OUTPATIENT REHABILITATION FOR A PATIENT FOLLOWING A MINIMALLY DISPLACED FRACTURE OF THE DISTAL LEFT FIBULA

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A Comprehensive Case Analysis

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Tyler Green

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Abstract

of

OUTPATIENT REHABILITATION FOR A PATIENT FOLLOWING A MINIMALLY DISPLACED FRACTURE OF THE DISTAL LEFT FIBULA

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A patient status post closed treatment without manipulation of a minimally displaced fracture to the distal left (L) fibula was seen for physical therapy (PT) treatment for 16 sessions over a three-month period at an outpatient PT clinic. Treatment was provided by a student physical therapist under the supervision of a licensed physical therapist.

Upon initial evaluation, the patient, an 83-year-old female who experienced an ankle fracture two-months prior, was to remain weight bearing as tolerated with the L lower extremity in a controlled ankle motion walker boot for six weeks. During her course of treatment, the following measures were assessed: goniometry to assess active range of motion (AROM), manual muscle test to assess strength, Timed Up and Go to assess risk for falls, Lower Extremity Functional Scale to assess activities of daily living, and Berg Balance Scale to assess impaired mobility and balance in standing. Deficits were identified and a plan of care was established. The goals for this patient were to improve AROM, strength, balance, gait, and return to her prior level of function. The

patient's central goal was to prevent future falls. Main interventions used were manual therapy, task-specific therapeutic exercise, proprioception and balance training, warm water aquatic therapy, gait training, and instruction in a home exercise program (HEP). The patient achieved gains in AROM, strength, balance, gait, and functional independence. The patient's goals to reduce fall risk and return to her prior level of function were met as well. The patient was discharged to home with a HEP.

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TABLE OF CONTENTS

Page

LIST OF TABLES

Tables Page

Chapter 1

General Background

Ankle fractures are common among lower limb fractures, accounting for 9% of all fractures in the body with a quarter of these occurring in adults over the age of 60.[1] The annual incidence of ankle fractures is between 107 and 184 per 100,000 persons.[2] A 2005 retrospective study identified 33,704 Medicare Part B beneficiaries in the United States with ankle fractures.[3] The authors discovered that 50.8% of ankle fractures in their sample were isolated lateral malleolar fractures, and the rate of ankle fractures was highest in white women at 5.8 per 1,000 Medicare enrollees.[3] It has been shown that falls are the primary source of fatal and nonfatal injuries in the elderly resulting in major health and socioeconomic issues, accounting for an estimated seven to 10 billion healthcare dollars spent per year.[4]

The ankle joint, also known as the talocrural joint or mortise joint, is composed of three articulating bones: the tibia, fibula, and talus. The mortise is comprised of: the inner, distal articular surfaces of the tibia and fibula; the medial malleolus; and the lateral malleolus.[5] The mortise functions as a roof over the talus, constructing a uniplanar hinge joint.[6] Joint motion in the ankle is an intricate phenomena, which is guided and stabilized through a close relationship of the geometry of the ligaments and the shapes of the articular surfaces.[6]

Current literature has identified the mechanism for acquisition of an isolated fracture of the distal fibula to be abnormal axial loading of the lower limb while the foot remains planted on the ground. The ankle joint may be forced into supination and

external rotation resulting in fracture of the distal fibula.[7-9] This may be the consequence of either a high-energy trauma such as a motor vehicle injury, or a low-energy trauma such as a fall in individuals with low bone mass and abnormal bone microarchitecture.[8] Signs and symptoms of a distal fibular fracture include inability to bear weight immediately after the injury, point tenderness over the inferior tip of the lateral malleolus, and inability to walk four steps.[6] Non-modifiable risk factors for a distal fibular fracture include: female gender and older age.[6,8,10,11] Modifiable risk factors for a distal fibular fracture include: obesity, diabetes, smoking, prior injury, propensity for falls, level and type of physical activity, and osteoporosis (OP).[6,9,10,12] There is growing evidence to support an association of older women with ankle fractures and lower bone mineral density (BMD); OP management within these individuals should not be dismissed.[6,11,13,14]

The prognosis for individuals with an isolated fracture of the distal fibula is generally favorable, particularly when the fracture is non-displaced and there is no associated ligamentous injury.[15] Treatment begins with the individual placed in a fiberglass posterior leg splint for at least 1 week to accommodate swelling.[6] The individual is then placed in a light weight cast for several weeks, followed by a controlled ankle motion (CAM) boot to maintain immobilization. Weight bearing as tolerated (WBAT) in the CAM boot for six weeks is usually required as the fibula has been reported to carry 6.4% to 17% of the axial load during weight bearing.[16] During that time the individual will receive physical therapy (PT) where interventions will allow for improvements in flexibility, strength, and proprioception.[17]

Chapter 2

Case Background Data

Examination – History

The patient was an 83-year-old female who was evaluated in the Emergency Department (ED) two hours after she fell in her garage sustaining a left (L) ankle injury. She reported that she slipped on a step and fell backwards, causing her to hit her head on a cabinet and twist her L ankle. The patient denied loss of consciousness, but she was unable to ambulate and complained of left lower extremity (LLE) pain. The patient's computed tomography scan of her head was negative. She was diagnosed with a minimally displaced fracture of the L distal fibula. The patient was initially treated in a fiberglass posterior leg splint for two weeks by the ED. She required follow up evaluation by an orthopedic surgeon who prescribed a cast for 6 weeks and then a CAM walker boot.

The patient arrived to the clinic for PT two months after her injury. The patient was wearing a CAM walker boot on her LLE which had been prescribed one day prior, used a front wheel walker (FWW) to assist her in walking, and reported no modifications within her home. The patient's chief complaint was that she felt "off-balanced" with sit-to-stand transfers and while walking independently. At the time of the initial examination, the patient did not report any pain in her LLE. The patient's goals were to: prevent future falls, return to walking 1 hour per day with her dog; return to gardening around her home 1 hour per day, 3 times per week; and participate in swimming with her family.

The patient had a past medical history of hypertension (HTN), osteoarthritis (OA) (L acromioclavicular joint, bilateral hips, and L knee), and OP. She had a past surgical history including cholecystectomy and appendectomy. The patient had no prior history of an ankle fracture, but did report that she had fallen three times in the past two years without sustaining any serious injuries. The patient was a retired photographer who lived independently in her community home. She recently adopted a dog whom she took for a one hour walk daily. The patient also spent one hour gardening three times per week, and enjoyed swimming in her pool at regular family functions at her home.

Systems Review

The patient's cardiopulmonary system was impaired due to history of HTN controlled by medication; blood pressure was 126/74 millimeters mercury and hear rate was 57 beats per minute. The patient's integumentary system was impaired with ecchymosis of her L foot (plantar surface), and her L foot and ankle skin was scaly and dry due to splinting and casting for eight weeks. The neuromuscular and musculoskeletal system was impaired based on observation and patient report of the LLE impairments which are reported in Table 2. The patient's communication, cognition, and learning were not impaired based on observation. The patient's affect and mood were not impaired based on observation and patient report, respectively.

Examination – Medications

Table 1

Medications[18]

MEDICATION	DOSAGE	REASON	SIDE EFFECTS
Lisinopril (ZESTRIL) (ACE inhibitor)	30 milligrams (mg)	Hypertension (HTN)	Cough, dizziness, headache, excessive tiredness, nausea, diarrhea, weakness, rash
Dihydropyridine ER (FELODIPINE) (Calcium Channel Blocker)	5 mg	HTN	Headache, flushing, dizziness or lightheadedness, weakness, fast heartbeat, heartburn, constipation, enlargement of gum tissue around teeth
Glucosamine (RELAMINE) (Amino monosaccharide + glycosaminoglycan)	1,500 mg	Osteoarthritis Multivitamin, joint health, cartilage supplement	Gastrointestinal(GI) upset, nausea, heartburn, diarrhea and constipation, increased blood glucose, cholesterol, triglyceride and blood pressure.
Aspirin (BAYER) (Antiplatelet)	81 mg	Coronary Artery Disease Prevention	Nausea, vomiting, stomach pain, heartburn, bleeding
Vitamin C (electrolyte replacement)	500 mg	Electrolyte Replacement, Daily Vitamin	GI upset, diarrhea
Calcium carbonate (CALTRATE)	600 mg	Elemental Calcium Supplementation, bone health, osteoporosis	GI discomfort, hypercalcemia, hypercalcuria
Omega 3 Fish oil (EPA/DHA) (Multivitamins/Minerals)	1,200 mg	Multivitamin, joint health, cartilage supplement	Easy bruising, bleeding, may potentiate anticoagulants
Vitamin D3 (Multivitamins/Minerals)	2,000 mg	Multivitamin, aides in Calcium supplement absorption	Kidney stones, confusion, muscle weakness, bone pain, weight loss, poor appetite, extreme thirst, frequent urination, nausea, vomiting, constipation

Chapter 3

Examination – Tests and Measures

The patient's deficits were categorized using the International Classifications of Functioning, Disability and Health (ICF) Model.[19] Measurements obtained to identify the patient's potential body structure and function impairments included: goniometry to measure active range of motion (AROM) and manual muscle testing (MMT) to measure strength. Measurements obtained to identify the patient's potential activity limitations included the Lower Extremity Functional Scale (LEFS) to identify mobility deficits and the Berg Balance Scale (BBS) to identify mobility and balance deficits. The Timed Up and Go (TUG) test was used as a prognostic tool to predict the patient's potential fall risk. Participation was measured by: the patient's report to walk one hour per day with her dog; ability to garden around her home one hour a day, three times per week; and participation in swimming with her family.

Goniometry was utilized to measure AROM of a joint in angular degrees. Goniometry was also applied as a tool to assess the changes in AROM due to treatment. The minimal detectable change at a 95% confidence level (MDC_{95}) for the lower extremity (LE) is reported to be six degrees.[20] If the patient's score increases six degrees, it is 95% likely that the smallest amount of change required to exceed measurement error and variability has occurred. One reliability study found the MDC_{95} for ankle inversion to be seven degrees.[21]

Physical therapists have commonly incorporated MMT into their practice to document impairments in muscle strength in patients with pathological problems and

neurologic or physical injuries.[22] A MMT is based on a six-point ordinal scale with a grade of 0 of 5 (0/5) representing no contraction performed, and 5 of 5 (5/5) representing a contraction performed against gravity through a full ROM and then accepting maximal resistance by the examiner. The MDC for MMT has been determined to be one full grade.[22]

The LEFS has been established as an activity measure developed for musculoskeletal conditions of the LE.[23] The LEFS was validated as a self-reported questionnaire consisting of 20 items which assess limitations of various activities of daily living (ADL). Each item consists of five statements scored as 0-4 based on the patient's level of agreement with the statement. The score, ranging from 0-80 scale points, is converted into a percentage and the higher the percentage the greater the disability. The LEFS was found to have a MDC with a 90% level of confidence (MDC_{90}) of nine scale points.[24] The minimal clinically important difference (MCID) for the LEFS was also found to be nine scale points. The MCID indicates that if, on a follow-up measure, a patient scores nine points above the baseline measure a change has occurred that is meaningful to the patient's functional activities.[24]

The BBS has been established to measure balance among older individuals with impairment in balance function by assessing the performance of functional tasks.[25] The test consists of 14 motor tasks that are scored on a five-point ordinal scale (0-4); lower scores are given when the individual requires greater levels of supervision or assistance. In a study of the elderly population, initial BBS scores were categorized into 4 groups

and each individually assigned an MDC_{95}. The MDCs for a patient scoring between 0-24, 25-34, 35-44, and 45-56 were 4.6, 6.3, 4.9, and 3.3, respectively.[26]

The Wells Criteria was validated as a clinical decision rule (CDR) used in clinical practice to screen for the presence of a LE deep vein thrombosis (DVT). A CDR score of < two points indicates that a DVT is unlikely, and a score of ≥ two points indicates that a DVT is likely.[27] In a study of 1,082 outpatients, 27.9% of those classified as likely had a proximal LE DVT or a pulmonary embolism (PE), and 5.5% of those classified as unlikely had a proximal LE DVT or a PE.[27] The information provided by the Wells Criteria will affect the clinical impression for a typical patient as the clinician evaluating the patient will have to determine whether or not the patient is suitable for exercise or if he or she will need to be referred to a specialist.

The TUG was a prognostic measure implemented in clinical practice to identify community-dwelling, frail older adults who are at risk for falls. The TUG is measured with a stopwatch. The patient is instructed to stand up from a standard arm chair and walk 10 feet at a comfortable pace, turn, walk back, and sit down.[28] Shumway-Cook et al.[29] discovered that a TUG score >13.5 seconds (s) was an accurate predictor of an older adult being at a high risk for falls. A positive likelihood ratio and negative likelihood ratio were calculated to be 6.69 and 0.15, respectively. The post-test probability of falling for a positive TUG test was reported to be 77%.[29]

Table 2

Examination Data

BODY FUNCTION OR STRUCTURE		
Measurement Category	Test/Measure Used	Test/Measure Results
Active range of motion	Goniometry	DF: R = 0˚ - 15˚, L = 0˚ Inv: R = 0˚ - 20˚, L = 0˚ - 4˚
Strength	Manual muscle test	PF: R = 5/5, L = 4/5, pain L gastroc with test Hip F: R = 5/5, L = 4/5, pain L anterior thigh with test
FUNCTIONAL ACTIVITY		
Measurement Category	Test/Measure Used	Test/Measure Results
Fall risk	Timed Up and Go	Total time: 25.1 s with FWW, Indicative of high risk for falls
Activities of Daily Living	Lower Extremity Functional Scale	87% impaired (severely disabled)
Impaired mobility/balance in standing	Berg Balance Scale	Total Score: 40/56 with FWW
Gait	Observation	Step-to gait pattern with FWW, WBAT in CAM walker boot
PARTICIPATION RESTRICTIONS		
Measurement Category	Test/Measure Used	Test/Measure Results
Unable to walk dog for 1hr a day	Patient report	The patient reported use of FWW and unable to walk dog due to feeling unstable
Unable to garden for 1hr 3x/week	Patient report	The patient reported being unable to continue gardening at her home due to use of FWW and feeling unstable
Unable to use swimming pool	Patient report	The patient reported she feels unsafe getting in and out of the pool at her home
Abbreviations: CAM = controlled ankle motion, DF = dorsiflexion, F = flexion, FWW = front wheel walker, Inv = inversion, hr = hour, L = left, PF = plantar flexion, R = right, s = seconds, WBAT = weight bearing as tolerated, x = times		

Chapter 4

Evaluation

Evaluation Summary

The patient was an 83-year old female who had sustained a L distal fibula fracture two months prior to being evaluated in an outpatient physical therapy clinic. The patient had previously been in a fiberglass posterior leg splint for two weeks followed by a cast for six weeks, and presented with a CAM walker boot at the time of the initial PT evaluation. The orthopedist ordered her to be WBAT in CAM walker boot for six weeks. The patient had no prior history of ankle fracture, however she reported a past medical history of OA and OP. The patient reported that she had fallen three times in the past two years. Based on the Wells Criteria CDR, the patient scored one point and was at lower risk for a DVT. The patient was found to have decreased ROM and strength, as well as activity limitations as evidenced by a score of 85% on the LEFS, indicating severe disability. The patient reported she felt off balanced when transitioning from sit to stand and was found to be at high risk for fall as evidenced by a TUG score of 25.1 s. The patient reported that her impairments prevented her from: walking her dog one hour per day; gardening for at least one hour per day, three times per week; and swimming with her family.

Diagnostic Impression

The patient's presentation was consistent with the medical diagnosis of a minimally displaced fracture of the L distal fibula. The PT diagnoses were limitations at all three levels of the ICF model. The patient's body structure and function impairments

in AROM and strength contributed to the activity limitations in sit-to-stand, balance, and gait which restricted her participation in walking her dog one hour per day, gardening for at least one hour per day, and swimming with her family.

Prognostic Statement

The patient's positive prognostic factors included: highly motivated to adhere with treatment/HEP, active lifestyle prior to injury, healthy body weight, nonsmoker, negative past medical history for diabetes, subjective reports of no pain, and minimal displacement of fracture. Patient's negative prognostic factors included: female gender and older age, OP, history of knee and hip pain due to OA, and a TUG score greater than 13.5 s indicating the patient is at an increased risk for falls. A recurring fall may potentially delay healing time. The rehabilitation potential for this eight-week episode of care was good; improvements in ROM, strength, balance, and return to her prior level of function were expected as the patient's positive prognostic factors outweighed her negative prognostic factors.

G-Codes

Current with modifier: G8978CM (87% impaired based on LEFS)

Goal with modifier: G8979CK (40% impaired based on LEFS)

Discharge Plan

The patient was expected to be discharged to her home with a detailed HEP in eight weeks.

Chapter 5

Plan of Care-Goals and Interventions

Table 3

Evaluation and Plan of Care

PROBLEM	PLAN OF CARE Short Term Goals (Anticipated Goals) (4 weeks)	Long Term Goals (Expected Outcomes) (8 weeks)	Planned Interventions Interventions are Direct or Procedural unless they are marked: (C) = Coordination of care intervention (E) = Educational intervention
BODY FUNCTION OR STRUCTURE IMPAIRMENTS			
Decreased L Ankle ROM: DF AROM 0˚	Increase DF AROM to 0˚- 6˚	Increase DF AROM to WNL (0˚- 15˚) (to exceed MDC of 6˚)	- (E) Patient was educated on doffing CAM boot 3x/day for 1 hr - Retrograde massage of LE, 5 mins - In early rehab physiological PROM grade III-. 30 s, 3 sets. Progressed to grades III and then IV in middle and then late rehab. - PNF stretching in long sit of the calf muscle using CRAC, 15 s calf stretch followed by isometric contraction of PF muscles followed by dynamic contraction of DF muscles for 15 s, 3 sets. In middle rehab progressed in pool self-stretching and strengthening utilizing PNF in standing wall push position, 3 sets. - In pool performed squats 10 reps, 3 sets while holding on to rail. Progressed to no assistance with rail. - In pool standing gastroc stretch 60 s hold, 3 sets. - In late rehab, mini squat with GB, 10 reps, 3 sets. Progress with teal TB above knees. HEP:

Inv AROM 0˚ - 4˚	Increase Inv AROM to 0˚ - 11˚	Increase Inv AROM to 0˚ - 20˚ (to exceed MDC of 7˚)	- Doff CAM boot 3x/day for 1 hr each time to perform HEP. - AROM DF in long sit - Auto PNF in long sitting against a wall as described above. - Auto gastroc stretch in long sit with towel, 60 s, 3 sets. Progressed to standing PNF once patient was removed from CAM boot. - Retrograde massage as described above - In early rehab physiological PROM grade III-. 30 s, 3 sets. Progressed to grades III and then IV in middle and then late rehab. - PNF stretching in sitting of peroneal muscles using CRAC as described above. HEP: - AROM inversion in sitting. - Auto PNF in sitting against a wall, same application described above. - Auto peroneal muscles stretch 60 s, 3 sets, 3x/day.
Decreased LE strength: Decreased strength in L ankle PF 4/5	Increase strength in L ankle PF to 4+/5	Increase strength in L ankle PF to 5/5 (to meet MDC of +1 grade)	- In early rehab, in sitting, PF with resistance band, orange TB, 10 reps, 3 sets. Progressed to higher level of resistance, black TB. - In pool toe heel rises, 10 reps, 3 sets. Progressed in late rehab to one leg heel rises, 10 reps, 3 sets. - In early rehab rhythmic stabilization, 10 s, 3 sets. Progressed to a diagonal pattern, D2. HEP: - In sitting, PF with resistance band, orange. - In standing, heel raises once CAM boot removed.
Decreased strength in L hip F 4/5	Increase strength in L hip F to 4+/5	Increase strength in L hip F to 5/5 (to meet MDC of +1 grade)	To increase hip F strength: - In supine, SLR without weight, 10 reps, 3 sets. Progressed to adding ankle weight up to 5 lbs - In pool, standing hip flexion with knee bent, 10 reps, 3 sets.

			HEP: - In supine, SLR without weight, progressed to SLR with CAM boot on for added weight. - (C) referral to orthopedist for further evaluation of hip OA by radiography.
ACTIVITY LIMITATIONS			
Fall Risk	Patient will decrease fall risk by decreasing TUG score to 13.5 s	Patient will decrease fall risk by decreasing TUG score to 12 s (to not exceed cutoff score of 13.5 s)	- All interventions mentioned above - Rocker board in sitting in all direction of ankle ROM including circular motions in clockwise, counter clockwise, and diagonals. Progressed in duration and functional positions: standing with FWW assist, eyes closed/eyes opened, 3 min to 5 min; standing without FWW, eyes closed/eyes opened, 6 min to 8 min. - Aquatic therapy 30 mins: - In early rehab walking FWD, BWD, side to side. Progressed to walking with eyes closed and holding on to rail, then walking eyes closed without rail. - Walking in tandem stance; progressed to eyes closed holding rail; then eyes closed without rail. - Standing with various base of support perturbations. Progressed to eyes closed, tandem stance, and then tandem stance with eyes close. - In late rehab walking against current from jets, FWD, BWD, side to side. Progressed to tandem stance and then tandem stance with eyes closed. - Perturbations mentioned above added and progressed with jets. - Large steps with high knees 50 ft, progressed to 150 ft, eyes open and eyes closed. In late rehab when CAM boot was removed: - Foam pad was used to treat balance on land. Various bases of support, tandem stance, eyes open/eyes closed, arms extended/arms crossed, and perturbations. Progressed to one leg stance, 10 s per position, 3 sets. - Marching in place, 30 s, 3 reps, progressed to marching in place with teal TB above knees.

			HEP: - Standing on pillow following same interventions performed in the clinic. Same progression applied. - In late rehab marching in place. - Walking at home with TB above knees with FWW, taking large steps. Progressed to walking at home without FWW in late rehab. 10 min, 3x/day.
Impaired ability to perform ADLs	Patient will decrease LEFS score to 76% impaired	Patient will decrease LEFS score to 40% impaired (to exceed MCID of 9 points)	- All interventions listed above addressed patient's limitations to perform ADLs. - In early rehab towel toe curls with sliding board and marble pick up with toes, 5 min each. - In sitting, ball belt exercise, teal TB. Progressed to black TB. - In sitting, HS curls and quad extensions, teal TB. Progressed to black TB. - In pool upper body supported by noodle, flutter kicks, hip ABD and ADD, bicycle peddles, and alternating hip F, 30 s each, 1 set. - In late rehab when CAM boot was removed, GT with SBA and without AD 150 ft Progressed to 260 ft with teal TB above knees and instructed to take large steps with high knees. - (E) Patient education on maintaining function of the joints above and below the ankle where her CAM walker boot is limiting her use of the extremities. HEP: - Same interventions and progression performed in the clinic mentioned above. - Walking in boot with FWW and progress to no AD.
Impaired mobility/balance	Patient will increase BBS score to 45/56	Patient will increase BBS score to 50/56 (to exceed MDC of 5 points)	All interventions listed above will address patient's ability to improve mobility/balance during functional tasks. - In early rehab sit to stand with arms crossed in pool 30 s, 3 sets. Progressed to teal TB above knee joint. HEP: - Same HEP as above to improve the patient's balance. - Sit to stand exercise performed in the clinic with same progression.

Impaired gait	Patient will be able to walk with a step-through gait pattern and without a FWW	Patient will be able to walk with a step-through gait pattern and without a CAM walker boot	All interventions listed above will address patient's ability to improve gait during functional tasks.
PARTICIPATION RESTRICTIONS			
Unable to walk dog for 1 hr	The patient will be able to walk dog for 30 min without FWW	The patient will be able to walk dog 1 hr without FWW while feeling stable.	All interventions listed above will address patient's ability to participate in walking her dog
Unable to garden around her home for 1 hr	The patient will be able to garden her home for 30 min, 3x/week, without use of FWW	The patient will be able to garden her home for 1 hr., 3x/week, without use of FWW, and without feeling unstable.	All interventions listed above will address the patient's ability to participate in gardening around her home for 1 hr, 3x/week.
Unable to use swimming pool at family function	No change is expected.	The patient will be able to use her swimming pool with her family feeling stable.	All interventions listed above will address the patient's ability to participate in using her swimming pool at family functions. - (E) Educated patient on safe strategies for entering and exiting her pool at home.

Abbreviations:
ABD = abduction, ADD = adduction, AD = assistive device, ADL = activities of daily living, AROM = active range of motion, BBS = Berg Balance Scale, BWD = backward, CAM = controlled ankle motion, CRAC = contract relax antagonist contract, D2 = Plantar flexion/inversion, dorsiflexion/eversion, DF = dorsiflexion, F = flexion, ft = feet, FWD = forward, FWW = front wheel walker, GB = gym ball, GT = gait training, HEP = home exercise program, hr = hour, Inv = inversion, L = left, lbs = pounds, LE = lower extremity, LEFS = lower extremity functional scale, MDC = minimal detectable change, MCID = minimally clinically important difference, min. = minute(s), OA = osteoarthritis, PF = plantar flexion, PNF = proprioceptive neuromuscular facilitation, PROM = passive range of motion, Rehab = rehabilitation, Reps = repetitions, ROM = range of motion, SLR = straight leg raise, SBA = stand by assist, s = second(s), TB = theraband, TUG = Timed Up and Go

Plan of Care – Interventions

See Table 3.

Overall Approach

The patient was seen in an outpatient clinic twice a week for eight weeks. The treatment sessions last 60 minutes in duration. Treatment approach was based on a multimodal approach as well as the regional-interdependence examination model.[30] This combined approach was elected for two reasons: the evidence for the effectiveness for rehabilitation after ankle fractures is incomplete, and there is some evidence that suggests ankle fractures predict osteoporotic fractures at other sites.[7,8] The multimodal approach consisted of manual therapy (MT), task-specific therapeutic exercise, aquatic therapy, gait training (GT), balance and proprioceptive training, patient education, and an independent HEP. The regional-interdependence examination model focused on providing treatment to the joints above and below the ankle.

One of the main interventions selected was proprioceptive neuromuscular facilitation (PNF) as it provided stretching and strengthening, and improved balance and equilibrium through specific patterns and techniques.[31] Initial manual techniques were low vigor respecting fracture healing. Another main intervention included warm water aquatic therapy. This was chosen so that the patient could remove her CAM walker boot; the buoyancy of the water unloaded the patient's joints providing a safe environment to perform functional activities without ankle ROM being restricted by the boot. Due to the patient's history of HTN and her medications, she was always monitored for signs and symptoms of hypotension. On the seventh week of treatment (15 weeks post-injury) the

patient was progressed out of her CAM walker boot; treatment in this late stage involved a progression of land based exercise and GT. A HEP was established so that the patient could independently gain and maintain ROM, strength, functional mobility, and balance following discharge from PT.

PICO question

For a community-based elderly patient with balance deficits (P), is an aquatic environment (I) more effective than a land-based environment (C) for improving balance (O)?

In a study utilizing a 2-group pretest-post-test deign, patients were placed in either an aquatic environment (n=6) or a land-based environment (n=6), and performed similar balance retraining interventions (level of evidence: 2b). This study performed by Douris et al.[4] incorporated the BBS as the outcome measure (OM) in order to examine the effectiveness of a six week, 12 session balance retraining intervention. The main effects studied were time (pretest vs. post-test) and group (water vs. land). The authors determined that there was a significant main effect of time, which demonstrated there were significant differences in BBS scores between pre and post-test scores for the two groups. However, the differences in BBS scores between groups was not significant. The author's concluded that regardless of the exercise medium, significant improvements in balance can be attained by lower body exercises. The strength of this study is limited by the sample size which decreased the statistical power. Also, the subjects were not randomly assigned due to recruitment challenges. For each group, two investigators were allocated to administer the BBS and oversee the exercise sessions. A weakness of this

study was that the investigators were not blinded to the subject's respective group when administering the test. The strength of the study may have also been improved if the authors included a control group that did not receive treatment for comparison to the two treatment groups. A long-term follow up test to track retention of the subjects' improvements in BBS score may provide more solid evidence as well.

Aquatic therapy was integrated into the plan of care (POC) for this patient, which was supported by the authors' findings. The authors confirmed that balance ability in older adults could be improved using land-based or aquatic-based therapeutic exercise. The authors explained that prior studies showed aquatic therapy to be more effective than land-based therapy, however those studies only looked at single components of balance such as postural sway or functional reach. The study reviewed used a balance specific comprehensive approach toward assessment of balance by using the BBS. The patient fit the inclusion criteria as she was over 65 years old, an independent ambulator with an AD, and her BBS score was less than 47 at the beginning of treatment. The interventions that the study incorporated were similar to those used with the patient in this case study, as they incorporated tandem walking, marching, sidestepping, hip ROM, heel raises, and sit to stand. Although, the authors did not find aquatic therapy to be more effective than land based exercises, they also did not find it to be less effective. It was determined that the patient would be a better fit for aquatic therapy due to her healing fracture that would have been otherwise restricted in a CAM walker boot if therapy was land-based. However, once her fracture was healed a transition from water to land was initiated.

Chapter 6

Outcomes

Table 4

Outcomes

OUTCOMES				
BODY FUNCTION OR STRUCTURE IMPAIRMENTS				
Outcome Measure	Initial	Follow-up (DC)	Change	Goal Met? (Y/N)
Goniometry	DF: 0˚ Inv: 0˚- 4˚	DF: 0˚ - 20˚ Inv: 0˚ - 22˚	+20˚ MDC=6˚ +18˚ MDC=7˚	Y Y
MMT	PF: 4/5* Hip F: 4/5*	PF: 5/5 Hip F: 5/5	+1 grade +1 grade MDC=1 grade	Y Y
ACTIVITY LIMITATIONS				
Outcome Measure	Initial	Follow-up (DC)	Change	Goal Met? (Y/N)
TUG	25.13 s with FWW	12 s without FWW	Improved by 13.3 s Cutoff score for fall risk >13.5 s	Y
LEFS	Score 10/80 = 87% impaired	Score 59/80 = 26% impaired	+49 points MCID=9 points	Y
BBS	Score = 40/56	Score = 50/56	+10 points MDC=5 points	Y
Observation of patient's gait	Patient unable to complete a step-through gait pattern with AD and CAM walker boot	Observed patient walking with a step-through gait pattern without an AD and CAM walker boot	Patient can walk with a step-through gait pattern without an AD and CAM walker boot	Y
PARTICIPATION RESTRICTIONS				
Outcome Measure	Initial	Follow-up (DC)	Change	Goal Met? (Y/N)
Walk dog for 1 hr	Patient unable to walk dog due to feeling unstable	Patient reported walking dog for 1 hr 1x/day, without feeling unstable	Patient can walk dog for 1 hr, 1x/day without feeling unstable	Y
Garden home for 1 hr	Patient unable to garden due to feeling unstable	Patient reported gardening for 1 hr, 3x/week, without feeling unstable	Patient can garden for 1 hr, 3x/week without feeling unstable	Y
Use swimming pool	Patient unable to use swimming pool	Patient reported using swimming pool	Patient used swimming pool	Y

Abbreviations:
AD = assisted device, BBS = berg balance scale, CAM = controlled ankle motion, DC = discharge, DF = dorsiflexion, F = flexion, FWW = front wheel walker, hr. = hour(s), Inv = inversion, LEFS = lower extremity functional scale, MDC = minimal detectable change, MCID = minimally clinically important difference, MMT = manual muscle test, N = No, s = second(s), PF = plantar flexion, TUG = Timed up-and-go, Y = yes, * = indicates with pain, > = greater than

Discharge Statement:

The patient attended outpatient PT for treatment of deficits following a fracture of the L distal fibula twice a week for eight weeks. The patient received ROM and strengthening exercises, proprioceptive and balance exercises, aquatic therapy, GT, patient education, and a HEP. She was limited in ADLs as evident by an LEFS score of 10/80, had functional balance impairments based on her BBS score of 40/56, and was at an increased risk for falls as evident by her TUG score of 25.13 s. Over the course of therapy, the patient achieved goals associated with ROM, strength, functional mobility and balance, gait, and decreased risk for falls. Upon completion of therapy, the patient could: sit-to-stand without feeling off balanced; walk her dog for one hour per day; resume gardening around her home for one hour per day, three times per week; and use her swimming pool with her family. The patient reported that after her follow up visit with the orthopedist following the sixth week of treatment with PT, the fracture had completely healed. On discharge the patient was given a HEP to continue working on strengthening and maintain ROM of the ankle. She was given a HEP, which included dead bug exercises, for balance and core strengthening to do on a gym ball. She was also given educational material and a HEP directed towards osteoporotic fracture prevention to help improve her BMD.

DC G-Code with modifier: G8980CJ (26% impaired based on LEFS)

Chapter 7

Discussion

It has been reported in the literature that aquatic therapy may improve balance and coordination in older individuals with impaired balance as water viscosity slows the rate of a fall allowing for correction of postural errors.[6] Aquatic therapy has been shown in women with or at risk for OP to build strength, endurance, self-efficacy, and well-being.[32] I recommended aquatic therapy for ankle weakness and instability while recovering from a fracture because it allowed the patient to work on multiple goals, while providing an environment for her to exercise more comfortably considering her history of OA and OP.

The patient responded to treatment as anticipated as she was adherent and motivated from the start. The patient's history of OP increases risk of fragility fractures, and ankle fractures are a predictor of future osteoporotic fracture risk.[8] The improvements in AROM, strength, and balance using the regional interdependence model hopefully decreased the patient's risk of future osteoporotic fracture.

Two aspects of the examination I did not incorporate were proprioception and passive range of motion (PROM). Proprioception was subsequently evaluated during later treatment, and initial assessment of PROM was avoided as a precaution to bone healing. Both measures were assessed as the patient's condition improved. Further investigation led me to believe that diminished proprioception was a contributing factor to the patient's history of falls. Based on the evidence, it was hypothesized that physical activity improving muscle strength can improve proprioception.[33]

Researchers have noted that individuals that completed aquatic based therapy had greater compliance and continued to exercise for several months succeeding the study.[4] The patient in this case study had a pool at her home, and with education on the benefits of aquatic therapy she took an interest to the activities performed in the clinic.

The patient's presentation was atypical in that she had no pain and very little ROM and strength deficits bilaterally. Furthermore, she had previously affected joints that needed to be considered with loading forces, as to not aggravate preexisting conditions. Special considerations were made as the patient's past medical history of OP and multiple falls in the last two years were reported by the patient.

Aquatic therapy is an intervention that should be broadly applied when a patient presents with WBAT status post fracture of the LE, patients with balance issues, OP, and history of OA. Meanwhile, aquatic therapy was also a special consideration for this patient as she enjoys this activity and made it one of her goals; this scenario has shown me that tailoring treatment to my future patients' interests could improve outcomes.

Presently, the American Physical Therapy Association has not produced a clinical practice guideline for ankle fractures. In addition, the evidence for the effectiveness for rehabilitation after ankle fractures is incomplete.[7] There is little evidence for rehabilitation during the immobilization period after conservative orthopedic management, and no evidence for stretching, manual therapy or exercise compared to usual care following the immobilization period.[7] The majority of authors agree that a key variable to a successful outcome to treatment is early and accurate reeducation of the joint and commencement of joint motion as quickly as possible.[6]

References

1. Willett K, Keene DJ, Morgan L, et al. Ankle Injury Management (AIM): design of a pragmatic multi-centre equivalence randomised controlled trial comparing Close Contact Casting (CCC) to Open surgical Reduction and Internal Fixation (ORIF) in the treatment of unstable ankle fractures in patients over 60 years. *BMC musculoskeletal disorders.* 2014;15(1):79.
2. Singh R, Kamal T, Roulohamin N, Maoharan G, Ahmed B, Theobald P. Ankle fractures: a literature review of current treatment methods. *Open Journal of Orthopedics.* 2014;4(11):292-303.
3. Koval KJ, Lurie J, Zhou W, et al. Ankle fractures in the elderly: what you get depends on where you live and who you see. *Journal of orthopaedic trauma.* 2005;19(9):635-639.
4. Douris P, Southard V, Varga C, Schauss W, Gennaro C, Reiss A. The Effect of Land and Aquatic Exercise on Balance Scores in Older Adults. *Journal of Geriatric Physical Therapy.* 2003;26(1):3-6.
5. Surgeons AAOO. Ankle Fratcures (Broken Ankle). 2013; http://orthoinfo.org/topic.cfm?topic=A00391. Accessed September 6, 2017.
6. Scott AM. Diagnosis and treatment of ankle fractures. *Radiologic technology.* 2010;81(5):457-475.
7. Lin CWC, Donkers NA, Refshauge KM, Beckenkamp PR, Khera K, Moseley AM. Rehabilitation for ankle fractures in adults. *Cochrane Database Syst Rev.* 2012;11:CD005595.

8. Guggenbuhl P, Meadeb J, Chalès G. Osteoporotic fractures of the proximal humerus, pelvis, and ankle: epidemiology and diagnosis. *Joint Bone Spine.* 2005;72(5):372-375.

9. Knutsen AR, Sangiorgio SN, Liu C, et al. Distal fibula fracture fixation: Biomechanical evaluation of three different fixation implants. *Foot and Ankle Surgery.* 2016;22(4):278-285.

10. Strauss EJ, Egol KA. The management of ankle fractures in the elderly. *Injury.* 2007;38(3):2-9.

11. Kannus P, Palvanen M, Niemi S, Parkkari J, Jrvinen M. Increasing number and incidence of low-trauma ankle fractures in elderly people: Finnish statistics during 1970–2000 and projections for the future. *Bone.* 2002;31(3):430-433.

12. Hasselman CT, Vogt MT, Stone KL, Cauley JA, Conti SF. Foot and ankle fractures in elderly white women: incidence and risk factors. *JBJS.* 2003;85(5):820-824.

13. Lee K, Chung C, Kwon S, et al. Ankle fractures have features of an osteoporotic fracture. *Osteoporosis International.* 2013;24(11):2819-2825.

14. Biver E, Durosier C, Chevalley T, Herrmann F, Ferrari S, Rizzoli R. Prior ankle fractures in postmenopausal women are associated with low areal bone mineral density and bone microstructure alterations. *Osteoporosis International.* 2015;26(8):2147-2155.

15. Tejwani NC, Park JH, Egol KA. Supination external rotation ankle fractures: a simpler pattern with better outcomes. *Indian journal of orthopaedics.* 2015;49(2):219-222.

16. Markolf KL, Jackson S, McAllister DR. Force and displacement measurements of the distal fibula during simulated ankle loading tests for high ankle sprains. *Foot & ankle international.* 2012;33(9):779-786.

17. Asimenia G, Paraskevi M, Polina S, Anastasia B, Kyriakos T, Georgios G. Aquatic training for ankle instability. *Foot & ankle specialist.* 2013;6(5):346-351.

18. Medical Prescribing Reference. 2017; http://www.empr.com/. Accessed September 28, 2017.

19. World Health Organization. International classification of functioning, disability and health: ICF. 2001.

20. Boone DC, Azen SP, Lin C-M, Spence C, Baron C, Lee L. Reliability of goniometric measurements. *Phys Ther.* 1978;58(11):1355-1360.

21. Menadue C, Raymond J, Kilbreath SL, Refshauge KM, Adams R. Reliability of two goniometric methods of measuring active inversion and eversion range of motion at the ankle. *BMC musculoskeletal disorders.* 2006;7(1):60.

22. Cuthbert SC, Goodheart GJ. On the reliability and validity of manual muscle testing: a literature review. *Chiropractic & osteopathy.* 2007;15(1):4.

23. Lin C-WC, Moseley AM, Refshauge KM, Bundy AC. The lower extremity functional scale has good clinimetric properties in people with ankle fracture. *Phys ther.* 2009;89(6):580-588.

24. Binkley JM, Stratford PW, Lott SA, Riddle DL. The Lower Extremity Functional Scale (LEFS): scale development, measurement properties, and clinical application. *Phys Ther.* 1999;79(4):371-383.

25. Conradsson M, Lundin-Olsson L, Lindelöf N, et al. Berg balance scale: intrarater test-retest reliability among older people dependent in activities of daily living and living in residential care facilities. *Phys Ther.* 2007;87(9):1155-1163.

26. Donoghue D, Stokes EK. How much change is true change? The minimum detectable change of the Berg Balance Scale in elderly people. *Journal of Rehabilitation Medicine.* 2009;41(5):343-346.

27. Hillegass E, Puthoff M, Frese EM, Thigpen M, Sobush DC, Auten B. Role of physical therapists in the management of individuals at risk for or diagnosed with venous thromboembolism: Evidence-based clinical practice guideline. *Phys Ther.* 2016;96(2):143-166.

28. Podsiadlo D, Richardson S. The timed "Up & Go": a test of basic functional mobility for frail elderly persons. *Journal of the American geriatrics Society.* 1991;39(2):142-148.

29. Shumway-Cook A, Brauer S, Woollacott M. Predicting the probability for falls in community-dwelling older adults using the Timed Up & Go Test. *Phys Ther.* 2000;80(9):896-903.

30. Wainner RS, Whitman JM, Cleland JA, Flynn TW. Regional interdependence: a musculoskeletal examination model whose time has come. *J Orthop Sports Phys Ther.* 2007;37(11):658-660.

31. Knott M, Voss DE. *Proprioceptive neuromuscular facilitation: patterns and techniques.* Hoeber Medical Division, Harper & Row; 1968.

32. Becker BE. Aquatic therapy: scientific foundations and clinical rehabilitation applications. *PM&R.* 2009;1(9):859-872.

33. Ribeiro F, Oliveira J. Aging effects on joint proprioception: the role of physical activity in proprioception preservation. *European Review of Aging and Physical Activity.* 2007;4(2):71-76.