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Complete Decompression Therapy in a Patient with Chronic, Non-Surgical Upper-Extremity Lymphedema during Radiation Therapy: A Case Study

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Background and Purpose: The purpose of this case study is to describe complete decongestive therapy on the upper extremity as an intervention for an atypical patient with chronic lymphedema. Typically this is performed on women with acute lymphedema that have had breast cancer, have already completed radiation therapy, and have undergone a mastectomy and lymph node dissection. The patient in this case was atypical because he was male, did not have breast cancer, did not have any surgical intervention, and was being treated with concurrent radiation therapy. **Case Description:** This patient was a 73-year-old male with a six month history of insidious right upper extremity pain and was diagnosed with a large thoracic costal cancerous tumor, a full thickness tear of the rotator cuff muscles, and three rib fractures. Then he presented to physical therapy with right shoulder girdle pain, limited function, and significant swelling throughout the entire right upper extremity. **Intervention:** This patient was treated with daily Complete Decongestive Therapy treatment for lymphedema over a twenty-one day period, which included manual lymph drainage, compression bandaging, skin care, gentle stretching and strengthening exercises, and education. The goal of this intervention is to reduce girth, reduce pain, and improve function of the affected limb. **Conclusion and Clinical Relevance:** Complete decongestive therapy is commonly performed for acute lymphedema after lymph node dissection; however, delivering this treatment to an atypical patient resulted in decreased circumferential measurements, suggesting the utility of this intervention beyond its typical application.

Key Words: *radiation, complete decongestive therapy, lymphedema, cancer*

INTRODUCTION

Lymphedema is a chronic and costly[1] condition caused by impaired function of the lymphatic system. The lymphatic system consists of lymph vessels and lymph nodes that eliminate waste and fight infection. The vessels in this system carry fluids, and the nodes collect fluid for filtration. Failure of this system causes lymphedema and results in impaired filtration, decreasing the body's ability to fend off infection. It also can result in a backup of fluid and lead to fluid accumulation, which is typically the first indication of lymphedema[2].

Lymphedema is divided into two categories. The first type is primary lymphedema, meaning that the condition is congenital and chronic. The second type is secondary lymphedema, which is caused by acute or chronic trauma to the lymph vessels. Both types often result in a swollen, heavy, painful, weak limb and decreased function. Lymphedema is further classified by four stages, 0-3, ranging from, asymptomatic with the exception of possible tingling sensations or fatigue in the affected area in stage 1 to marked by swelling, deformity, and hardening of the skin in stage 3. When detected in the early stages, this condition can be managed easily or even reversed, but if left untreated, it can result in permanent and dire consequences. See Table 1.

Table 1. Stages of lymphedema

Stage	Lymphedema Characteristics
0	Usually asymptomatic. May experience some tingling sensation or some heaviness.
1	Pitting edema present. Usually reversible and improved with limb elevation
2	Non-pitting edema. Some trophic changes such as redness and thickening skin
3	Large limb. Significant trophic changes with a leathery appearance.

The resulting impairments from lymphedema can present in many aspects of a patient's independence and self-image. The World Health Organization's model on International Classification of Function highlights the manner in which lymphedema impacts a patient's autonomy and overall wellness[3]. The involved limb typically is characterized by weakness, increased girth, decreased range of motion, pain, feelings of heaviness, and impaired vascular function. These impairments can severely limit the patient's mobility and ability to perform activities of daily living (ADLs). The inability to self-sufficiently perform these activities limits the patient's independence, as well as decreases their participation in society.

Clinical Implications

One population that is at an increased risk for secondary lymphedema is patients with cancer who are currently or have previously received surgical intervention, radiation therapy, or chemoradiation therapy. The mechanical damage to the soft tissue can result in disruptions to the lymphatic system. A study on lymphedema characteristics reported more than three-quarters of new-referrals were cancer patients[4].

Several therapy options have been pursued as options to manage this condition. A 2014 systematic review[5] considered 75 articles from January 2009 to February 2014 about management of lymphedema management. Of the twenty-seven studied treatment options, complete decongestive therapy (CDT) was found to be paramount. CDT includes manual lymph drainage (MLD), compression bandaging, compression garments, and light exercise, which were each found to be less effective when delivered as individual, isolated treatments. The review concluded that CDT is considered best clinical practice for managing lymphedema as it had the most supporting literature and the highest-level evidence compared to the other twenty-six treatment options for lymphoedema[5].

The typical patient undergoing upper extremity CDT are women with acute lymphedema with a history of breast cancer, who have already completed radiation therapy, and who have undergone a mastectomy and lymph node dissection, which is performed to assess for cancer metastasis to the lymphatic system. The removal of even this one lymph node can alter the efficiency of the lymphatic system and increase the risk of lymphedema.[6] CDT has been studied primarily in these patients. The purpose of this case study is to describe CDT as an intervention for an atypical patient. The patient in this case was atypical because he was male, had no history of breast cancer, did not have any surgical intervention, had chronic lymphedema, and was currently being treated with radiation therapy. The literature suggests that CDT will at a minimum, cause no harm, [7] but is likely to demonstrate improvements in limb size.[5, 8]

Case Description

This patient was a 73-year-old male with a six-month history of insidious right upper extremity pain. He was right hand dominant, and he thought his rotator cuff was torn because his right shoulder pain felt similar to the pain he experienced when he tore his left rotator cuff. He consulted an orthopedic surgeon for right arm and shoulder pain. Upon imaging, the patient was diagnosed with a large thoracic costal cancerous tumor, a full thickness tear of the rotator cuff muscles, and three rib fractures. The patient did not report the relationship or etiology of these injuries. The orthopedic surgeon deferred intervention until after oncological treatment. The patient was referred to a radiologist for treatment and then to physical therapy at a cancer rehab facility for a general evaluation.

The patient had just begun twice daily radiation therapy without chemotherapy upon his referral to rehabilitation. This patient presented to physical therapy with right shoulder girdle pain, limited function, and significant swelling throughout the entire upper extremity. These limitations interfered with the patient's ability to maintain the treatment position for radiation therapy. The positioning required 90° of shoulder abduction, 90° of shoulder external rotation, and elbow flexion with the hand placed behind the head in supine. He reported extreme pain and discomfort, but he tolerated it, as the treatment was very brief. While concerned about the pain and limited mobility, the patient denied concerns about the swelling, reporting that, "my arm's just fat. It's been fat for a few years." Lymphedema management became the primary focus of the patient's treatment to decrease pain, increase range of motion, and encourage better lymphatic function, despite the high risk of further lymphatic damage from the concurrent radiation therapy.

Examination

This patient complained of constant pain in the right shoulder and heaviness in the arm. He denied any inciting factors and reported improvements with rest and immobilization. He reported a constant dull ache and sharp, shooting pain exacerbated by movement but not elicited by anything in particular. At initial evaluation, his pain was currently, minimally and maximally 6, 0, and 8 out of 10 respectively, using the numeric pain rating scale. The patient denied tenderness to palpation or changes in sensation.

The patient presented with poor scapulohumeral rhythm bilaterally with horizontal adduction, tipping of the inferior angle of the scapula, forward head posture, decreased thoracic kyphosis, decreased lumbar lordosis, and global range of motion deficits in the affected limb. However, the extent of these limitations was challenging to measure due his contralateral limitations. The patient reported having a history of a prior untreated full-thickness rotator cuff tears in the uninvolved shoulder, resulting in bilateral range of motion deficits and pain. The involved limb did present with more limitations than the uninvolved limb in shoulder external rotation, internal rotation, flexion, and abduction. However, the patient demonstrated greater cervical mobility toward the involved side than the uninvolved side. Cervical flexion and extension were within functional limits.

The patient was unable to attain or maintain the positions for manual muscle testing as he was limited by pain in the shoulder. While he demonstrated functional strength in the left upper extremity, he was extremely limited in range of motion on the right side. The patient was tested for elevation, flexion, abduction, external rotation and internal rotation of the shoulder, flexion and extension of the elbow, scapular protraction, and grip strength. The patient strength ranged from 4-/5 to 5/5 on the uninvolved side and was pain free. The involved side ranged from 2/5 to 3+/5 and most tests were painful with the exception of the upper trapezius and serratus anterior, which were both 5/5.

The patient also presented with significant, non-pitting edema on the right upper extremity. Circumferential measurements were taken of both upper extremities, using the unaffected side as a reference for the amount of swelling. Eight measurements were taken using bony landmarks to take the circumferential measurements and presented with differences of up to 10 cm. A 2006 study by Taylor et al[9] reported this method as valid and reliable for assessing upper extremity lymphedema. Using anatomical landmarks for circumferential measurements produces similar, but not interchangeable, results to water displacement volumetric and is superior to measurements taken using distance from the fingertips. These data are shown in Table 2.

Evaluation

The patient presented with impaired independence in ADLs as he reported being unable to utilize his dominant hand and arm. The patient denied feeling limited by his pain, range of motion deficits, and weakness because he was sedentary, retired, and relied heavily on his wife to perform any task that he could not perform independently. However, the extent of his impairments gave the clinical impression of advanced lymphedema,

but these are all also common symptoms of the patient's concurrent pathology, a fully torn rotator cuff. The most compelling indication for lymphedema was the significant, pervasive, chronic swelling. The combination of these factors directed the therapist toward complete decongestive therapy as the most effective treatment. The short-term goals at this time for this patient were to attain and maintain the impaired shoulder in a position necessary for radiation treatment, abduction and external rotation, and to be able to use the upper extremity to assist in transfers. The long-term goals were to decrease pain with self-care for activities that required external rotation of the shoulder and to be able to lift items into an overhead position independently.

Intervention

This patient was treated with daily CDT for lymphedema over a twenty-one day period. This course of treatment consists of two large components, compression bandaging and garments and MLD. This regimen also includes gentle exercise, skin care, education, and self-drainage. The outcome of this intervention was assessed by circumferential measurements[9] and overall pain scores[10] which are both valid and reliable.

Manual Lymph Drainage

The goal of MLD is to redirect and retrain the lymph to utilize the body's healthy lymph nodes and vessels. MLD is a hands on technique performed to facilitate fluid mobility in the lymphatic system. Using gentle stretch, with preferably skin-to-skin contact, the therapist opens target vessels before guiding the fluid away from the impaired nodes and towards the functioning nodes. A recent study found an immediate decrease in fluid accumulation and backflow in the lymphatic system in real-time during MLD using a fluorescent green dye and lymphography.[8]

MLD was performed first in supine beginning with deep breathing techniques purported to open and stimulate the deep vessels, followed by opening of the subclavian vessels. Superficial vessels were used to drain away from the affected vessels and toward functional vessels using the anterior axillary anastomoses and axillary inguinal anastomoses. The arm was then drained away from the axilla beginning proximally starting near the humeral head and ending at the fingertips. The patient was then placed in-sidelying for drainage using the posterior axillary anastomoses. Ideally this is done in prone, but the patient could not attain this position.

Compression Bandaging and Compression Garments

The intent of compression bandaging is to prevent further increase in girth and shrink the lymphedematous area. Since compression bandaging is shown to be more effective than compression garments[11], the patient was not be fitted for a custom compression garment until after the wrapping regimen. This was hypothesized to allow for the greatest amount of shrinkage before purchasing a custom garment. This also reduces expenses by eliminating the need for a second garment if the limb should continue to shrink.

The patient was then wrapped with compression bandaging in a seated position with his arm propped on a table, as it was too heavy and painful for him to maintain in a suspended position or against the therapist. The patient was fitted with 1-inch thick foam pads that were trimmed throughout treatment as necessary. The bandages were wrapped over the foam beginning with a 6-inch bandage around the hand, leaving the fingers free, with the fingers abducted to permit maximum movement in the hand. The rest of the arm was bandaged distally to proximally with 2 8-inch, 2 10-inch, and 1 12-inch bandage with alternating spiral and herringbone patterns with the arm in full extension and the hand in a fist to allow function of the wrist flexors and extensors.

The patient was asked to touch his fingers to his nose throughout the wrapping to ensure function of the arm. The patient was also instructed to only remove the most proximal, superficial layer of bandaging if the pressure became unbearable. This would create a more tolerable, less intense version of the treatment without completely abandoning it. Compression bandaging relies

on layers to combat swelling instead of the elastic properties of alternative bandages.

The bandages were applied daily Monday through Friday by the primary author under the supervision of the clinical instructor, and the therapist thoroughly moisturized the arm with an unscented moisturizer before every application. Because the skin surrounding lymphedematous tissue is very fragile and bandaging decreases the amount of oxygen available to the tissue, skin care is vital. Circumferential measurements were taken once a week to measure changes in girth.

Exercise, Education, Skin Care, Self-Care

The patient and his wife were taught bandaging and skin care to allow re-wrapping over the weekend. They were educated on maintaining moisture in and preventing trauma to the skin on the affected limb during the brief unwrapped periods. The patient's wife was educated on wrapping techniques and foam placement to allow for daily bandaging to continue during the weekends. They were also both educated on self-drainage and deep breathing techniques.

The patient's referral orders did not come with any movement restrictions. The patient was initially treated with passive range of motion, grade II and III mobilizations, long axis traction, and grade II and III mobilizations with flexion, abduction, and external rotation for the glenohumeral joint. He was also treated with scapular mobilization using proprioceptive neuromuscular facilitation techniques. The patient was also initially prescribed isometric exercises to strengthen the rotator cuff muscles. These were discontinued early in treatment plan due to significant increases in the patient's pain that created extreme difficulty with the positions necessary for bandaging and MLD.

To account for these changes, the range of motion component was modified to a less-aggressive home exercise program. The patient was prescribed shoulder flexion and abduction exercises to perform either in supine with a cane, in sitting at a table with a towel or in standing at a wall with a towel to improve range of motion to tolerance. The patient was instructed in low rows with a theraband. After demonstrating competence with these exercises, the patient and his wife were educated on the utility of the exercises and instructed to perform them twice daily. This was done to ensure ample time was allotted for MLD and bandaging.

Compliance

The patient reported non-compliance with the home exercise program from the beginning of treatment. The patient's wife declined to perform bandaging and the patient denied performing self-management techniques. They did however agree to leave the bandages on over the weekend to maintain compression. Similar behaviors were reported in a 2014 study[12] exploring self-care in women with breast cancer related lymphedema. The authors examined frequency of adherence to self-care. Adherence rates were less than 25% for more than half for exercise and more than a third for bandaging and self-drainage at baseline. This indicates that improvements can still occur in spite of non-compliance.

Towards the end of the four-week period, the patient reported costal tenderness due to his radiation treatment and skin tag irritation. The patient refused bandaging, as he attributed some of the skin tag irritation to the friction between the bandages and his skin tags, but consented to continuing MLD. He pursued an over the counter compression sleeve to wear instead of being bandaged despite the therapist's recommendation to continue with compression bandaging first and wait for a custom compression garment. The treatment progression was to order a custom garment upon discharge to ensure the greatest amount of shrinkage before purchasing the sleeve, which also reduces the need to purchase another sleeve, should more shrinkage occur.

Outcomes

Observations

The patient demonstrated slight improvements in extremity mobility. The patient did not demonstrate any improvements with strength, as he was still unable to

attain or maintain standard strength testing positions without pain. The patient demonstrated visual and numerical changes in arm girth, but continued to complain of pain with active and passive range of motion. The patient declined to participate in reassessment of range of motion testing, but did report increased tolerance of the treatment position during radiation.

Pain

His initial pain was a 6/10 with a maximum of 8/10. Upon discharge his pain was a 4/10 with a maximum of 6/10 (Figure 1.) By the standard for chronic musculoskeletal pain, the patient's reported 2-point decrease in pain exceeded the criterion for a 1-point minimum clinically important difference; [13] however, by the standard for shoulder pain, his rating change did not exceed the 2.17-point difference criterion.[14]

Circumferential Measurements

Circumferential measurements decreased from evaluation to discharge (Table 2). The patient initially had no side-to-side difference at the styloid processes and maintained symmetry at discharge. He demonstrated improvements at each of the other landmarks. The patient's circumferential measurements at 8 cm above the styloid processes, 8 cm, 16 cm, and 18 cm above the antecubital fossa exceeded the minimum detectable change for girth, 1.64 cm (Figure 4.) [9]

Table 2. Circumferential measurements at each site on each day on which a measurement was taken on the affected limb and the initial measurement of the unaffected limb. All measurements are in centimeters. * - difference from initial visit to discharge exceeded minimal detectable change.

	Day 0 L-unaffected	Day 0 R-affected	Day 5 R-affected	Day 14 R-affected	Day 19 R-affected	Day 21 R-affected
Web space	25.5	26	23.5	24.5	25	25.5
Styloid process	22	22	22	22.5	22	22
8 cm above styloid	26.5	31	29	30	30	28.5*
16 cm above styloid	31	37	36	36	36	35.5
Antecubital fossa	32.5	38	38	36.5	36.5	36.5
8 cm above fossa	39	48.5	48	47.5	47.5	46.5*
16 cm above fossa	40	50	50	48	47	46*
18 cm above fossa	40.5	50	48.5	47.5	45.5	47*

Discussion

The patient reported a decrease in maximum pain levels from evaluation to discharge, but the varying literature on statistically meaningful changes according the numeric pain rating scale makes drawing a conclusion about the meaning of this decline difficult. However, a statistical threshold for change in pain does not necessarily mirror the threshold for an impactful change in ADLs from a patient perspective. Changes in pain that do not meet the minimum clinically important difference criterion may still have a positive impact on

patient function or participation. The patient's trends in pre and post treatment pain suggest that the CDT itself is unrelated to pain, but the overall change in limb-size may make the limb more manageable and thus less painful.

This patient demonstrated improvements with CDT at all of the landmark sites, except the styloid processes, at which the sides were symmetrical at evaluation and discharge. This is relevant because much of the literature regarding CDT for the upper extremity is as an intervention for post-surgical and post-radiation breast cancer patients. Because they comprise such large portion of upper extremity lymphedema patients, they are the often the subject of intervention. The results of this case study indicates that CDT may be an appropriate treatment for more than just acute post-radiation, post-surgical women with a history of breast cancer. It may also be beneficial for men, those with chronic lymphedema, and patients currently undergoing radiation or chemoradiation therapy for various types of cancer.

These results of this case study mirror the findings of the 2014 systematic review[5] that indicate while CDT is an effective treatment for lymphedema, compression bandaging is the most successful individual component of the intervention. Components such as MLD and gentle exercise are only effective when combined with the compression bandaging, indicating that the self-management and exercise components may not be essential to improvements. This also indicates that compression bandaging and MLD can be employed for patients with lymphedema and suspected non-compliance.

Study Limitations

A major limitation in this case study is the lack of outcome measures. The patient's full thickness rotator cuff tear made other aspects of treatment very challenging. The initial goal included increasing strength and range of motion while decreasing pain and swelling; however the therapist was unable to reassess strength and range of motion. The patient declined range of motion reassessments due to pain. This also precluded the therapist from testing strength, as many of the testing positions could not be attained. A decrease in girth would have likely had a positive impact on strength and range of motion, and these measures might have been obtained from a healthy shoulder. However, these additional measures may not be necessary when assessing the direct impact of lymph mobility as a result of bandaging and drainage.

Strength and range of motion are measures of body structure whereas circumferential measurements indicate fluid accumulation. CDT is designed to facilitate fluid transport and decrease backflow, not to improve mobility. Therefore, changes in mobility and strength may be secondary to the elimination of fluid, not a result of the treatment. Furthermore, while fluid accumulation may impact strength and mobility, it is not always an indicator of these things. Patients with varying degrees of lymphedema present with varying levels of function, indicating that fluid accumulation may not always result in a loss of strength and/or range of motion. Conversely, reduction in fluid may not always result in an improvement in strength and/or range of motion either.

Another limitation in this study is the lack of patient compliance. While studies suggest that non-adherence is generally to be expected in CDT self care[12] and that bandaging and MLD are the most effective parts of CDT, [5] compliance might have improved outcomes for bandaging and self-MLD because CDT as a whole is more effective than any of its individual components. Although the patient agreed to maintain the bandages over the weekends, the initial plan entailed educating the patient's wife on wrapping techniques so that the bandages could be applied freshly on weekend days well. The wife declined to participate and the particular dynamic between the couple indicated that the wife would not be an authority figure on care delivery, even once educated on technique. Patient compliance regarding self-management for MLD might also have improved patient outcomes, especially in the long-term. Patients are educated in self-drainage because lymphedema is typically life-long. The principle behind the technique is that the lymph needs to be constantly "reminded" through tactile facilitation. While the therapist does perform a more thorough and skilled

drainage, patient participation serves an important role in the daily "education" of the lymphatic system. The patient's failure to incorporate this into his treatment on the weekends may have negatively impacted his improvements.

Future Study Recommendations

This case report may serve as a pilot for larger studies on CDT patients outside of post-treatment breast cancer patients with acute lymphedema. More interventional studies with a larger number of patients would provide a foundation to expound these findings. Because the established literature indicates that CDT is the best clinical practice, [5] the control group necessary for randomized control trials would be unethical. Conducting retrospective or prospective studies would provide the comparative aspect required to evaluate the treatment without crossing ethical boundaries.

While compression bandaging is suggested to be the best component of CDT, [5] the literature does not provide information on follow-up time to indicate if CDT remains superior to its isolated components after completion of the intervention. A future study that includes patient follow up would be instrumental in determining the necessity of home exercise prescription. This would also allow for comparison of lymphedema stage progression, extremity function, and quality of life in compliant patients against non-compliant patients. This type of study could further examine factors that predict, contribute to or facilitate adherence to further improve patient compliance and outcomes.

CONCLUSIONS

The typical patients undergoing CDT are women that have completed radiation therapy and surgical intervention for breast cancer and present with acute upper extremity lymphedema. The findings of this study may serve as a foundation for future research exploring the effectiveness of this intervention for other types of patients, including men, non-surgical patients, and patients with chronic lymphedema or other types of cancer. The application of CDT may help to decrease upper extremity girth in these populations.

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