left upper extremity. Table 1 has the upper extremity initial evaluation.
measurements. These measurements were repeated at the conclusion of therapy, 8 weeks later. The volume of lymphedema could be determined using geometric equations based on the shape of the limb or by using a volumeter to measure the amount of water displaced, however both of these methods are time consuming and rarely used in the clinical setting. Taylor et al has found the interrater reliability of circumferential measurement from anatomical landmarks to be 0.97 to 0.99, and more valid than circumferential measurements from the fingertips, thus this is the method chosen for this study due to its high interrater reliability and ease of use in the clinical setting.

Table 4: Initial upper extremity measurements:

<table>
<thead>
<tr>
<th>Location</th>
<th>Distance from Anatomical Landmark</th>
<th>Right Upper Extremity Measurement (cm)</th>
<th>Left Upper Extremity Measurement (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metacarpals</td>
<td>On metacarpals</td>
<td>18</td>
<td>18.4</td>
</tr>
<tr>
<td>Wrist</td>
<td>At the styloid process</td>
<td>15</td>
<td>16.2</td>
</tr>
<tr>
<td>Distal Forearm</td>
<td>8cm superior to styloid process</td>
<td>18.2</td>
<td>20.1</td>
</tr>
<tr>
<td>Proximal Forearm</td>
<td>16cm superior to styloid process</td>
<td>24.3</td>
<td>25.8</td>
</tr>
<tr>
<td>Elbow</td>
<td>Taken at the elbow crease</td>
<td>26.3</td>
<td>26.7</td>
</tr>
<tr>
<td>Distal Upper Arm</td>
<td>8cm superior to the elbow crease</td>
<td>30.9</td>
<td>30.5</td>
</tr>
<tr>
<td>Axilla</td>
<td>On the humerus, even with the superior aspect of the axilla</td>
<td>36.3</td>
<td>37.7</td>
</tr>
</tbody>
</table>
Functional activities. The patient reported the most difficulty with reaching overhead, but noticed pain with all left upper extremity movements, likely due to the increased size of the limb.

Evaluation, Diagnosis, Prognosis, and Plan of Care

Evaluation. The patient had left upper extremity lymphedema following lymph node removal and chemotherapy of the left axillary region, limiting her range of motion. This impairment in AROM affected her functional activities.

Diagnosis. The patient’s physical therapy treatment diagnosis was lymphedema of the left upper extremity post mastectomy with lymph node removal.

Prognosis. The patient was referred to physical therapy within approximately one month of her lymphedema diagnosis. Due to the nature of her scheduled breast reconstruction, a longer course of therapy was advised, approximately 3 months instead
of the standard 4 week timeline. The patient appeared to be a good candidate for physical therapy, showing motivation for participation to attain her goals of decreasing the arm swelling, returning to prior functional levels, and decrease her upper extremity pain.

**Plan of care.** While there are many research studies recommending complete decongestive therapy five times per week (Holtgrewe, 2006). The patient was only able to attend therapy sessions 2-3 times per week based on personal factors. She also took a week off of treatment to undergo a bilateral breast reconstruction. Her program consisted of manual lymph drainage techniques to decrease the amount of fibrotic tissue and aid in the mobilization of fluid to the nearest lymph node (with an emphasis on self-manual lymph drainage in her home exercise program), compression (utilizing both compression bandaging and compression garments), therapeutic exercise (to aid in the reduction of fluid), and education in skin care and self-management of lymphedema.

**Interventions**

The first session consisted solely of the evaluation and patient education about lymphedema and the treatment. This education consisted of skin care education to decrease the risk of infection in the limb, information about the use of compression bandaging in treatment of lymphedema, information about manual lymph drainage, precautions brought about by this lymphedema, and answering any additional questions the patient had. The next four visits (visits 2-5) focused on decreasing the volume of the left upper extremity in order to fit the patient for a compression garment. This decrease in volume was accomplished by manual lymph drainage of the left upper extremity and trunk, therapeutic exercise, and multi-layer compression bandaging. The manual lymph drainage was applied according to the Vodder technique, with the self-manual lymph
drainage home program prescribed according to the Vodder technique as well. This technique employs four basic strokes that utilize a skin-stretch technique to encourage increased circulation of the lymphatic pumps, which will in turn increase lymphatic flow and decrease limb volume. Due to her decreased frequency of visits, the self-manual lymph drainage portion of the home exercise portion was emphasized, and the patient was encouraged to complete the sequence at least once per day. Both the patient and her spouse were instructed in the strokes of the Vodder technique. A combination of verbal and tactile cues given by the physical therapist were used to assist them. The patient showed competence in completing the steps, and her spouse was also educated in the program as well to assist when necessary. Self-manual lymph drainage was applied in a manner very similar to that that was applied by the therapist, and was applied over the trunk, neck, and left upper extremity. At each visit, the therapist answered any questions regarding the self-manual lymph drainage, as well as demonstrating the techniques or checking the proficiency of the patient and her spouse when deemed necessary. The therapeutic stretches and exercises were chosen specifically for the patient, and are described in Tables 2 & 3. While no research has been done on the optimum type and duration of therapeutic stretches for lymphedema patients, it is believed that prolonged stretching can reduce the range of motion lost and joint stiffness that often accompany breast surgery (Kilbreath et al., 2006). Unfortunately, this patient was unable to complete long-duration holds due to pain, so shorter duration stretches were used.

Exercises were given on the second visit for the patient to complete at home. They were chosen specifically for her based on her initial presentation. Isotonic exercises were chosen for the benefits in increasing the flow of lymph fluid. The patient was given
Therabands to complete the exercises at home, and instructed to complete each exercise two to three times a day. However, the patient was instructed by her surgeon to discontinue both the stretching and strengthening exercises after undergoing the breast reconstruction. The therapist was unable to progress the patient in these exercises as the precautions were not lifted before she was discharged from physical therapy.

Multi-layer compression bandaging was used as well, with the physical therapist applying it when in the clinic. The patient and her spouse were also instructed in application of the compression bandaging for days she did not have an appointment in the clinic, as well as for bandaging at night. At the fifth visit, the patient was re-measured for circumferential volume, as this was the first visit after the breast reconstruction. At this visit it was deemed the patient was reduced to an appropriate size for a compression garment, and the patient was instructed in donning and doffing compression garments, as well as education about compression garments. The patient was instructed to continue with her self-manual lymph drainage, exercises, bandaging, and skin care daily at home.

The patient received her compression garment at visit 6, and was monitored with donning and doffing to ensure a proper fit and proper care for the garment. At this visit, the patient also reported her surgeon told her to discontinue exercises at this time due to the reconstruction surgery. For the remainder of her visits (visits 6-9), the therapy continued to emphasize reducing the effective limb, utilizing the methods mentioned above. However, during these four visits, there was an increased emphasis on self-manual lymph drainage and at-home maintenance of symptoms, as well as a decreased emphasis on manual lymph drainage in the clinic by the physical therapist, other than that which was given for educational purposes. This was to ensure a smooth and successful
transition home for the patient. The patient was also given two additional progressions of exercises, as well as instructions when to progress from one set to the next at home. Finally, the patient was given additional instruction in skin care, due to scratches the patient received on the affected upper extremity. The importance of skin care was once again emphasized, as infection can progress quite quickly in patients with lymphedema.
Table 5: Initial stretches

<table>
<thead>
<tr>
<th>Name of Exercise</th>
<th>Description</th>
<th>Hold Time</th>
<th>Repetitions</th>
<th>Sessions per Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pectoralis Doorway Stretch</td>
<td>With arms positioned in doorway, gently lean forward until a stretch is felt in the chest and shoulders.</td>
<td>30 seconds</td>
<td>3 times</td>
<td>3 sessions/day</td>
</tr>
<tr>
<td>ROM Exercise for Shoulder Flexion</td>
<td>Draw your hand back away from the wall, hold.</td>
<td>10 seconds, then return to starting position</td>
<td>10 times</td>
<td>2 sessions/day</td>
</tr>
<tr>
<td>ROM Exercise for Shoulder Abduction</td>
<td>Draw your hand back away from the wall, hold.</td>
<td>10 seconds, then return to starting position</td>
<td>10 times</td>
<td>2 sessions/day</td>
</tr>
<tr>
<td>ROM Exercise for Shoulder Flexion (using pole)</td>
<td>While lying down, grasp the pole with both hands, palms up. Keeping arms straight, raise both arms up until a stretch is felt in your shoulder.</td>
<td>15 seconds, then return to starting position</td>
<td>5 times</td>
<td>3 sessions/day</td>
</tr>
<tr>
<td>Corner Stretch</td>
<td>Standing facing a corner, place hands at shoulder level as shown. Lean forward until a gentle stretch is felt across the chest.</td>
<td>30 seconds, then return to starting position</td>
<td>3 times</td>
<td>3 sessions/day</td>
</tr>
</tbody>
</table>
Table 6: Initial strengthening exercises

<table>
<thead>
<tr>
<th>Name of Exercise:</th>
<th>Description:</th>
<th>Hold Time:</th>
<th>Repetitions:</th>
<th>Sessions per Day:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoulder External Rotation</td>
<td>Keep elbows tucked in at your sides. Hold the ends of a theraband in each end, with thumbs up. Externally rotate your arms out to the side, while keeping your elbows tucked at your sides.</td>
<td>2 seconds, then return to starting position</td>
<td>10 times</td>
<td>2-3 sessions/day</td>
</tr>
<tr>
<td>Shoulder Horizontal Abduction</td>
<td>Hold arms straight out in front of you. Hold each end of a red theraband in each hand, with thumbs up. Slowly bring your arms out into a T-shape.</td>
<td>2 seconds, then return to starting position</td>
<td>10 times</td>
<td>2-3 sessions/day</td>
</tr>
<tr>
<td></td>
<td>Anchor the red theraband at your hip with one hand, and bring your hand out to the side, hold for 2 seconds, then bring your hand to the front and overhead.</td>
<td>2 seconds at each position, then return to starting position</td>
<td>10 times</td>
<td>2-3 sessions/day</td>
</tr>
</tbody>
</table>
Outcomes

Final outcome measurements were taken on the ninth visit, just under 8 weeks after her initial visit. It is important to note that the patient underwent a bilateral breast reconstruction in the middle of her treatment, increasing the duration of her treatment.

Observation

The patient presented with decreased edema of the trunk and left upper extremity.

Range of Motion of the Upper Extremities

The patient’s active range of motion for left shoulder flexion and abduction were both markedly improved from her initial visit. Passively, she was able to achieve 176° of shoulder flexion, and 174° of shoulder abduction. Actively she achieved 166° of shoulder flexion and 165° of shoulder abduction.

Girth: Girth measurements were taken in the same manner as they were measured at the initial visit, and are listed in Table 4. The patient had reductions in circumference than ranged from 1.2cm (at the metacarpals) to 3.4cm (at the axilla). The patient had a reduction in volume of approximately 9%. Matthews and Smith estimated the percentage of weight loss in their study with the following formula:

\[
\frac{\text{Initial}_\text{affected} - \text{Post}_\text{affected}}{\text{Initial}_\text{affected}} \times 100\%
\]

Unfortunately this has not been a validated method of measuring a reduction in limb size, however when combined with the circumferential differences, it helps to give an overall picture of the reduction in lymphedema, and is especially useful if patients have bilateral lymphedema.
Table 7: Final upper extremity measurements:

<table>
<thead>
<tr>
<th>Location</th>
<th>Distance from Anatomical Landmark</th>
<th>Left Upper Extremity Initial Measurement (cm)</th>
<th>Left Upper Extremity Final Measurement (cm)</th>
<th>Difference (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metacarpals</td>
<td>On metacarpals</td>
<td>18.4</td>
<td>17.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Wrist</td>
<td>At the styloid process</td>
<td>16.2</td>
<td>14.9</td>
<td>1.3</td>
</tr>
<tr>
<td>Distal Forearm</td>
<td>8cm superior to styloid process</td>
<td>20.1</td>
<td>17.5</td>
<td>2.6</td>
</tr>
<tr>
<td>Proximal Forearm</td>
<td>16cm superior to styloid process</td>
<td>25.8</td>
<td>22.7</td>
<td>3.1</td>
</tr>
<tr>
<td>Elbow</td>
<td>Taken at the elbow crease</td>
<td>26.7</td>
<td>24.7</td>
<td>2.0</td>
</tr>
<tr>
<td>Distal Upper Arm</td>
<td>8cm superior to the elbow crease</td>
<td>30.5</td>
<td>28.5</td>
<td>2.0</td>
</tr>
<tr>
<td>Axilla</td>
<td>On the humerus, even with the superior aspect of the axilla</td>
<td>37.7</td>
<td>34.3</td>
<td>3.4</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td></td>
<td>175.4cm</td>
<td>159.8cm</td>
<td>15.6cm</td>
</tr>
</tbody>
</table>

**Functional Activities**

At discharge, the patient reported that she has been able to return to all functional activities. She no longer reported pain or difficulty with overhead actions. The patient was able to demonstrate adequate self-care of her lymphedema and symptoms, with only a mild assist from her spouse when necessary. The patient requested to end therapy as she is managing her treatment well and has had a satisfactory reduction in volume. The patient’s therapy goals were met so she was discharged from therapy and instructed to call the physical therapist if she had any problems, questions, or concerns.
Discussion and Conclusion

Upper extremity lymphedema often occurs following lymph node removal or radiation following breast cancer diagnosis and treatment. The number of patients suffering from lymphedema is constantly growing due to the increasing number of patients surviving cancer as well as the increasing awareness of treatment for lymphedema. Unfortunately lymphedema can be extremely debilitating for the patient, greatly impacting functional abilities, range of motion, and greatly decreasing their quality of life. Fortunately, there is a gold-standard treatment for lymphedema, Complete Decongestive Therapy, which has been shown to effectively manage the condition.

Most studies recommend a frequency of 5 times per week during the initial stage of treatment to decrease lymphedema. Unfortunately, this was unattainable due to various factors in this case study. However, this case study still proves that reductions in limb volume and circumference are possible in cases where frequency of therapy is
suboptimal. This could be attributed to a number of factors, including a relatively low level of lymphedema, the increased emphasis on the home exercise program (including instruction in self-manual lymph drainage), and/or the high level of motivation in the patient. The increased emphasis on the home program and self-care was due to the breast reconstruction in the middle of her physical therapy treatments, likely lengthening the duration of treatment and decreasing the speed of results.

One of the limitations of this case study is the breast reconstruction during the middle of the physical therapy treatments. The patient was forced to take time off from physical therapy, likely slowing the reduction of her left upper extremity volume. Another limitation was the decreased frequency per week of this patient. While a larger reduction in circumference or volume was not expected (as final left upper limb measurements were at or below the unaffected right upper limb measurements), a quicker reduction in volume was to be expected, as the entire course of her therapy was 8 weeks in duration. By increasing the frequency of her sessions, the patient likely would have been discharged from therapy in the traditional four week timeline (Holtgrefe, 2006; Morrell et al., 2005). A third limitation of this study is the unknown compliance with the home exercise program. The patient demonstrated competency in the application of the self-manual lymph drainage strokes and techniques, compliance is always in question when home programs are prescribed. A final limitation for this study is that this was a relatively mild case of lymphedema. Further studies are needed to determine if a lesser frequency still is efficacious for more extreme cases of lymphedema, as well as to determine if these finding hold true on a larger scale. This case presentation demonstrates
the effectiveness of a home exercise program as the primary focus with self-manual lymph drainage as the primary intervention.

Lymphedema is a devastating condition that affects a large number of people. It can be caused by a wide variety of factors, however it is most commonly associated with cancer treatments in the United States. While it doesn’t have a single set diagnostic criterion, it does have a gold-standard for treatment known as Complete Decongestive Therapy, or CDT. This is a method that involves four different interventions: compression bandaging, therapeutic exercise, fastidious skin care, and manual lymph drainage, and has been shown to be very effective both in research trials and in clinical scenarios. Manual lymph drainage itself has three main schools of thought, each bringing their own ideas to the table. The main methods are the Vodder method, the Földi method, and the Casley-Smith method. While each method is different and employs different strokes, they all work on draining lymph fluid to reduce the volume of the limb. Current research suggests a treatment frequency of five times per week for the first four weeks of clinic-heavy treatment (Holtgrefe, 2006; Morrell et al., 2012). While this has produced excellent outcomes in the past, studies such as the aforementioned case presentation, are beginning to show that gains are still possible with a decreased treatment frequency. Lymphedema therapy still is, in many ways, a developing field for physical therapists. While more research is needed in many areas of lymphedema therapy, such as pathology, diagnosis, measurement techniques, or treatment frequency, there have been large advancements made in recent years in terms of treatment and reimbursement, greatly increasing the quality of life of patients suffering from lymphedema.
References


