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Functional Rehabilitation and Strength Training-Focused Interventions for an Achilles Tendon Rupture and Repair: A Case Report

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Functional Rehabilitation and Strength Training-Focused Interventions for an Achilles Tendon Rupture and Repair: A Case Report

by

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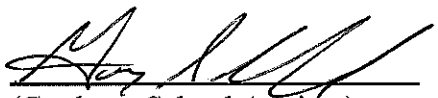
This Scholarly Project, submitted by Anna Murphy in partial fulfillment of the requirements for the Degree of Doctor of Physical Therapy from the University of North Dakota, has been read by the Advisor and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.



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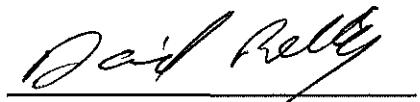

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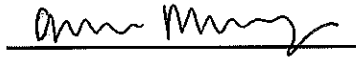
Signature 

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ABSTRACT

Background and Purpose. Current literature identifies a lack of consensus regarding specific rehabilitation protocols following acute Achilles tendon ruptures. This case report highlights the rehabilitation of a patient following an Achilles rupture and surgical repair, who underwent a physical therapy treatment program, focusing on interventions to increase function, strength, and return to activity. **Description.** The patient is a 64-year-old male, evaluated in the clinic four weeks following a status-post left Achilles tendon repair surgery, and presented with left ankle pain, decreased left ankle range of motion and decreased left ankle strength. The treatments and interventions used for this patient included Blood Flow Restriction training, interferential current electrical stimulation, ASTYM, and therapeutic exercise. **Outcomes.** Following 9 weeks of Physical Therapy intervention, with five weeks devoted to Blood Flow Restriction and functional strength training, the patient demonstrated gaining 85% improvement in their ankle active range of motion, normal to good ankle strength, and decreased ankle pain. Patient was returning to prior level of function and performing activities such as hiking, golfing, and playing backyard football with the grandkids. **Discussion.** Based on the results of this case, incorporating tourniquet-assisted blood flow restriction with functional rehabilitation programs may be a safe and effective protocol component to improve strength, endurance, and overall function after an Achilles tendon rupture.

Key Words: Achilles tendon Rupture, Functional Rehabilitation, blood flow Restriction, strengthening protocol, ankle pain, ankle support

CHAPTER I

BACKGROUND AND PURPOSE

The Achilles tendon, also known as the Common Tendon or Calcaneal Tendon is the joined tendon of the gastrocnemius and soleus muscle.[1] Located in the posterior compartment of the leg, the tendon inserts onto the calcaneal tuberosity of the calcaneus and promotes plantarflexion of the foot and ankle.

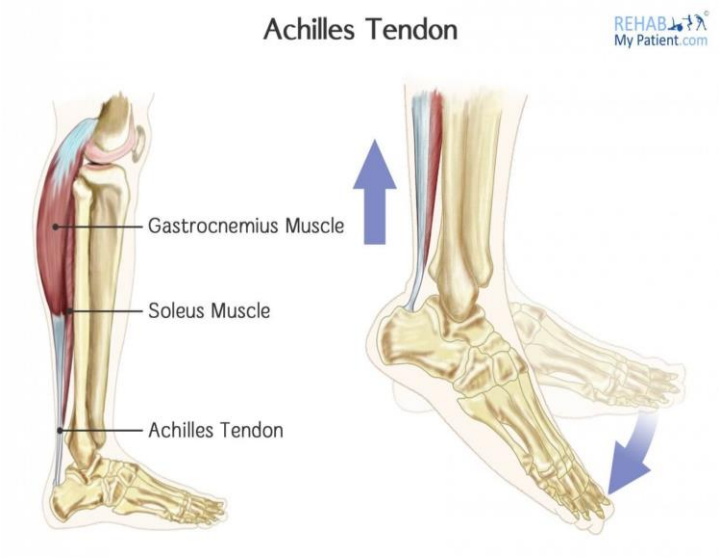


Figure 1. Anatomy of Achilles Tendon[2]

Accounting for 20-30% of tendon-involved injuries, the Achilles tendon is the most commonly ruptured large tendon in the general population.[3] An injury to the Achilles Tendon most often occurs as the result of direct or indirect trauma. A combination of mechanical stress, hypovascularity, and tissue degeneration at a specific site on the tendon are often causes. The location of injury is most often found to be two to six centimeters proximal to the insertion of the tendon onto the bone.[3]

The severity of the injury can be classified into one of two categories: a partial tear or a complete tear, also classified as a rupture of the tendon. A partial tear occurs when 25-75% of the tendon has been torn between the muscle and the point of insertion. A complete tear or rupture is when there is no connection between the muscle bellies and the point of insertion.

The mechanism of injury occurs when a high stress force is applied to the Achilles tendon, often into the direction of hyper-dorsiflexion of the ankle. The rupture can also be a result of the high-impact force from the push-off mechanism or a sudden stop and change in direction.[2] Individual's will often report having heard a "pop" in addition to a sharp, localized pain in the back of their calf at the moment of injury.

Risk Factors that may increase an individual's prevalence of an Achilles tendon rupture include the following: age, sex, use of steroids, chronic use of antibiotics or anti-inflammatories, obesity, and predisposing conditions like rheumatoid arthritis, hyperparathyroidism, or any previous injuries to the lower extremities. The age of incidence ranges from 30 to 55-years old and is most common in males.[3]

Another prevalent and emerging risk factor is the use of fluoroquinolones. Fluoroquinolones are a physician-prescribed antibiotic medication used to treat a wide variety of bacterial infections, most commonly associated with genitourinary and respiratory infections.[4] While the exact pathophysiology linking the use of fluoroquinolones and tendon rupture is undetermined, it has been found that over-use of this prescription drug can exert a negative effect on the human body. Directly targeting connective tissue and promoting a catabolic effect, fluoroquinolones continue breaking down tissues that already have a limited capacity for repair.[5] In a recent article by Persson[6], multiple studies were analyzed based on the results from the use of fluoroquinolones, in addition to the use of corticosteroids. The results have identified

combining the two drugs may increase tendon degeneration and further increase the risk of tendon injury or rupture. These findings are imperative when it comes to asking what medications or prescriptions a patient may have been taking prior to injury or could still be currently taking at the time of evaluation.

Thevendran et al[7] reported that a sufficient and thorough collection of patient history and examination findings can lead to an obvious and accurate diagnosis of an Achilles tendon rupture. The use of Magnetic Resonance Imaging (MRI) is often used in conjunction with physical examination findings to determine the location and severity of the rupture, as well as, any damage that might have occurred to surrounding structures and tissues. An MRI plus examination findings and patient history yields a sensitivity of 100% when detecting a complete tendon tear. The use of an MRI on its own decreases the sensitivity to 90.9%.[8] Therefore, MRI results and examination findings allow for the most accurate diagnosis of an Achilles tendon rupture. However, MRI findings may be beneficial when confirming findings or when deciding whether a surgical approach is needed.

There are multiple factors to consider when determining the course of treatment for patients with complete Achilles tendon ruptures. Factors including age, previous activity level, severity of the injury, and pre-existing health conditions may determine whether conservative treatment is favored over surgical treatment.[3] Factors that influence the healing process including age or pre-existing health conditions might lean more towards surgical treatment. If the patient had a high activity level prior to injury or was of a younger age, the physician might consider using conservative treatments. The goals for either course of treatment is to restore normal tendon length, optimal strength and range of motion, and overall function. Currently there is

insufficient evidence that proves one course of treatment to be more beneficial or successful than another.[8] Therefore, the course of treatment is often based on patient and physician preferences.

Recent conservative treatments consisted of immobilization of the injured limb for eight to twelve weeks, followed by an accelerated eight-week rehabilitation protocol.[9] Throughout this protocol, the patient transitions from non-weightbearing, to controlled ankle motion braces, with strengthening, proprioception and functional activity retraining. Benefits of this course of conservative treatment include a decreased risk of surgical complications, infection, and no incisional scarring.

Non-conservative treatment involves a surgical procedure. Surgical repair of the Achilles tendon can be performed from by a variety of approaches, depending on the severity of the injury. The most common and successful approach is the minimally invasive, percutaneous repair. Through small incisions in the skin, sutures are looped and tied to the Achilles, joining the proximal portion of the ruptured tendon to the distal end of the tendon proximal to the insertion on the calcaneus.[10] The benefits of minimally-invasive surgical repairs are decreased re-rupture potential, reduced damage to the surrounding tissues, and less pain with shorter recovery time.[11]

Three phases are involved during the tendon healing process (Inflammatory, Proliferative, and Remodeling). Immediately following an acute injury or surgical repair, the inflammatory phase begins and lasts anywhere from three days to one week, as an influx of cells promote vascular blood flow which recruits proliferative cells.[12] Next is the proliferative or reparative phase that begins approximately two days following injury or repair and lasts a few weeks. This phase is characterized by fibroblasts producing and rebuilding collagen fibers.[13] The transition from the proliferative phase to the final phase, the remodeling phase, is the most

important to consider during rehabilitation. It is at this time the tendon is at its weakest point as the collagen Type III fibers are being converted and replaced with collagen Type I fibers. The remodeling phase can last anywhere from weeks to months.[12] During this phase, it is important to start stressing the tendon appropriately, as it will allow for the crosslinked fibers within the tendon to be broken down and realigned to improve strength of the tendon.[12-13]

A systematic review by Holm et al[14] stated there are no clinically significant differences whether surgical or nonoperative treatment was determined the best course of treatment. In turn, the results proposed that the rehabilitation aspect following an Achilles tendon rupture is more important than the initial treatment, including surgery or immobilization.

Following surgical intervention, a rehabilitation protocol should be immediately implemented to restore the patient's prior activity levels, it should integrate early mobility, with a focus on functional activities, to increases the rate of recovery and decrease the risk of re-rupture.[15] While current literature lacks a consensus for a specific rehabilitation protocol to implement following a surgical repair, most continue to direct back to the effectiveness of incorporating functional rehabilitation.[16] Brumann et al[17], investigated treatment effectiveness, patient satisfaction, and time until return to work or activity to be among three of the most common functional rehabilitation protocols. Trials comparing non-weightbearing immobilization, non-weightbearing with early ankle mobilization, and full weightbearing with early ankle mobilization were completed. The results identified that full weightbearing immediately following surgery with early controlled ankle mobility in the second postoperative week to be superior. Full weight bearing and controlled ankle mobility was found to have increased patient satisfaction, decreased the duration prior to the return to activity, and demonstrated optimal improvement in strength and ankle mobility.

Traditional strength-focused interventions that are often utilized include resistive training using hand held weights, body weight, and resistance bands. Recently, a new strength-based intervention has been introduced. Blood Flow Restriction (BFR) training is the new treatment intervention being researched for its rehabilitation potential of both operative and nonoperative musculoskeletal deficits, because it allows for strength improvements when higher loads are either not attainable or contraindicated owing to surgical precautions.[18] Much like the phases of tendon healing, utilizing a Personalized Tourniquet System targets the inflammatory cascade through the temporary breakdown of proteins during muscle loading by limiting the percentage of oxygen that is being delivered by arteries to the muscles and surrounding tissue. In turn, the "healing process" results in an increased response of protein synthesis, which is used to build both type I and type II muscle fibers. Following a six-week randomized controlled-trial, results suggest that low-load BRF training to the lower extremity may produce an increase in strength, muscle hypertrophy, and increased endurance capacity in proximal, distal, and contralateral muscles.[19] Current research and literature has suggested that the use of BFR training is a safe efficient tool that can be used to increase muscle strength and endurance.[20]

This paper will focus on the postoperative recovery and rehabilitation of the patient in the case study, along with the physical therapy treatment interventions used to specifically address strength, range of motion, pain control, and time before return to activity, as an adapted protocol of functional rehabilitation for an Achilles tendon rupture and repair.

CHAPTER II

CASE DESCRIPTION

The patient was a 64-year old male who acquired a traumatic left Achilles Tendon rupture while playing Pickleball in late August of 2019 during his vacation to Florida with his wife. The patient ambulated with bilateral axillary crutches for one-week while waiting for the completion of an MRI. MRI results identified a complete left Achilles tendon rupture. The patient was scheduled for and received a surgical repair of his Achilles tendon. The tendon was percutaneously re-attached with the left ankle splinted in an immobilizing cast for three weeks following surgery.

Once the cast was removed and the patient was four weeks from the surgical date the primary physician referred the patient to physical therapy. The patient had been placed on a post-surgical protocol by the surgeon, to be followed until the removal of the immobilizing cast, however, no protocol was given by the surgeon or physician once the cast was removed. The patient could be weightbearing as tolerated (WBAT) and begin active range of motion (AROM) of his left ankle to his tolerance.

The patient was in good health status prior to injury and had no previous history of left ankle or foot injuries. He self-reported as very active and enjoyed hiking, golfing, all which often requires walking long distances on uneven ground. In addition, the patient is a co-owner of an insurance company and spends most of his workday sitting at his desk on his phone or computer. The patient lived at home with his wife with no difficulty negotiating his way around the house since surgery. The patient's primary complaint was having had difficulty ambulating long

distances, especially on uneven surfaces. The patient reported and complained that pain levels were consistently at a 6/10 (with 0=no hurt and 10=hurts worst), on the Wong-Baker FACEPain Rating Scale[21] since his surgery. He had been utilizing ice packs and compression stockings on his left ankle to control the swelling and moderately decreased his pain. The patient reported that his goal for physical therapy was to be able to walk long enough distances without pain in order to participate in his annual deer and pheasant hunting trips during the fall. He also wanted to be able to keep up with his grandchildren, playing games with them and being able to attend their sporting events.

Examination

The physical therapy evaluation for this case was based on *Dutton's Orthopaedic Examination, Evaluation, and Intervention* evaluation of the ankle.[22] Upon initial evaluation, patient presented to physical therapy and was observed using a knee scooter for independent ambulation to the treatment room and independently transferred to the treatment table. Patient was able to stand independently, with full weightbearing on the left and right ankle. Bilateral ankle AROM was measured in the sitting position with a standard goniometer and the obtained measurements were recorded, followed by passive range of motion (PROM) in the same position (see Table 1.).

Table 1. Initial Ankle Range of Motion (in Degrees)

	Left	**Right**
Dorsiflexion	-5 AROM/ 0 PROM (painful)	12 AROM/ 14 PROM
Plantarflexion	20 AROM	45 AROM
Inversion	13 AROM (painful)	30 AROM
Eversion	9 AROM (painful)	12 AROM

All bilateral hip and knee range of motion was within normal limits (WNL). Bilateral hip and knee strength tested as strong and painless with resisted isometrics (RIMS) strength testing in all planes of motions. Bilateral ankle strength was tested using Manual Muscle Testing (MMT) and the result recorded were documented as seen in Table 2.

Table 2. Initial Ankle Strength

	Left	**Right**
Dorsiflexion	3/5, painful	5/5
Plantarflexion	2/5, painful	5/5
Inversion	3/5, painful	5/5
Eversion	3/5, painful	5/5

Patient demonstrated pain during palpation along the left anterior ankle, inferior and superior to the medial and lateral malleoli, at the calcaneal tendon insertion, and along the entire gastrocnemius and soleus muscle bellies. A four centimeter, closed surgical incision was observed on the left posterior ankle. No redness, warmth, or abnormal swelling was observed to suspect infection, following the criteria for signs and symptoms of a surgical site infection.[23]

Due to the physician-report diagnosis, no special tests were performed during the evaluation of this patient. The Thompson calf-squeeze test is a common special test used for diagnosis of complete Achilles tendon ruptures. Recent studies have found the sensitivity and specificity of this test to be 0.96 and 0.93 respectively[24], making this a clinically significant test to confirm the diagnosis of a complete tendon rupture.[25]

The patient was given a Lower Extremity Functional Scale (LEFS) as an appropriate functional outcome measure to fill out and assess activities of daily living (ADLs) (See Appendix 1). According to Binkley et al[26], the LEFS has a 95% confidence interval, making it a

clinically significant functional outcome measure to administer in regard to reliability, validity sensitivity to change when compared the Short Form-36 (SF-36). The use of this outcome measure is widely accepted for clinical use as the functional items can be scored and directly translated into patient goals for therapy. The patient scored a 48/80, putting him at 50% of his maximal function.[27]

During a gait analysis, the patient demonstrated a decreased stance time on the left lower extremity, with decreased dorsiflexion in loading response and midstance. The restrictions in motion were due to the limited ankle range of motion and increased ankle pain in single leg stand on the left at the time of examination. The mobility of the surgical scar was moderately restricted utilizing scar mobilization techniques, most likely due to the presence of scar tissue in the area.

Evaluation and Diagnosis

Following the initial examination, an appropriate list of problems and impairments were developed to determine the PT diagnosis. Due to the patient being referred from a physician with a confirmed diagnosis, no differential diagnoses were explored.

The problem list included decreased left ankle strength and ROM, impaired gait, lower extremity pain, and a decreased activity tolerance. Based on the Guide to Physical Therapy Practice, these impairments and activity limitation were placed into the International Classification of Functioning, Disability, and Health (ICF) model that would direct the patient's plan of care (See Appendix 2).[28] Given the patient's previous level of activities, absence of co-morbidities or red flag signs and/or symptoms, referral for further testing and evaluation was not deemed necessary.

Prognosis and Plan of Care

The patient's prognosis during the course of Physical Therapy treatment was deemed good, and was expected to return to prior level of function, due to no prior co-morbidities and increased patient self-motivation. It was determined that the patient would be seen two times per week for 10 weeks, for 45-minute sessions. The patient was seen by a student physical therapist (SPT) for nine of his ten weeks and was transferred back to the overseeing clinical instructor for the final week of his treatment and discharge. The patient verbalized agreement for the transfer of care.

The primary goal of physical therapy was to return the patient to previous level of functional activities, many of which were located on the LEFS outcome measure.

Short term goals for the patient included: following physical therapy intervention,

1. The patient will increase left ankle dorsiflexion from -5 degrees to 5 degrees in order for patient to sit comfortably at his desk at work for 30 minutes at a time (to be met in three weeks).
2. The patient will increase left ankle plantarflexion to from 2/5 to 4/5 in order to improve push-off during gait, to allow for him to ambulate independently from the parking lot to the gym for his grandkid's basketball game (to be met in four weeks).

Long term goals for the patient included: following physical therapy intervention,

1. The patient will independently ambulate 600 meters in order to take his dog on walks around his neighborhood (to be met in eight weeks).
2. The patient will demonstrate at least 80% competency in performing his Home Exercise Program in order to reduce the risk of re-injury (to be met in ten weeks).

Interventions used to address these goals included therapeutic exercise, manual therapy, therapeutic activities, and neuro re-Education (i.e. Blood Flow Restriction (BFR) training).

CHAPTER III

INTERVENTION

There is no universal post-surgical rehabilitation protocol identified for Achilles tendon repairs. Current research suggests that the first stage, allowing full weightbearing in an orthotic cast, zero to two-weeks post-surgery, can produce optimal results and increase overall patient satisfaction.[29-30] The second stage, three to six weeks post-surgery, allows full weightbearing is encouraged during ambulation with interventions focused on increasing dorsiflexion range of motion at the ankle. The third and final stage begins at approximately seven weeks post-surgery where the patient may begin ankle-specific strengthening and proprioception interventions. The initial encounter and physical therapy treatment began four weeks post-surgery, therefore, the initial treatment commenced during the second stage of the guided rehabilitation program and phases of tissue healing.[12-13]

Interventions of week one and two focused on therapeutic exercise consisting of supine short arc quads with a bolster under the knee, heel slides on a sliding board, side lying hip abduction and clam shells, and therapist-assisted passive range of ankle motion into all motions. Each session was completed by applying a pain controlling modality, Interferential Current (IFC) electrical stimulation, with an 80-100Hz frequency sweep for 20 minutes. The IFC E-stim utilized four two-inch circular electrodes located on the left ankle as follows: anterior to medial malleolus, anterior to lateral malleolus, posterior to medial malleolus, posterior to lateral malleolus. The electrodes were arranged in a crossed manner with the intensity increased to the patient's tolerance of a strong, but comfortable level. The initial week two goal was control pain,

initiate left ankle range of motion, and to maintain range of motion and strength of the left knee and hip. In addition, the patient was instructed in a written home exercise program to be performed at least once a day which included light ankle stretches with a towel around the foot in all motions. With plantarflexion stretching, the patient was instructed to stretch into a range that produced discomfort, but did not increase or produce pain.

Weeks three and four transitioned from supine to seated and upright weightbearing exercises. Seated exercises included the use of a Biomechanical Ankle Platform System (BAPS) board on level two in the forward, backward, lateral, and clockwise/counterclockwise directions to increase left ankle multi-directional range of motion and left ankle proprioception. In standing, the patient performed bilateral hip abduction and extension, and bilateral heel raises. After the completion of exercises, patient received ASTYM treatment (per treatment pattern) to the left lower extremity. ASTYM to the left ankle was completed in order to break down adhered and tight tissues and increase range of motion. The patient was given additional exercises to complete at home which included bilateral heel raises as tolerated and isometric ankle inversion and eversion (2 sets of 15) to be performed once daily as tolerated.

At week five, the patient was re-evaluated based on ankle range of motion and strength progression. While left ankle range of motion was improving, and functional improvements like increased ambulation distance and increased activity tolerance were being made, it was determined that traditional rehabilitative efforts were not allowing for adequate strength improvement. The need for a strength-focused intervention was directed to Blood Flow Restriction (BFR) training. The concept behind BFR training is to appropriately stress muscle tissue physiologically while minimizing the mechanical stress placed on the same tissue. Based

on current research, maximizing strength gains and muscle hypertrophy, would have the greatest benefit for the patient, allowing a quicker return to function and activity.[29-30]

At the beginning of week six, the patient began a personalized blood flow restriction program that followed the traditional BFR strengthening protocols. A Blood Flow Restriction tourniquet cuff was placed over a limb protection sleeve, at the most proximal location of the limb.[29] The personalized tourniquet system automatically calculates the patient's individual limb occlusion pressure (LOP) while resting in the supine position. LOP is the lowest pressure needed to stop the arterial flow of blood to the distal limb. Hughs et al[31] concluded in their meta-analysis and systematic review the recommended pressure for applying BFR training of the lower extremity is 80% of the LOP. This has been shown to produce the greatest effects of muscle hypertrophy with minimal vascular risk. Therefore, the individual's personalized tourniquet pressure (PTP) was set at 80% of the LOP and utilized for all BFR exercises. Due to this value varying throughout time, the PTP and thus 80% of the LOP are calculated by the tourniquet system before each exercise session. Within each session, the BFR exercises are performed in four sets consisting of 30, 15, 15, and 15 repetitions. Research is inconclusive in the optimal repetitions for BFR exercise, but the 30, 15, 15, 15 protocol is widely used throughout the literature and has been thought to allow for the largest accumulation of metabolites in the healing muscles.[27] A 30 second rest is allowed between each set, while maintaining the tourniquet pressure. The pressure is released after performing four sets of an exercise and the patient is allowed to rest for one minute. The PTP is then re-applied for the next BFR exercise. This process continued until all of the exercises were completed. The four exercises utilized with BFR included bilateral heel raises, single leg heel raises lying supine at 25 degrees inclination without any added weight, long sitting resisted ankle dorsiflexion using a green TheraBand, and

alternating long sitting resisted inversion and eversion using a green TheraBand. The patient completed four-sets (30, 15, 15, 15 repetitions per set) with 30 second rests in between each set.

The patient repeated this protocol and specified exercises for week seven thru nine, alternating resisted ankle eversion and inversion with a purple TheraBand during each session (see Table 3.). At the completion of BFR exercises for each session, the patient received ASTYM treatment to the left lower extremity in order to break down adhered and tight tissues around the left ankle and increase range of motion.

Table 3. Blood Flow Restriction Exercises and Protocol

Exercise	**Protocol**
Bilateral Heel Raises	• 80% of Limb Occlusion Pressure (LOP) • 4 sets, 30/15/15/15 reps, 30 second rest between sets. • 1-minute rest between each exercise
Single Leg Heel Raise at a 25-degree incline	
Resisted Dorsiflexion	
Resisted Inversion/Eversion	

Patient education included home and work activity modifications in order to decrease soreness and improve overall activity endurance. The patient also received education on scar management with the use of Vitamin E lotion and proper wound wrapping to reduce friction from the heel counter of the shoe rubbing on the healing scar. He was also encouraged to elevate, ice, and compress his left ankle to help with pain management.

CHAPTER IV

OUTCOMES

The patient tolerated treatment well and was always willing to try new interventions or exercises. However, he would often come to sessions complaining that he was sore or that he had overdone his activities at home. He continually stated he was pleased with the progress and improvements he was making and that he noticed he was able to tolerate more activities and his pain was decreasing.

Over the course of the first five weeks of Physical Therapy rehabilitation, patient reported a 50% decreased in frequency of pain, and a slow progression of functional use. Patient tolerated all of the exercises during the treatment session and progressed as able. Patient would often report left ankle stiffness and soreness following exercise and any increased activity or walking in between his physical therapy appointments.

During the tenth visit at the end of week five, the patient had strength, range of motion of the left ankle, and pain levels reassessed. The patient was able to complete ten bilateral heel raises, with a one to one-and-a-half-inch heel to floor difference noted between the involved and uninvolved extremity. In addition, the patient reported a noticeable strength deficit in his left ankle compared to the right ankle. The patient was also having difficulty walking long distances, which he thought was limited to about 400 meters.

Starting at the implementation of the five-week BFR strength training protocol, the patient was tested at the beginning of each week's treatment session to determine the number of bilateral heel-raises and left single-leg heel raises the patient was able to perform. The number of

heel-raises for each test was limited to a maximum of 30, as this is number of single heel raises is equivalent to 5/5 muscle strength, according to *Cram Session in Goniometry and Manual Muscle Testing*.[32] The number of bilateral and single heel raises were recorded and can be observed in Table 4.

Table 4. Weekly Bilateral and Left Single Leg Heel-raises tested prior to BFR training

	Week 5	**Week 6**	**Week 7**	**Week 8**	**Week 9**
Bilateral heel-raises	15	22	30	30	30
Left single-leg heel-raises	4	7	15	23	30

Before the transfer of care from student therapist to the overseeing clinical instructor, the patient's left AROM was re-assessed and appeared to be within functional limits (see Table 5.). Strength of the left ankle was measured to be 5/5 in all motions.

Table 5. Final Ankle Range of Motion (in Degrees)

	Left
Dorsiflexion	12
Plantarflexion	43
Inversion	28
Eversion	12

Overall, the patient was motivated to make improvement during rehabilitation. The BFR training was extremely intense and was occasionally associated with extreme exhaustion. The patient often reported BFR training as difficult and intense. The patient did report occasional

soreness on days following BFR training, but could notice the improvement of strength in his left ankle. There were a few setbacks during the episode of treatment, due to the patient missing or cancelling a total of six appointments. The patient would often show up 10-15 minutes late, so efficiency of the session was the main priority. The patient was still very pleased with his results and functional strength gains, and tolerated the progression of exercises and implementation of blood flow restriction training.

In terms of functional improvements, the patient reported he was able to progressively walk further distances of roughly 500 meters. He also noticed an overall improvement in his activity tolerance, as he was able to independently ambulate across parking lots and around his neighborhood, which allowed him to meet two of his goals. The patient did not fill out the LEFS during his ninth week of treatment as he would complete it the following week or during his discharge session. He was able to sit at his desk for about 45 minutes before he had to get up and walk around, which allowed him to meet one of his long-term goals. The patient was compliant with his home exercise program and stated it helped him maintain his strength and motion even though he was missing some of his appointments. He felt that he was confident enough to continue the exercises he was provided with on his own time. At the time of transfer of care, the patient had met many of his short- and long-term goals, but would be formally evaluated at his discharge appointment the following week.

CHAPTER V

DISCUSSION

A meta-analysis of current evidence by Mark-Christensen et al[33], determined that the use of functional rehabilitation did not have a clinically significant effect on the re-rupture rate after an Achilles tendon rupture. Their results concluded that patients self-reported a higher satisfaction with their care, along with an earlier return to work/activity and increase in strength and range of motion.

Throughout the course of physical therapy, the patient progressed in many of his limitations and restrictions. At the initial evaluation, the patient was limited in left ankle range of motion and strength, due to increased pain level with activity and a decreased tolerance to activity. The patient was also limited in his ambulation distance, which kept him from performing many of the activities and functions he enjoyed prior to his injury. As the weeks progressed, the patient reported stiffness and soreness following his physical therapy sessions. The results of this decrease in pain and discomfort allowed him to tolerate more activity throughout the day. He was able to return to many of his activities, like walking and playing with his grandchildren as he was able to prior to his injury. From session to session, the patient's gait pattern improved, resulting in a more forceful toe off and increased time during the stance phase on his left leg.

The patient reported increased lower extremity strength and was confident he would be able to get back to his prior activities, and would have no problem walking through the uneven fields during the hunting season.

The results of this case exhibit a positive correlation to the use of BFR training in addition to conventional Physical Therapy interventions to provide functional strength improvements for a patient of good health status and physical function. Compared with high-load/intensity training, low-load BFR training may be more effective, tolerable and therefore a potential clinical rehabilitation tool to be used side by side with conventional and traditional physical therapy interventions.[30] There is potential for the development of an individualized approach to training prescription to minimize patient risk and increase effectiveness. This case study suggests that BFR therapy, in addition to traditional interventions, may be beneficial in a healthy population to induce muscle hypertrophy and strength improvement in the rehabilitation phases following injury of the Achille's tendon.

A limitation to the effectiveness for the use of BFR in this case was the time of implementation within the rehabilitation timeline for this particular patient. There is no way to determine if the patient would have progressed the same without the addition of BFR therapy or what the results would have shown if BFR was implemented sooner during the course of therapy, rather than halfway through the plan of care

Future studies are needed to determine an appropriate and effective protocol for Achille's tendon ruptures and surgical repairs. Effective protocols must include interventions that focus on restoring range of motion, increasing strength and activity tolerance in accordance to tendon healing phases and timeline.

Reflective Practice

The plan of care of this patient allowed for critical thinking, use of prior knowledge learned, and searching the literature for current treatments and management of similar conditions to the patient that was seen. The prior knowledge and skills I had learned in the classroom were

applied by conducting an initial examination, using relevant tests and measures. Those results were then evaluated to create a working diagnosis and develop appropriate goals to resolve the impairments. Through critical thinking and problem solving, interventions were implemented to help address the deficits in strength and range of motion, educate the patient on his condition and prognosis, and get him back to his prior level of activity and function. The progress of the patient's goal and outcomes allowed for re-evaluation of his current condition, and the cycle of Clinical Decision Making (Examination, Evaluation, Diagnosis, Prognosis, Intervention, and Outcomes) was continued until all goals and functional activities were achieved, or near-achieve at the time of discharge. The use of this clinical decision-making model allowed for continual patient-centered care.[34]

While there are a wide variety of interventions, treatments, or exercises that one can utilize for outpatient rehabilitation during the patient's sessions, prior knowledge or resources from coursework and classes would be helpful. Rather than just going through basic range of motion and resistive exercises to improve motion and strength, there could be more benefit in learning the benefits, set up, and use of equipment used for Blood Flow Restriction training.

The patient was seen for a total of 14 visits by a student physical therapist. All treatments, interventions, and changes to the plan of care were overseen by a licensed clinical instructor. It was estimated that the total cost of the patient's physical therapy sessions equaled $980.00.[35] Through insurance coverage, the estimated out of pocket expense for the patient totaled $637.00.[35-36] The majority of the direct expenses came from billing neuro-reeducation and utilizing BFR, but also provided us with the best results in a short amount of time. The patient was still able to work during this time, and he would schedule his appointments over his lunch hour or at the end of the day, so there was no loss in productivity or money in regards to his

income. The patient stated he was planning on retiring within the next year, so the long term benefits of physical therapy were important in maintaining his mobility as he would see his activity levels increase over the next few years, and we wanted to decrease any risk of re-rupture through the continuation of a home exercise program.

The benefits of physical therapy for the patient include the following: increased left ankle strength, increased range of motion, decreased levels of pain at rest and during activity, improvements in gait pattern, and overall increase activity tolerance. There were no indirect factors like financial or ethical concerns that could have affected the plan of care. Therefore, the benefits of physical therapy far more outweighed the direct and indirect costs for the patient.

Additional time spent on patient education regarding energy conservation and activity workload may have further improved the patient's outcomes. Occasionally, exercise intensity was reduced or modified in order to ensure significant post-exercise soreness levels were not reached. More education on this topic may have allowed more efficient exercise sessions while preventing the occurrence of over-exercising. This might have encouraged the development of communication skills and learning style adaptations as information was presented and taught to the patient. In reflection of the initial evaluation, circumferential measurements of the lower leg, ankle, and foot would have been completed. This would have allowed the ability to compare the initial swelling of the left ankle to the right ankle, and then monitor the decrease in swelling from week to week and determine if that had any influence on range of motion.

This case allowed the application of knowledge and skill to take place and permitted an independent initial evaluation and the development of a plan of care to be completed. With the help and encouragement of the clinical instructor, current research and clinical practice guidelines were utilized to direct clinical decisions for optimal patient care. This case led to

experiencing and the utilization of BFR training, looking into the current research behind its use and determine if it was appropriate to administer with the patient. Looking back, this case was an integral part in the clinical education and professional development, creating a more informed and efficient healthcare professional.

APPENDIX 1

Lower Extremity Functional Scale (LEFS)[27]

Lower Extremity Functional Index

We are interested in knowing whether you are having any difficulty at all with the activities listed below because of your lower limb problem for which you are currently seeking attention. Please provide an answer for each activity.

Today, do you or would you have any difficulty at all with:

(Circle one number on each line)

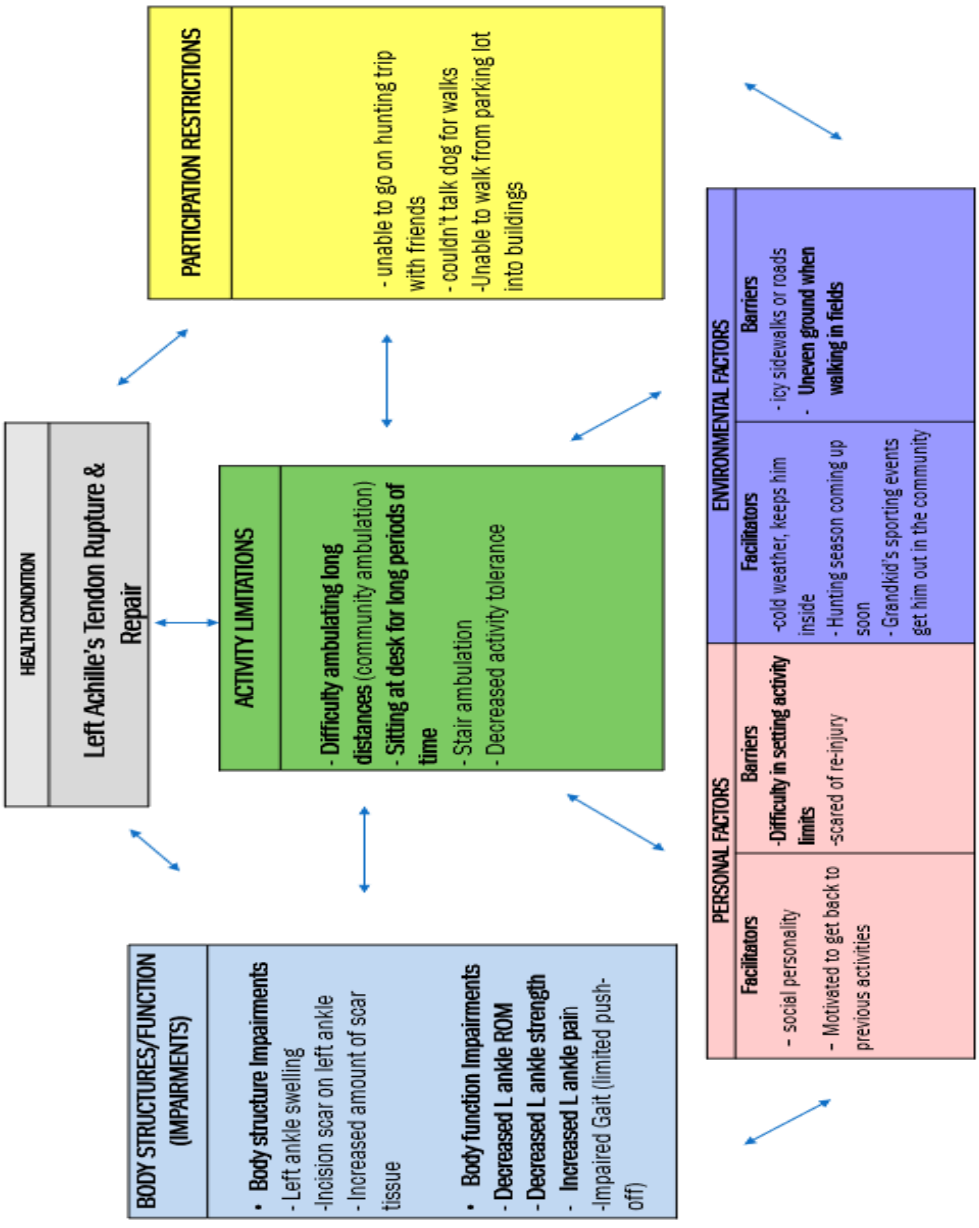
Activities	Extreme Difficulty or unable to perform activity	Quite a bit of difficulty	Moderate difficulty	A little bit of difficulty	No difficulty
a. Any of your usual work, housework or school activities.	0	1	2	3	4
b. Your usual hobbies, recreational or sporting activities	0	1	2	3	4
c. Getting into or out of the bath.	0	1	2	3	4
d. Walking between rooms.	0	1	2	3	4
e. Putting on your shoes or socks.	0	1	2	3	4
f. Squatting.	0	1	2	3	4
g. Lifting an object, like a bag of groceries from the floor.	0	1	2	3	4
h. Performing light activities around your home.	0	1	2	3	4
i. Performing heavy activities around your home.	0	1	2	3	4
j. Getting into or out of a car.	0	1	2	3	4
k. Walking 2 blocks.	0	1	2	3	4
l. Walking a mile.	0	1	2	3	4
m. Going up or down 10 stairs (about 1 flight of stairs).	0	1	2	3	4
n. Standing for 1 hour.	0	1	2	3	4
o. Sitting for 1 hour.	0	1	2	3	4
p. Running on even ground.	0	1	2	3	4
q. Running on uneven ground.	0	1	2	3	4
r. Making sharp turns while running fast.	0	1	2	3	4
s. Hopping.	0	1	2	3	4
t. Rolling over in bed.	0	1	2	3	4
COLUMN TOTALS					

Score variation ± 6 LEFTS points
MDC & MCID = 9 LEFS points

Score _____/80

APPENDIX 2

International Classification of Functioning, Disability, and Health Model[28]



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