Effect of Eccentric Strengthening and Neuromuscular Dynamic Balance Exercises on an Individual with a Right Lateral Ligament Reconstruction and Gastroc/Soleus Resection

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PTY 768 Capstone Experience: Case Report
The Sage Colleges Doctor of Physical Therapy Program

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May 2012
Abstract

Introduction: The purpose of this study was to determine the effects of a 14 week eccentric strength training and neuromuscular dynamic balance exercise program in an individual with lateral ligament reconstructive surgery and gastroc/soleus resection.

Case description: 45 year old female with right lateral ligament reconstruction and gastroc/soleus resection.

Examination: Patient had a long history of ankle sprains with degenerative joint disease and presented with limitations in standing posture and balance, ankle strength and motion, gait, edema, pain and impaired independence in activities of daily living.

Interventions: 14 week strength training program consisting of eccentric loading and neuromuscular dynamic balance exercises.

Outcomes: The patient met all short-term goals, most long-term goals and improved Lower Extremity Functional Scale (LEFS) score from 6/80 to 70/80.

Discussion: Eccentric strength training and neuromuscular dynamic balance activities exhibit significant increases in the patient’s function and reduction in pain after participating in a 14 week program following a right ankle ligamentous reconstructive and gastroc/soleus tendon surgery. Eccentric strength training and dynamic balance activities were effective at improving the patients clinical and outcome measures including: strength, range of motion, balance, flexibility, gait, along with the patients’ own perceptive score on the LEFS and reduction in pain.

Conclusion: The findings suggest that eccentric training is a safe and effective method for loading the right ankle ligamentous structures and the gastroc/soleus tendon following surgery.

Keywords: physical therapy, eccentric exercises, ankle sprains, Achilles tendinopathy and balance exercises.
Background and Purpose

Functional instability of the ankle is defined as the tendency of the ankle joint to give way after reoccurring chronic ankle sprains. Factors that may contribute to chronic functional instability are proprioceptive deficits, poor muscle function and anatomic laxity. These deficits cause overall scarring of the joint capsule and ligament structures and the patient loses their sense of awareness in the ankle joint leading to chronic ankle sprains and eventually degenerative joint disease.¹ Functional instability leads to degenerative joint disease and debilitating dysfunction as a result of flatfoot deformity, especially in the adult population. This progressive flattening of the arch results in the patient unable to form the appropriate biomechanical movements in the arch during normal activities such as walking. As a result of the biomechanical mal-alignments, abnormal forces are placed on the ankle joint and the surrounding tissue, including the medial and lateral ligamentous structures. These abnormal forces that are placed on the surrounding structures of the ankle lead to the vulnerability for reoccurring sprains and can cause degeneration of the articular cartilage requiring surgical intervention.²

The ankle joint is bound by medial and lateral ligamentous structures that span across the ankle joint itself and makes an important contribution to the stability and movement of the ankle, thus allowing free articulation of the fibula with the talus and calcaneus. The three components that make up the lateral ligaments of the ankle are the anterior talofibular, posterior talofibular and calcaneofibular ligaments. These ligaments are strong and durable, yet are vulnerable to sprains caused by extreme inversion alone, or combined with plantarflexion or dorsiflexion.

One of the most common surgical procedures used in ligament reconstruction, secondary to functional instability of the ankle, is the Modified Brostrom Procedure. With the Modified
Brostrom Procedure, the anterior talofibular and the calcaneofibular ligament’s are shortened and sutured down to the lateral distal fibula. The extensor retinaculum is then sutured and anchored to the outer tissue surrounding the bone, known as the periosteum, of the distal fibula, all while the foot is held in a slight everted and neutrally dorsiflexed position.\textsuperscript{21-23}

This procedure entails an anatomical repair and reconstructive tenodesis of the ankle joint and the surrounding ligamentous structures.\textsuperscript{21-23} Although 80\%-85\% of ankle sprains are successfully treated with some type of rehabilitation of the ankle, 15\% to 20\% of the ankle sprains have reoccurring functional instability and high risk for re-injury.\textsuperscript{22} This procedural approach helps to reinforce the ligamentous tissue, provide functional biomechanics at the ankle and prevent future reoccurring ankle sprains with increased strength of the ankle. Due to the ligamentous re-construction, the ankle will have a better biomechanical alignment with a decreased flattening of the arch and help to further prevent degenerative joint disease as a result of the previous functional instability.

Research suggests that eccentric strengthening, along with dynamic balance activities, can result in greater, and more significant, gains in muscle strength, pain and functional outcome measures. The suggestions of eccentric, versus concentric strengthening and dynamic balance activities, is based solely on rehabilitation programs for acute ankle sprains and Achilles tendinopathy.

With an eccentric contraction, the muscle and muscle tendon lengthens, versus a concentric contraction where the muscle and muscle tendon shortens. It has been proposed that with an eccentric contraction the muscle tendon produces a greater vibratory forces than in concentric contraction, and hence to a greater remodeling stimulus for the reconstructed tissue. An eccentric muscle contractions leads to a greater force fluctuation, which results in a greater
remodeling stimulus of the injured tendon. The pattern of tendon lengthening within eccentric contraction, with the difference in force fluctuation rather than the magnitude of force with a concentric contraction, is responsible for the benefits seen over the concentric contraction. Eccentric contractions have better bone and muscle remodeling because of the high-frequency oscillations rather than the frequency of the magnitude of force like concentric exercises.\textsuperscript{26}

In the case of a gastroc/soleus resection, concentric muscle contraction can require too much power generation, or peak torque force, putting the surgical procedure at risk for damage, sometimes permanent.\textsuperscript{3-5,9} The type of mechanical force that is applied to the tendon has a great affect on the outcomes of the loading response. Some evidence shows that an eccentric program to improve strength may have yielding effects in the management of Achilles tendinopathy more so than concentric loading. It is suggested that the type of tendon loading through eccentric contraction, with the force fluctuating and oscillating, rather than the degree of force with a concentric contraction, is the sole reason for the therapeutic benefits in functional outcomes gained.\textsuperscript{24}

In the study by Henriksen, et al. low mean electromyography (EMG) amplitude was observed in an eccentric contraction and compared to the concentric contraction in the muscle of the lower leg. The eccentric contraction was different from the concentric contraction in the ground reaction force (GFR) frequency and the reduced EMG activity. The findings of their study showed even though the load on the tendons were similar, in both eccentric and concentric, the tendon is has a higher vibratory frequencies during an eccentric contraction more than the a concentric contraction. The reduction in the eccentric EMG contraction suggests that there is an insufficient activation of motor neurons in the lower extremity muscles. Even though the tendon loads are comparable, the tendon vibrates at a higher frequency with an eccentric contraction.
more than a concentric contraction. This explains the effectiveness and benefits of an eccentric strengthening program used as part of the treatment for Achilles tendinopathy over concentric exercises. The eccentric contraction phase was shown to have a higher GRF frequency and reduced EMG activity, and should be considered over concentric exercises for Achilles tendinopathy rehabilitation.25

Contributing factors of proprioceptive deficiencies and anatomical laxity can lead to dynamic balance impairments and instability in the ankle.1 Physical therapy focusing on dynamic neuromuscular balance activities is important to regain normal biomechanical function in patients returning to previous level of function. Dynamic balance activities are an important aspect of the rehabilitation of functional instability because they help to increase proprioception, improve anatomic laxity and reduce the risk of reoccurring ankle sprains. Balance activities should include standing and walking on a variety of different supported surfaces, standing with one foot on front of the other (tandem) or semi-tandem position, one legged stance, and/or standing with both feet together. To make the balance activities more of a challenge, the patient can perform such balance activities while keeping their eyes open or closed.16,17

The Lower Extremity Functional Scale (LEFS) is used to assess the functional disability of a patient with impairments in one or both of their lower extremities. The LEFS is used to analyze the patient over a period of time and to evaluate the benefits and effects of a particular intervention. The LEFS was used with this patient as a means of determining her progress in a 14 week program. The LEFS looks at whether or not a patient is having difficulty with any, or all, listed activities because of their lower limb impairments. These activities are scored into 5 categories on a scale of: 0 (extremely difficult or not able to be performed), 3 (able to perform with a bit of difficulty), 2 (moderately difficult), 1 (little bit of difficulty) and 4 (no problems
performing activity). Activities include: any heavy or light housework, school activities, sport activities; getting in and out of the bathtub or a car; walking from room to room, 2 blocks or a mile; put shoes and/or socks on, squat or lift objects of the floor; going up and down 10 stairs; sitting or standing for more than an hour at a time; running on level and unlevel ground; hopping and making sharp turns and/or rolling over in bed. Interpretation of the LEFS reflects a minimum score of 0 and a maximum score of 80, meaning the lower the patients score the greater the difficulty and disability. The LEFS has a Minimal Detectable Change (MDC) of 9 points and a Minimal Clinically Important Difference (MCID) of 9 points. A MDC and MCID of 9 points for the LEFS means that the patient needs to score 9 points or higher in order for the improvement to be significant on this scale from initial evaluation to discharge. For the LEFS, the potential error at a point in time is +/- 5.3 scale points, test-retest reliability was 0.94 and sensitivity and specificity of .81 and .70 respectively.29

The purpose of this study is to determine the clinical improvements of a 14 week strength training program consisting of eccentric loading and neuromuscular dynamic balance exercises in a patient 6 weeks post-op lateral ligament reconstructive surgery and gastroc/soleus resection. The research question is, “what are the effects of eccentric strength training along with a dynamic balance exercise program in an individual who has had a lateral ligament reconstructive surgery with gastroc/soleus resection?” There are several studies looking at the best evidence based practice to rehabilitate an acute ankle sprain and Achilles tendinopathy.3 However, there is no evidence in the literature that supports the best plan of care for a patient with chronic ankle instability, since childhood, resulting in poor biomechanics throughout adolescence into adulthood that required a lateral ligament reconstruction with gastroc/soleus resection. This case is very unique because with this type of surgery, required for the functional instability, there has
been limited physical therapy research available for the appropriate plan of care and interventions for treatment following a lateral ligamentous reconstruction surgery with gastroc soleus resection.

This case will help to provide an insight on the effectiveness of an eccentric strengthening and dynamic balance program on a lateral ligament reconstruction surgery with gastroc/soleus resections, a condition not commonly documented in the physical therapy literature as to the appropriate plan of care to follow.

This case report has been approved by the Internal Review Board at The Sage Colleges in Troy, New York. I chose to study this patient and further my understanding regarding the surgery, and to see how effective an eccentric strengthening and dynamic balance physical therapy program would be for a lateral ligament reconstruction with gastroc/soleus resection, based on the patient’s functional improvement in clinical measures and LEFS outcome measure.

Case Description

The patient is a 45 year old female, 5’ 8” and weighed 180lbs (BMI= 27.37), with a medical diagnosis of right lateral ligament reconstruction with gastroc/soleus resection. The patient is a mother of 2 children, age 12 and 18, married and worked 5 days a week at a local supermarket, where she did a majority of her working hours standing, pushing, walking and lifting. The patient’s husband works at a college in the maintenance department and both incomes allows the family to “just make ends meet.” This patient was referred to outpatient physical therapy after right lateral ligament reconstruction with gastroc/soleus resection and removal of bone spur on the calcaneus. The physician’s orders for physical therapy consisted of evaluation and treatment, modalities for pain control, strengthening, home exercise program, gait training secondary to weight bearing as tolerated with boot, active range of motion only, no
manipulation with inversion and eversion and massage for edema control for the first 4 weeks, being seen 2-3 times per week. The patient was seen by physical therapy roughly 9 months prior to her surgery as a referred patient from her primary doctor for evaluation and treatment of a painful and swollen right ankle.

The patient has had a long history of right ankle sprains since she was 9 years old. The patient also has a history of degenerative joint disease in the right ankle, has had 4 cortisone shots 2 years prior to the surgery in her right ankle and was fitted for orthotics due to her increased inversion and poor ankle biomechanics with foot-flat deformity. After so many years of chronic instability and ankle inversion sprains, the patient had surgery on her lateral ligament of right ankle with gastroc/soleus lengthening and bone spur removal on the calcaneus, and was casted with weight bearing at 50% for 4 weeks following the surgery.

**Examination**

Following surgery the doctor's orders were for non-weight-bearing on the right lower extremity for the first 4 weeks and to ambulate with axillary crutches.

**Systems Review**

Cardiovascular-pulmonary system revealed edema in the right ankle, with no other cardio-pulmonary issues. The patient also had a 1+ measurement for pitting edema in the right foot. As for the patient's integumentary system, the skin was not warm to touch, had mild redness, the surgical sutures and site was dry and intact, and the overall healing looked unremarkable. There were no changes in skin color and skin integrity and the patient was negative for deep vein thrombosis using the Homan’s Sign test. With this test, the patient is lying supine and their foot is put into dorsiflexion passively with the knee full extended. Pain in the calf is a positive Homan’s sign, which is indicative of deep vein thrombophlebitis.
Tenderness is also elicited on palpation of the calf. In addition, the examiner may notice pallor and sweating in the leg with an absence of the dorsalis pedis pulse.\textsuperscript{31}

**Test and Measures**

The patient's pain scale, for both rest and with activity, was measured using a Verbal Numeric Pain Rating Scale of 0 to 10.\textsuperscript{34} Upon initial examination, the patient reported pain in the right ankle as being intermittent, 8/10 and sharp with activity. The patient's pain scale at rest on a scale of 0 to 10 was a 0, patient reports this is due to pain medication. Patient was unable to provide a pain scale for the right ankle with activity for the first 4 weeks due to the patient being in the boot and the right ankle being immobilized.

The patient’s right ankle swelling measurements were taken using a Figure 8 Method. With this method the patient is positioned in a long sit with the ankle and lower leg beyond the examining table. Using a 6 mm wide plastic tape measure, the examiner places the end of the tape measure midway between the tibialis anterior tendon and the lateral malleolus, drawing the tape medially across just distal to the navicular tuberosity. The tape is then pulled across the arch of the foot just proximal to the base of the 5th metatarsal, across the tibialis anterior tendon, and then around the ankle joint just distal to the tip of the media malleolus, across the Achilles tendon, and just distal to the lateral malleolus, returning to the starting position.\textsuperscript{30} See Table 1 for measurements of right ankle edema.

The patient's standing posture and alignment were impaired due to the non weight-bearing and the use of crutches as an assistive device. The patient's musculoskeletal strength in the right ankle was unable to be determined, and was deferred, secondary to patient's pain and doctor’s order for only active assistive range of motion for the first 4 weeks.
For the patient's functional range of motion, only active range of motion was able to be assessed during the initial evaluation as per doctor’s orders. Her muscle performance and flexibility, including strength, was not able to be determined secondary to deference as a result of pain and doctors order for no resistance.

Gross range of motion of the right ankle was measured using a standard goniometer. For right ankle plantar flexion and dorsiflexion, the stationary arm is lateral midline of the fibula and in line with the fibular head. The axis is in line with the lateral malleolus and the movable arm is at the lateral midline of the fifth metatarsal. For right ankle inversion and eversion, the stationary arm is on the anterior midline of the fibula in line with the tibial crest. The axis is on the anterior aspect of the talocrural joint and the moving arm is on the anterior midline of the second metatarsal. See Table 2 for range of motion measurements.

For neuromuscular gross coordinated movements, including balance and gait, the patient was ambulating non weight-bearing of the right lower extremity in a boot while using crutches. The patient was able to transfer to a standing position from a chair, bed and car independently with and without an assistive device. The patient was able to ambulate non weight-bearing in boot with crutches, following the appropriate three-point gait pattern around her house and to and from the car, approximately 200-300 feet. Static standing balance with assistive device was good. However, patient’s dynamic standing balance without an assistive device was not assessed secondary to non weight-bearing of the right lower extremity. The patient was able to initiate heel to toe in the boot after instructions and verbal cueing.

The patient’s sensation integrity was impaired on the dorsal and lateral aspect of the right ankle due to surgical incisions, medications and swelling, along with sensory discrimination and reflex integrity impairments.
The patient's initial LEFS score was 6/80, putting her in the category of having extreme difficulty and/or inability to perform activities due to difficulty. The patient had difficulty with activities such as housework, hobbies and recreational sports. She was unable to get into and out of the bathroom, squat and put her shoes and socks and while sitting. The patient was unable to lift a bag of groceries off the floor and get into and out of her car. Patient was unable to go up and down a flight of stairs and stand for a period of one hour. Because of the patient's surgery, and weight-bearing status, the patient was unable to run on even and unlevel ground, turn sharply while running fast and hop on 1 foot. The only activity that the patient had moderate difficulty in was rolling over in bed and she had no difficulty in sitting for one hour.

**Evaluation**

The patient presented with limitations in standing posture, right ankle strength and range of motion, gait, standing balance both static and dynamic, significant edema and girth, pain, independence in activities of daily living and impaired ankle joint mobility. These impairments are all secondary to the surgical procedure on the right lateral ligamentous structure and gastroc/soleus resection, along with the medical doctor’s orders of non-weight bearing and boot wearing following the surgery.

**Diagnosis**

The patient has the following PT Diagnosis: Pattern 4I: Impaired Joint Mobility, Motor Function, Muscle Performance, and Range of Motion Associated With Bony or Soft Tissue Surgery.\(^{35}\)

**Prognosis**

This patient is a good candidate for outpatient physical therapy. The patient is very motivated to return to previous level of function consisting of both work and responsibilities at
home as a mother to her children and a wife to her husband. Along with this, the patient has a very good support system at home from her family. The impairments of the right ankle are the only physical limiting factors that she has to face. By the end of the 14 week eccentric strength training and dynamic balance program the patient will be able to return to work and be able to perform tasks around the house without any difficulty or limited difficulty.

**Goals**

The patient’s short-term impairment goals are as follows:

1. Patient will improve right ankle active range of motion in the following ranges: dorsiflexion to 0° – 2°, plantarflexion to 0° to 20°, inversion to 0° -20° and eversion 0° - 10° in 4 weeks.
2. Patient will improve right ankle strength to 4/5 in 4 weeks.
3. Patient will have decrease complaint of pain to 3/10 with any right ankle movement in 4 weeks.

The patient’s long-term impairment goals are as follows:

1. Patient will improve right ankle strength to 5/5 to be able to carry a box at work without any limitations in 6 weeks.
2. Patient will have no complaints of pain with any right ankle movement while getting in and out of her car at 6 weeks.
3. Patient will demonstrate proper performance of home exercise program to be able to maintain muscle strength and flexibility in 6 weeks.

The patient’s functional long term goals are as follows:

1. Patient will be able to ambulate community distances independently without an assistive device with a normal gait pattern at discharge.
2. Patient will be able to negotiate stairs 10 times independently without an assistive device to be able to get into her house and up into her bedroom at discharge.

3. Patient will be able to stand independently and perform tasks at the counter at work for an 8 hour shift at discharge.

**Plan of care**

The patient was seen 2 times a week for 14 weeks for the duration of 30-45 minute each session and then re-evaluated after every 4 weeks. The plan of care included: passive/active/active-assistive range of motion, stretching of the ankle joint and surrounding musculature, closed kinetic chain/open kinetic chain eccentric progressive resistive exercises, static and dynamic balance activities, gait training with and without assistive device, and modalities as needed for pain management.

**Interventions**

For week 1, the program consisted of: moist hot pack to the right ankle followed by soft tissue massage to increase joint extensibility and decrease pain. This was followed by passive and active assistive range of motion in each direction, all while sitting and lying supine. The patient performed towel crunches to strengthen intrinsic muscles of the right foot while sitting at the edge of the plinth. Patient was ambulating 200 feet non-weight bearing (NWB) using bilateral crutches. However, patient stated that she did not use crutches within her house to ambulate to and from kitchen and bathroom.

For week 2, the same activities as week one were continued but concentric straight leg raise exercises on the right without weight while lying supine were performed along with supine isometric abdominal exercises were added. Week 3 and 4 were just a continuation of week 2 (no increase in repetition or sets). The only addition was left side-lying straight leg raises without
weight while the patient was lying on the right side on the mat table. Patient remained NWB using bilateral crutches.

For week 5, the seated recumbent bike x 5 minutes and eccentric leg press were added as a means of strengthening the bilateral lower extremities. The leg press Cybex machine was performed while the patient was lying supine. The patient’s feet were placed on the footplate of the Cybex machine and the patient performed concentric contractions that were slow and controlled to improve the strength of bilateral knees and hips. The patient also performed heel raises while lying supine on the Cybex machine as well. The patient would place both feet on the footplate of Cybex machine, concentrically perform a heel raise and then perform an eccentric lowering of the heels while using the right foot. Since the patient was able to put full weight on her right lower extremity without precautions by the 5th week, gait training with a straight standard cane was added to the program. The patient performed a 3 point step-through gait pattern, approximately 300 feet, without any gait deviations or loss of balance. However, as part of the home exercise program, the patient was instructed to ambulate with the standard cane on even and uneven surfaces for community distances. The patient was instructed to do this as part of the home exercise program based on limitations in space at the outpatient clinic. Ambulating community distances were advised to help improve the patient’s endurance and overall standing tolerance and balance. The patient was ambulating weight bearing as tolerated (WBAT) x 300 feet with standard cane. Patient reports not using the cane inside home but only using it for community distances.

By week 6, plantar flexion and dorsiflexion range of motion was added to the program to improve all direction range along with the seated tilt board to progress and improve bilateral lower extremity strength. Weeks 7-8 were a continuation of week 6 with the addition of the
standing tilt board to the program while the patient was standing in the parallel bars. The patient stood with both feet on the tilt board while holding onto the parallel bars with both hands. The patient rocked the tilt board forward and backwards to improve range of motion, strength and coordination in the bilateral ankles. Also by the 8th week, hamstring curls were done in sitting on the Cybex machine. The patient would concentrically bend both knees slow and controlled then eccentrically lengthening her right lower extremity and straighten it out to the starting position at a weight of 50 plates performing 2 sets of 10 reps, all while having the left lower extremity on the foot plate. The eccentric inversion and eversion yellow Theraband while sitting was added for 2 sets of 10 reps. With the Theraband wrapped around the distal portion of the patient foot and the other end of the theraband held with the left hand, the patient performed inversion and eversion with the right foot. The patient also performed inversion and eversion eccentric Theraband activities while sitting to strengthen the ankle musculature as part of home exercise program. The patient was instructed to wrap the theraband around her right forefoot, placed the left leg across her right leg to hold the Theraband with her left foot. This would allow the patient to perform a slow and controlled eccentric contraction of the right ankle. The patient also performed eccentric Theraband strengthening activities of the right ankle in plantarflexion and dorsiflexion. The patient would place the Theraband around the dorsal aspect of the right forefoot and perform eccentric plantarflexion while the therapist would stand in front of the patient holding the other end of the Theraband. For the eccentric dorsiflexion contraction, the patient would hold the Theraband while performing the slow and controlled eccentric contraction. Eccentric heel raises were added to all previous weeks of the physical therapy program.
By the 9th week, the only increase in exercise was the recumbent bike which was increased to 10 minutes and the eccentric leg press while supine which was increased to 6 plates x 20 reps. To improve the patient's standing balance, the single leg stance balance activity was added to the program along with the supine eccentric heel raise. For her balance training, the patient would stand on her right lower extremity for a timed duration while holding onto an external source.

By the 10th week, the eccentric leg press was increased to 7 plates 3 sets x 15 reps, the eccentric heel raise was increased to 6 plates 3 sets x 15 reps and the single leg stance was still 4 set of 30 seconds while trying to not hold onto an external surface. The patient at this time was able to ambulate without an assistive device both around the house and in community distances. By the 11th week, the single leg stance while holding onto an external source was then progressed to a single leg stance while tossing a therapy ball at the trampoline, as a rebound catcher. The patient initially would stand on the flat level surface while tossing the ball, then progressed to standing on a foam disk while the therapist stood at her side for contact support. The patient was eventually able to progress and perform this activity without assistance and loss of balance while standing on the foam disc by the 14th week. See Table 3 for progression of intervention program.

**Outcomes**

At discharge the patient's LEFS score was 70/80. The patient reported still having a little bit of difficulty with squatting, walking a mile, standing for longer than an hour, and running on unlevel ground, hopping and sharp turning while jogging. The patient improved right ankle strength in the directions of: plantarflexion, dorsiflexion and inversion to 5/5 and eversion to 4+/5. The patient's girth measurements for both left and right Figure 8 Method were the same at
55 cm. As per doctor’s orders, the patient was able to return to work, but was only able to do a 4 to 6-hour workday with periodic rests including sitting down throughout her shift. At rest and with movement the patient had no complaints of pain. The patient was able to ambulate without an assistive device, without weight bearing restrictions and with normal footwear without any impairment’s in step in stride length, or an antalgic gait pattern. Patient’s right ankle range of motion improved in all ranges. See Table 2 for range of motion improvement.

At discharge the patient met all short-term goals with improvements in range of motion, strength and a decrease in pain both at rest and with movement. For her long-term goals, the patient met right ankle strength goals to 5/5(except for eversion which was 4+/5), able to negotiate up and down 10 stairs independently and able to walk community distances without an assistive device with a normal gait pattern. However, the patient did not meet her long-term goal of standing at work for an 8 hour period without any pain. The patient was only able to tolerate 4 to 6 hours at work, but needed periodic rest breaks in which she had to sit due to the pain in her right ankle. The patient reported this was her only real limitation, along with squatting and running, in which she still felt that she had impairments and limitations in.

**Discussion**

As in this case report, a reduction in function is common in patients who undergo right lateral ligament reconstruction with gastroc/soleus resection.\textsuperscript{21,23} To better understand the effects of this eccentric strengthening and neuromuscular dynamic balance activity program, a functional outcomes measure was recorded using the LEFS, along with clinical measures such as strength, range of motion and pain. Previous work on Achilles tendinopathy and acute ankle sprains exhibited improvements of the tendons structure, function and the reduction of pain following an eccentric strength training and neuromuscular dynamic standing balance program.
In this present case report, it is believed that the greatest factor that contributed to an extensive load endurance was the eccentric intervention, which helped in the remodeling of the Achilles tendon and right ankle ligamentous structures.\(^3\)\(^-\)\(^7\) The findings based on this case suggest that eccentric strength training, achieved within the patient's tolerance to pain, along with neuromuscular dynamic standing balance activities, are safe and effective methods for loading the right ankle ligamentous structures and the gastroc/soleus tendon following surgery.

In studies that looked at eccentric exercise programs for Achilles tendinopathy subjects were within the same age range, 40-60 years old,\(^3\)\(^-\)\(^7\) as the patient in this study. The subjects in these programs performed single leg eccentric calf lowering exercises on a step. The patients stood on their forefoot with their ankle plantarflexed and then they lowered their heel below the step to maximize ankle dorsiflexion. Exercises were performed with the injured leg straight and bent. This subject also performed seated eccentric lowering activities in the same manner. All other concentric exercises were avoided. The research based on the Achilles tendinopathy, and confirmed by this case, concluded that eccentric strengthening exercises should be incorporated into the program of patients with chronic mid-portion Achilles tendinopathy to provide more effective relief of pain and improvements in strength and function following a 12 week program.\(^3\)\(^-\)\(^7\) The incorporation of eccentric strength training and dynamic balance activities were effective at improving the patient’s clinical measures including strength, ROM, balance, joint play, flexibility and gait along with the patients’ own perceptive score on the LEFS and overall quality of life. The patient was able to reach these improvements in clinical and outcome measures following a 14 week program. The patient exceeded the 12 week program as followed in the literature, but only by 2 weeks which was contributed by time off for vacation.
As for the neuromuscular dynamic standing balance activities, research has had patients perform single leg balancing exercises on an even floor and on a foam stability pad. The progression of the balance training included single leg balancing on a balance board and a foam pad while throwing a ball to a partner. The neuromuscular balance programs were performed for 12 to 14 weeks in these studies.\textsuperscript{13, 14, 16, 18, 20} The major difference between the current studies and the dynamic balance studies for ankle sprains was the age group. The neuromuscular exercise research studies for ankle sprains were done on high school age soccer, basketball and football players. The research concluded that a balance board training program, along with single leg balance activities, effectively reduce the incidence of ankle sprains among high school sports players with prior ankle sprains.\textsuperscript{13, 14, 16, 18, 20} The incorporation of neuromuscular dynamic standing balance activities into the 14 week program helped the patient by improving her proprioception and strength, thus providing support for the ankle structures and reducing the risk for continued ankle instability.

When searching in PubMed, Science Direct and the Physical Therapy Journal using the MESH words of: physical therapy, eccentric exercises, ankle sprains, achille’s tendinopathy and balance exercises; no research has been found on functional ankle instability resulting in right lateral ligamentous reconstruction and gastroc/soleus resection and the effects of an eccentric strengthening program with neuromuscular dynamic balance activities. This present case can be related to the literature involving eccentric strengthening and neuromuscular dynamic balance activities for acute ankle sprains and Achilles tendinopathy due to similar impairments in strength, range of motion, pain and overall quality of life. The strengths of this case study was that there were similar and notable improvements in functions, strength, range of motion and reductions in pain as a result of a 14 week program involving eccentric strengthening and
dynamic balance activities to published research. In both the eccentric and dynamic standing balance this patient showed improvement from initial evaluation to discharge in pain, function and a reduction in reoccurring ankle pathologies that were similar to the improvements found in the literature.\(^5\)

A limitation within this study is the lack of information presented by the patient on the compliance with the home exercise program and weight-bearing status as ordered by the doctor. The lack of information surrounding these aspects could have caused the patient to progress slower than anticipated. Strict compliance with a home exercise program and a weight-bearing status, as it pertains to a lateral ligamentous reconstructive and gastroc soleus resection surgery, is crucial in the improvements of pain, function and overall quality of life.\(^3\-7\) The patient felt that she could have made gains sooner, but the doctor was very strict on her weight-bearing status and her progression due to the surgery. The patient also admits that she missed a few weeks throughout the 14 week program and did not perform her home exercise program, which she felt set her back as far as it relates to her strength, pain and standing tolerance. Other than these impairments, the patient was very pleased with her overall progression throughout the program and realized that her slow progression was due to the extent of the surgery and the doctor’s restrictions, along with her missing a few weeks of therapy.

Another limitation of this present study is that it is a case report with only one subject. Further studies with larger and different intervention groups should be conducted to determine whether eccentric exercises with dynamic balance activities is superior to concentric exercises with dynamic balance activities. Larger and different intervention groups could show that the changes between the pre-intervention and post-intervention scores would help to determine whether the eccentric strength training and dynamic balance activities resulted in greater
reduction in pain, and improvements in strength, function and overall quality-of-life versus a concentric strength training and dynamic balance exercise program.

**Conclusion**

This is a case report of a 45 year old woman who had a right lateral ligament reconstructive surgery with gastroc/soleus resection. At the initial examination she showed impairments in: range of motion, pain, strength, static and dynamic standing balance, endurance and decreased scores on the functional outcomes measure, the LEFS. The results of this case report showed that eccentric strength training and neuromuscular dynamic balance activities demonstrated significant increases in the patient’s function and reduction in pain upon completion of a 14 week program following a right ankle ligamentous reconstructive and the gastroc/soleus tendon surgery. Eccentric strength training and dynamic balance activities were effective at improving the patients clinical and outcome measures including: strength, range of motion, balance, flexibility, gait, along with the patients’ own perceptive score on the LEFS and reduction in pain. This case report demonstrated that eccentric strength training and neuromuscular dynamic balance activities were a safe and effective treatment in the rehabilitation following a right lateral ligament reconstruction with gastroc/soleus resection surgery with this patient.
References


Appendix:

Table 1: Measurement of Right Ankle Edema

<table>
<thead>
<tr>
<th>Right Ankle</th>
<th>Figure 8 in cm</th>
<th>Right metatarsal head</th>
<th>Right lateral malleoli (3” above)</th>
<th>Right lateral malleoli (6” above)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial</td>
<td>58cm</td>
<td>24.6cm</td>
<td>27.5cm</td>
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<tr>
<td>D/C</td>
<td>55cm</td>
<td>22.6cm</td>
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Table 2: Measurements of Right Ankle Range of Motion

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<tr>
<th>ROM</th>
<th>Active DF</th>
<th>Active PF</th>
<th>Active INV</th>
<th>Active EV</th>
<th>Passive DF</th>
<th>Passive PF</th>
<th>Passive INV</th>
<th>Passive EV</th>
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<tr>
<td>Initial</td>
<td>0(-12°)</td>
<td>0-10°</td>
<td>0-5°</td>
<td>0-5°</td>
<td>0(-8)°</td>
<td>0-20°</td>
<td>*Not tested</td>
<td>*Not tested</td>
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<tr>
<td>D/C</td>
<td>0-18°</td>
<td>0-20°</td>
<td>0-12°</td>
<td>0-10°</td>
<td>0-20°</td>
<td>0-30°</td>
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*Passive inversion (INV) and eversion (EV) were not tested secondary to doctor’s orders
### Table 3: Interventions

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<tr>
<th>Week</th>
<th>IE</th>
<th>MHP/STM supine</th>
<th>PROM/AROM Sitting supine</th>
<th>Towel Crunch sitting</th>
<th>Iso Abd supine</th>
<th>SLR supine</th>
<th>SL SLR</th>
<th>Recumbent Bike</th>
<th>LP/ECC supine</th>
<th>Tilthboard</th>
<th>HS curls-ECC sitting</th>
<th>T-band INV/EV ECC sitting</th>
<th>ECC HEEL RAISE Supine</th>
<th>Balance</th>
<th>Gait</th>
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Key:
MHP-Moist Hot Pack
STM-Soft Tissue Massage
PROM/AROM-Passive/Active range of motion
PF/DF/INV/EV-Plantarflexion/Dorsiflexion/Inversion/Eversion
Iso Abd- Isometric Abdominals
SLR- Straight Leg Raise
S/L-Side-Lying
LP-Leg Press
ECC-Eccentric
HS-Hamstring
AD- Assistive Device
NWB- Non-Weight bearing
WBAT-Weight Bearing as Tolerated
FWB- Full-Weight Bearing
Y/G/O-Yellow/Green/Orange
pl-Plate

Table: 4: Lower Extremity Functional Scale (LEFS) Score from Initial Eval to Discharge:

<table>
<thead>
<tr>
<th>LEFS Score</th>
<th>Initial</th>
<th>Discharge</th>
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<tbody>
<tr>
<td>Out of 80 points</td>
<td>6/80</td>
<td>70/80</td>
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</table>

Activities

**Difficulty with:**
1. Housework
2. Hobbies and recreational sports
3. Getting in and out of the bathroom
4. Squatting and putting her shoes and socks and while sitting
5. Lift objects like a bag of groceries off the floor
6. Get in and out of her car
7. Going up and down a flight of stairs
8. Standing for one hour
9. Unable to run on even and uneven ground
10. Make sharp turns while running fast
11. Hop on 1 foot
12. Rolling over in bed
13. Sitting for one hour

**Difficulty with:**
1. Squatting
2. Walking a mile
3. Standing for longer than one hour
4. Running on uneven ground
5. Hopping
6. Making sharp turns while jogging