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Physical Therapy Management for a 16-year old Female Following Arthroscopic Plica Resection and Partial Synovectomy: A Case Report

Hannah Brennan

Physical Therapy Management for a 16-year old Female Following Arthroscopic Plica Resection and Partial Synovectomy: A Case Report

by

Hannah Brennan
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This Scholarly Project, submitted by Hannah Brennan 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.

Mohamed Elhamadany

(Graduate School Advisor)

DocuSigned by:
David Kelling
AE147CE500EA419...

(Chairperson, Physical Therapy)

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Department Physical Therapy

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ABSTRACT

Background and Purpose. Synovial plica is a common abnormality found primarily in the knee joint. Plicae can become irritated and inflamed with repeated motions causing pain and limited range of motion. Conservative management of symptoms is often the first method of treatment. However, surgical excision is considered if symptoms still persist. **Case Description**. The patient is a 16-year-old female referred to physical therapy (PT) for post-arthroscopic management of a left plica resection and partial synovectomy. The patient presented with limited strength, range of motion and increased pain, congruent with her post-operative condition. The patient was seen by PT 2 times per week for 7 weeks. **Intervention.** Physical therapy management focused on implementing blood flow restriction training (BFR) along with neuromuscular re-education (NMR), stretching, and gait training to improve her overall functional status and return to prior level of function. **Outcomes.** The patient's Focus on Therapeutic Outcome Measure (FOTO) score improved from a 62/100 to a 84/100, visual analog scale (VAS) from a 3/10 to a 0/10, and improved strength from a 3/5 to 5/5 in the left lower extremity. The patients left knee range of motion was also normalized to >120 degrees of flexion and 0 degrees of extension. **Discussion**. This case report outlines how a combination of BFR training, NMR, stretching, and gait training can improve the functional status of a patient post- arthroscopic plica resection. Limited literature is available on post-operative management for patient who had undergone arthroscopic knee surgery for a plica resection. More research is needed to define the appropriate PT treatment methods for those with a similar post-operative condition.

CHAPTER I

BACKGROUND AND PURPOSE

Synovial plica can be described as inward folds of the synovial lining that occur during fetal development. Over time, the shelf-like membrane is reabsorbed leaving a single knee cavity. However, in many individuals the mesenchymal cavitation fails to combine creating folds within the synovium. [1] It is estimated that about 50-70% of the world population have plica in the knee that do not cause symptoms. [2] However, when repeating the same knee movement too often, such as bending and straightening the knee, or in the case of a trauma, these plicae can become irritated and inflamed. [1]

Synovial Plica Syndrome (SPS) is found in approximately 10% of the world's population. Research has showed that the medial patella plica (MPP) is a common site for irritation based on anatomical location. It is suggested that the primary cause of irritation to the MPP is due to its proximity to the femoral condyle and being prone to impingement causing inflammation.[3] Some symptoms that are often present with MPP include dull anteromedial knee pain generally aggravated by physical activity. Patients may also report sensations of locking, clicking, or instability in the knee.[4] Symptoms generally begin to worsen as inflammation increases. A common cause of excessive inflammation of the MPP is repetitive flexion activities. Overtime, the normally thin, flexible, and elastic tissue becomes fibrotic. The development of the fibrosis and inflammation is then characterized by the diagnosis of MPP syndrome.[5]

Conservative management is often the first method of treatment when it comes to MPP syndrome. Conservative management is found to be an effective treatment for most cases of pathological synovial plicae, and surgical intervention should be reserved

for those who do not have an improvement in symptoms with conservative treatment.[6] Some methods used in physical therapy (PT) practice for the management of knee syndromes include activity modification, exercise therapy involving hip and knee musculature, and other specialized treatments like blood flow restriction training (BFR) for symptom management. [1,7]

If conservative management fails, surgery is often utilized to remove the problematic plica. A meta-analysis was performed and discussed the outcomes of surgery. The study noted that the surgery is performed arthroscopically where the symptomatic plica is either excised or divided. Excision of the plica can involve many different tools to ultimately move or remove the plica to a point where it no longer impinges. Dividing the plica essentially breaks it into smaller segments. However, this can cause a scar to form and the divided segments to reform causing a return of symptoms. For this reason, excision of plica has become the treatment of choice. There were 7 articles included in the meta-analysis and results demonstrating outcomes of good or excellent in about 84.2% of cases following an arthroscopic excision of the medial patella plica. [8]

After a review of literature, many articles provide information on conservative management for MPP, however, not much is known about post-operative physical therapy. The purpose of this case report is to review PT management of a patient status post arthroscopic plica resection with a partial synovectomy. This case report focuses on the use of BFR training in conjunction with neuromuscular re-education (NMR), stretching, gait training, and implementation of a home exercise program (HEP) to improve the patient's overall function and return to sport activities.

CHAPTER II

CASE DESCRIPTION

Patient History and Systems Review

The patient was a 16-year-old female who had ongoing left anterior knee pain for a year prior to being seen by PT. She had first noticed the onset of symptoms after participating at a volleyball camp. She continued with athletics for a year but ultimately opted for surgical intervention which included a plica resection and partial synovectomy of the left knee. The patient had not participated in physical therapy previously and there was no other relevant medical history or injury to the knee.

A systems review was completed on the patient and found most deficits related to the musculoskeletal, neuromuscular, and integumentary systems. Major impairments included loss of range of motion (ROM), strength, and pain in the left knee. The patient's history and systems review can be located in Table 1.

The patient lived in a multi-story home with her mother, father, and brother. Her room and bathroom were located on the second level. The patient's primary occupation was being a student at a local high school. However, she often participated in household chores and stated the need to be able to ambulate on uneven surfaces. She was also very involved in school athletics including volleyball.

Prior to her surgery, she was independent with all transfers, had no difficulty walking and was able to participate in athletics with pain present in the left knee. After surgery, the patient had difficulty walking and fully weight-bearing on the left lower extremity resulting in a need for bilateral axillary crutches. However, she was still

independent with all transfers. The patient's goals for PT were to improve strength in the left lower extremity, be able to walk without crutches, and return to volleyball.

Clinical Impression 1

The patient had received surgery one week prior to the initial evaluation by PT. The patient was referred to PT for lower extremity and core strengthening. The patient presented with impairments consisting of pain in the left knee along with limited ROM, strength, balance, coordination, and gait. All of these factors contributed to her decrease in overall functional ability. This patient was chosen for this case report due to previous high level of function, willingness to participate in therapy, and limited comorbidities. This helped to accurately assess the effect of therapy because there were very few variables involved. The patient read and signed consent forms to participate in this study.

Examination- Test and Measures

The results of the initial examination can be summarized in Table 2. Initial observation noticed the patient ambulating with ill-fitting bilateral axillary crutches and an anterior trunk lean. She preferred a non-weight bearing status due to pain with loading of the left lower extremity and was independent with transfers. Observational gait analysis was performed showing a three-point orthopedic gait pattern. When prompted to increase weight bearing on the left lower extremity, the patient demonstrated an antalgic gait with decreased stance time on left, decreased step length on the right, and overall decreased walking speed. The patient was then assessed for a deep vein thrombosis (DVT). The patient had no tenderness with palpation in the calf

along with no redness or erythema. The patient was then considered negative for a DVT.

The patient's knee musculature was tested on the non-operative limb using manual muscle testing (MMT) based on Magee's Orthopedic evaluation of leg, ankle, and foot. [9] The operative limb was tested based on the completion of functional tasks due to the limitations of her postoperative condition. ROM was then assessed using goniometric measurements on both limbs and the results were compared. Pain was assessed using the visual analog scale (VAS). The VAS was presented to the patient with 0 being no pain at all and 10 being the most pain imaginable. A study found high reliability of the VAS for acute pain. [10]

The last objective assessment performed during the initial evaluation was the patient's intake score for the functional outcome measurement. The functional outcome tool that was used for this patient was titled Focus on Therapeutic Outcomes (FOTO). FOTO uses a questionnaire for specific regions of the body to create an intake score based on a 100-point scoring system with 100 points being no impairment and a lower score meaning more significant impairments. The system then takes the intake score and compares to those with similar diagnoses and creates two other scores for the patient and clinician to use. It uses data from the patient to create a predicted outcome and discharge score. This information can be used by the clinician to hypothesize the relative number of treatment sessions that may be needed for this patient and where they are expected to be upon discharge from therapy. A meta-analysis was performed by finding good predictive ability for the FOTO tool. [11]

Evaluation

Based on the data collected from the initial examination, the patient had strength and mobility deficits that were congruent with her postoperative condition. The deficits found in her body structure and function contributed to her activity limitations and participation restrictions. Due to the pain, limited ROM, and decreased strength in the left knee, the patient was unable to ambulate without an assistive device, participate in athletics, or negotiate stairs to her bedroom.

Diagnosis

The patient's PT diagnosis was based on the International Classification of Disease- tenth edition (ICD-10). The diagnoses given were pain in the left knee (M25.625), difficulty walking not elsewhere classified (R26.2), and Chondromalacia patella in the left knee (M22.42). [12]

Prognosis

The patient was predicted to have a good prognosis due to her limited co-morbidities, active lifestyle, and motivation to return to a higher level of function. The patients driving factors that contributed to her positive prognosis were her supportive family, motivation to return to sport, hardworking values, open-mindedness to treatments, and an overall goal of independence. Some barriers to her recovery included the presence of bilateral joint laxity in the knee, along with her active school schedule and travel time needed for appointments. A study was completed to determine the prognosis of patients following a plica resection. Results of the study found that 109 out of the 118 knees evaluated had little, if any pain showing that arthroscopic excision of plica can relieve symptoms. All participants in this study had physical therapy as part

of postoperative management. [13] This study showed a positive outcome for surgical and therapeutic interventions and was thus applied to this case.

Plan of Care

The plan of care (POC) for this patient consisted of 45-minute treatment sessions 2 times per week for 10-12 weeks. The initial 7 weeks of care were provided by a student physical therapist (SPT) with supervising PT. At the end of 7 weeks, the care was transferred to the supervising PT to continue on with treatment until all goals were met. The patient was informed that the POC was subject to change based on the completion of her goals and functional status. The program primarily focused on restoring strength and ROM in the lower extremity, improving core stability, and decrease pain to help re-establish functional gait mechanics. The patient was also instructed to complete a home exercise program (HEP) once per day on the days that she did not attend PT. The patient was then re-examined based on progress for strength, ROM, FOTO scores, and gait periodically throughout the PT POC. Physical therapy's goals were to decrease pain and restore strength, range of motion (ROM), balance, and proprioception so the patient could return to her prior level of function. The patient's short-term and long-term PT goals can be located in Table 3. The POC was discussed with the patient and her guardian to which they consented to treatment.

CHAPTER III

INTERVENTION

Patient Education

The patient was educated on postoperative management including applying ice on the knee for 20 minutes to reduce swelling and encouraged to increase the amount of weight bearing on the limb. The patient had no weight bearing limitations postoperatively. Other education included the importance of completing her HEP to facilitate her rehabilitation process and return to functional activities sooner. The final instructions given to the patient were about BFR therapy. One important aspect about BFR training is the potential for adverse response. Some symptoms include lightheadedness and dizziness. These items were presented to the patient and the patient consented to BFR treatment despite potential for adverse effects. The patient was also instructed to consume 20 grams of protein with in 30 minutes of the treatment session along with 20 grams of protein in the next three meals based on Owens Recovery Science (QRS) BFR manual.[14] Current literature supports the International Society of Sports Nutrition stance on exercising individuals consuming at minimum approximately 1.4 to 2.0 grams of protein per kilogram of bodyweight per day to optimize exercise training.[15] The patient was compliant with her protein consumption, HEP, and PT visits due to her motivation to return to previous functional activities.

Procedural Interventions

The interventions chosen for this client focused on improving ROM, strength, proprioception, and gait training. A summary of interventions for the first 7 weeks of

treatment can be located in Table 4 along with a summary of the patients initial HEP in Table 5.

Gait Training

Gait training primarily consisted of education and demonstration of proper posture and use of bilateral axillary crutches. The patient was encouraged to fully weight bear on the left lower extremity and increase stance time on the affected limb during gait. The first two treatment sessions included practice of proper gait mechanics.

Stretching

Due to the patient's impaired ROM in her left knee, stretching was implemented into treatment sessions. The patient was instructed to perform active-assistive heel slides in supine with slight overpressure at full knee flexion and holding for 15 seconds for three sets. The patient continued to complete this stretch until active and passive ROM was normalized.

Strength

The primary focus of PT was restoring the patient's strength in her lower extremity. This was done by utilizing BFR training specifically with the Delfi Owens Personalized Tourniquet System. This system is unique in that the cuff, which is placed on the proximal thigh, inflates to cause 100 percent limb occlusion pressure. The machine then calculates the amount of pressure needed to maintain 80 percent limb occlusion pressure and will constantly monitor the amount of occlusion in the limb and change the amount of pressure accordingly. The amount of pressure needed to maintain 80 percent limb occlusion is known as the personalized tourniquet pressure. The personalized tourniquet pressure is evaluated at the beginning of every session.

Repetitions follow the unit's protocol by performing 30/15/15/15 repetitions of the same exercise. A 30 second break occurs between sets while the cuff is inflated. Once all four sets have been completed, the cuff is then deflated to zero mmHg of pressure and starts a one-minute lock out period. During this period of time, the patient is instructed to rest and have little to no movement in the limb. The next exercise is resumed once the one-minute lock out period is completed.

The exercises chosen for this specific intervention were based off of the QRS BFR manual. According to their research, the optimal load for resistance training with BFR is between 15-30 percent of the patient's one repetition maximum (1-RM). For this patient, rate of perceived exertion (RPE) based on the Borg Category Ratio (Borg-CR) was used to determine intensity of exercise. The full scale is pictured in Table 7. The target RPE for this patient based on the corresponding percent repetition maximum was between a two and three on the Borg-CR.

As the patient progressed in strength, exercises transitioned from BFR focused interventions to traditional strengthening methods. These methods included incorporating compound movements in a 70-80 percent 1-RM. This was done to create symmetry between both the right and left lower extremity along with training for return to sport activities. The patients HEP was also progressed throughout therapy to reflect her strength improvements following the principle of overload, stated in National Strength and Conditioning Association's "Basics of Strength and Conditioning Manual". [16]

Neuromuscular Re-education

NMR tasks were initiated starting the 3rd week of therapy. The patient completed tasks such as double and single leg stance, squats, and lunges on a dynamic surface.

Proprioceptive neuromuscular facilitation (PNF) was also used to aid in strengthening and coordinating movement of the lower extremity.

Communication and Documentation

Communication was clear and open between the patient, SPT , and supervising PT. The plan of care and expectations were always discussed among the three individuals. The patient also disclosed to the SPT and supervising PT about her work with an athletic trainer at school. Communication was essential to know what sort of activities were preformed outside of PT in order to know where to focus PT interventions. Documentation of all communication and interventions were completed at the end of every treatment session.

CHAPTER IV

OUTCOMES

Initial evaluation of the patient showed deficits in left knee ROM, strength, and balance. This led to an overall decline in physical functioning. After 7 weeks of physical therapy intervention, improvements were found in the patient's pain level, ROM, strength, and FOTO score correlating to an increase in functional capacity. The results of test and measures after the 7 weeks of intervention can be found on Table 2. The patient progressed rapidly in therapy with her gait being restored without the use of an assistive device after the first week of therapy. Also, knee active ROM was normalized to greater than 120 degrees of knee flexion and 0 degrees of knee extension within the first week of therapy. She continued to have gains in therapy with quadriceps strength returning to a normal 5/5 MMT grade at week 5. The patient's hamstring strength returned to normal 5/5 MMT grade at the end of the 7th week. Finally, the patients FOTO score increased consistently throughout treatment with a final score of 84/100 which is consistent with her overall improvement in functional activities. When comparing the intake FOTO score to the discharge score, there was a 22-point increase. Research has shown that the minimal detectable change for the FOTO tool was 11.9 points.[17] By definition, a change in 11.9 points corresponds to a noticeable change in ability. This means that the patient under study had a large improvement in functional capability.

The patient's improvement in functional ability can also be seen in her long-term and short-term goals. She was able to successfully ambulate without an assistive device, have normal AROM of her surgical knee, 5/5 quadriceps strength, and

stand for >10 second on a single leg. All of these improvements correlated with her ability to independently ambulate, negotiate stairs, and perform chores at home on uneven surfaces.

All of her improvements were completed in 15 visits, each lasting for 45 minutes in length. After the 15 treatment sessions, the patient was still lacking motor control and stability in the left lower extremity which was seen when performing more plyometric movements. While she had improved functionally and met all of her goals, the patient was unable to return to athletics in 7 weeks.

CHAPTER V

DISCUSSION

Overall, the patient showed good response to therapy demonstrated by her ability to achieve her goals and improve her function. The case report outlines the successful outcome of PT management measured by the patient's decrease in pain, increase in ROM, normalized strength, and improvement in proprioception. All therapy goals were met correlating to her overall increase in her functional ability.

The patient had multiple prognostic factors that are believed to have contributed to the success of her therapy. The patient demonstrated motivation to improve her level of functioning. She was determined to return to her previous level of independence which was seen in her willingness to participate in therapy. The patient had not missed any treatment sessions which played a significant role in her recovery.

In respect to this case report, a combination of BFR training, NMR, therapeutic exercise, and implementation of a HEP demonstrated positive outcomes for the patient. Current literature and evidence helped to support the intervention methods used in this case. Improvement of ROM was supported with evidence showing that holding stretches for 15 seconds for three sets compared to 5 seconds for eight sets significantly improved active ROM. [18] In regard to strengthening and intensity, RPE was utilized based on current research supporting a relationship between RPE and maximal contractility of muscle. [19] Progression and regression of exercises was determined based on patient response and tolerance to the strengthening interventions. NMR tasks were also chosen for this patient on the basis that proprioception, dynamic joint stability, and reactive neuromuscular control are affected by knee injuries. Due to injury, recent

surgery, and impaired mobilization of the knee joint, the entire kinetic chain between the hip, knee, and ankle joints had been disrupted. Implementing NMR tasks can help restore functional movement patterns. Research suggests that rehabilitation should focus on balance activities and movement in multiple planes on solid and dynamic surfaces to restore the sensorimotor system. [20] PNF techniques were also used to facilitate NMR along with improving strength. PNF techniques when compared to conventional weight training were shown to contribute to better strength improvements in athletes. This means that combining strength training and PNF can produce optimal recovering and strength improvements. [21]

The patient's outcomes can be reflected in the improvement of her FOTO score. It is suggested that a combination of the above-mentioned intervention techniques can provide a relief of symptoms and an improvement of function for patients who are status-post arthroscopic excision of MPP.

One important factor that must be considered is that the patient had worked with an athletic trainer outside of therapy. This trainer was not affiliated with physical therapy but did complete exercises with the patient three days a week. Communication was present between the patient, SPT and PT on what type of exercises were completed outside of therapy. The exercises performed outside of therapy focused on endurance. Communication between the athletic trainer, SPT, and PT could have been improved.

Further research is needed to understand the effect of BFR training

accompanied by NMR and therapeutic exercise in patient's post-arthroscopic plica resection of the knee. BFR training is known to be helpful in regaining strength, however many studies focus on post anterior cruciate ligament reconstruction (ACLR).[22]

In conclusion, BFR training in conjunction with NMR, a HEP, and therapeutic exercise can be an effective treatment for patients who are post-operative arthroscopic plica resection. This case report outlines how these interventions can effectively improve ROM, strength, and proprioception correlating to an improvement in functional ability. It is important to take into consideration the patient's positive prognostic factors and utilization of an athletic trainer outside of therapeutic interventions due to the likely impact it made on the patient's return to her prior level of function.

Reflective Practice

When reflecting on this case study, some changes could have been made to better enhance the care of the patient. One additional question that could have been incorporated in the initial evaluation was if the patient had experienced any feeling of joint instability. Later in the rehabilitation process, PT assessed for joint laxity and bilateral joint laxity was found in the knees. This information would have been helpful initially to help identify the need for a functional brace. This functional brace would provide more stability for the knee joint aiding in her recovery process and goal of returning to sport.

Along with additional history questions, some examination procedures could have been changed. The Homan's sign was used to assessment of a DVT due to the patient having a recent surgery. This specific test has poor specificity and sensitivity making it not the most appropriate way to assess for a DVT. [23] A sensitive test that

should have been used is the Wells criteria for DVT. A study reported that in low risk patients, Wells criteria had a sensitivity of 100% and 90% in more moderate risk patients. [24] These results show that the Wells criteria would have been a better tool for assessment of a DVT. The patient's hip strength should have also been tested in the initial examination. Given the biomechanical relationship between the hip and the knee, the hip should have been assessed to help identify any weakness that may have been present. Research shows there is a strong relationship between weakness in the gluteus maximus and medius muscles and anterior knee pain. [25] Assessing the strength in these muscles would have helped determine if there was weakness present, therefore, preventing further injury or recurrence of symptoms.

In addition to new examination procedures, the PT POC could have also been adjusted to focus more on the patient's goal of returning to her sport. At the end of 7 weeks, her strength had improved to 5/5 for knee extension and flexion. NMR tasks were also performed throughout therapy to help restore proprioception in the knee to the patient's need to ambulate on uneven ground in order to complete chores at home. However, the patient had not yet started performing high velocity single leg activities for return to sport. As her strength improved, the PT POC could have incorporated tests and interventions such as single leg hop for distance, 6 meter timed hop, and Y balance test to determine if instability was present but also as an intervention to aide in return to sport sooner. One study in particular concluded that single legged hop tests can be used to predict the likelihood of successful and unsuccessful outcomes in patients 1-year post ACL reconstruction. [26] While the patient under study did not have an ACL reconstruction, the same principles can be applied. The rest of the PT POC would not

have been changed due to the patient completing all other functional goals. No additional referrals were made because there was no complication with therapy, and everything completed was performed in the PT and SPT scope of practice

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Table 1. Medical History and Systems Review

Cardiovascular/Pulmonary	Unimpaired
Musculoskeletal	**Impaired:** Limited left knee range of motion Impaired strength of hip, knee, and core musculature Impaired gait mechanics Impaired posture with use of bilateral axillary crutches Unable to fully weight bare on left lower extremity
Neuromuscular	**Impaired** Unable to fully weight bare on left lower extremity resulting in diminished standing balance on the left
Integumentary	**Impaired** Three small sutures present on medial and lateral left knee. Incision intact with no drainage.
Cognition	Unimpaired

Table 2: Results from Initial Examination

Test and Measures	Initial Examination	Discharge
Homan's Sign	Negative	-
Right Knee Strength	Flexion: 5/5 Extension: 5/5	Flexion: 5/5 Extension:5/5
Left Knee Strength	Flexion: 3/5 Extension: 3/5	Flexion: 5/5 Extension: 5/5
Right Knee Active ROM	Flexion: WNL (>130 deg) Extension: 1 deg of hyperextension	-
Left Knee Active ROM	Flexion: 65 deg Extension: -5 (into flexion)	Flexion: >120 deg Extension: 0 deg
Left Knee Passive ROM	Flexion: 85 deg Extension: 0 deg	-
VAS for pain	3/10	0/10
Intake FOTO score	62/100	84/100

Table 3. Short- and Long-Term Goals

Short Term Goal (2 weeks)	Long Term Goal (12 weeks)
1. Following PT intervention, the patient will be able to independently ambulate without an assistive device for >200 ft with appropriate gait mechanics allowing her to ambulate around school. 2. Following PT intervention, the patient will have >125 deg AROM of the left knee allowing her to properly perform a reciprocal gait pattern on stairs, independently, into her home	1. Following PT intervention, the patient will have 5/5 strength in the lower extremity correlating to appropriate quadriceps control to allow the patient to safely and independently negotiate stairs to her bedroom on the 2nd level of her home. 2. Following PT intervention, the patient will be able to perform a single leg stance for >10 seconds with eyes open correlating to appropriate proprioception in the lower extremity allowing her to safely ambulate on uneven surfaces to complete chores at home.

Table 4. Interventions

Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7
BFR Exercise: Supine Straight Leg Raise (SSLR) Side lying hip abduction Side lying hip adduction Prone hip extension Standing bilateral calf raises **dizziness noted* All completed 30/15/15/15 reps expect calf raises (30 reps only due to dizziness)	**BFR Exercise:** Single Leg Glute Bridges Prone planks with hip extension Quadruped D2 Flexion w/ 3 lbs ankle weight Standing Split Squats Modified side-plank with hip abduction All completed 30/15/15/15 reps	**BFR Exercise:** Quadruped D2 Flexion w/ 4 lbs ankle weight Sidelying hip extension+ abduction using Theraball on wall Walking lunges w/ Bilateral upper extremity (UE) support Hip extension on Skill Mill w/ Level 8 resistance Front Squats w/ 45 lbs bar *anterior knee pain noted All Completed 30/15/15/15 except front squats (30 reps only due to anterior knee pain)	**BFR Exercise:** Walking lunges w/ UE support Prone hamstring curls w/ 3 lbs weight Side planks with hip abduction and 4-point contact Single leg calf raises All Completed 30/15/15/15 reps	**BFR Exercise:** Skill Mill hip extension w/ max resistance Prone hamstring curls on T-ball w/ 4 lbs weight Single leg pistol squat w/ TRX bands for UE support All completed 30/15/15/15	**BRF Exercise:** Prone Plank w/ hamstring curl 1-3 lbs Seated SLR on horizontal t-ball Standing Hamstring curl w/ stance leg on dynamic surface Modified side plank with hip abduction All completed 30/15/15/15	**BFR Exercise:** Single leg wall bridges Standing hamstring curl w/ 5 lbs weight All completed 30/15/15/15
Non-BFR Exercise: Supine active-assistive heel slides w/ TheraBand 3 reps x 15 second hold x 3 sets		**NMR:** mini squats on a Bosu ball dome side down x15 seconds x 3 reps single leg stand on blue Thera-disc with forward and	**Non-BFR Exercise:** Jogging at 5.3-5.7 mph on skill mill level 2 resistance x 10 min	**NMR:** Single leg stance on dynamic surface tossing and catching Theraball 3x 15 sec *Maximum assistance at gait belt to	**Non-BFR Exercise:** front squats with 45 lbs barbell 10 reps x 3 sets retro ambulation on a skill mill w/ level 3 resistance	**Non-BFR Exercise:** Side lunges with oblique twist using TRX RIP trainer w/ moderate resistance 12 reps x 3 sets bilaterally Theraband forward and

		lateral ball roll 12 reps x 3 sets *Completed w/ Stand by Assistance (SBA) x 1 at gait belt		prevent loss of balance	x 1 min intervals x 5 reps x 1 set stair stepper machine x 10 min	retro walk outs with emphasis on eccentric quad control 3 sets x 30 sec
			NMR: Bosu ball squats with the dome down, dome up partial squats including opposite hip abduction, flexion and extension using cone taps x 8 reps x 3 sets counter clockwise and clockwise rotations on Bosu ball with the dome down x 3 reps TRX bridges with knee extended x 10 reps x 3 sets Tandem stances on dynamic surfaces x 30 sec x 3 reps *Completed all w/ SBA at gait belt			

Table 5. Initial HEP

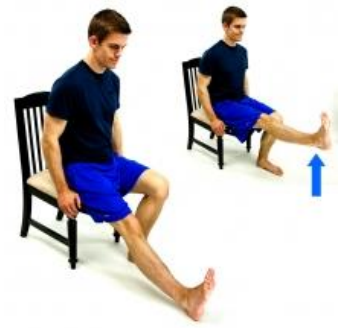
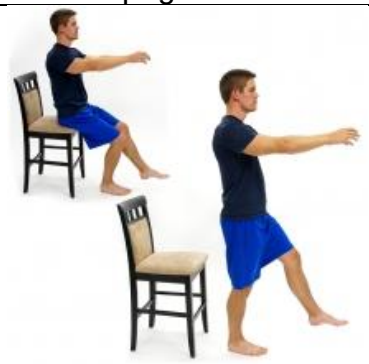
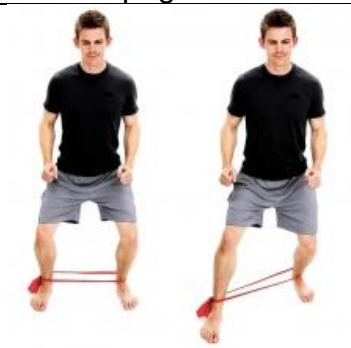
Exercise	Parameters	Diagram
Seated Straight Leg Raise	10-12 reps x 3 sets 1x/day	 www.hep2go.com
Single Leg Sit-to-Stands	10-15 reps x 3 sets 1x/day	 www.hep2go.com
Wall Sits	3 x 30 secs 1x/day	 www.hep2go.com
Monster Walks w/ yellow Theraband	20 reps x 3 sets 1x/day	 ******place band above the knees**

Table 6. Borg Category Ratio (Borg-CR)

Rating	Descriptor
0	Rest
1	Very, very easy
2	Easy
3	Moderate
4	Somewhat hard
5	Hard
6	-
7	Very Hard
8	-
9	-
10	Maximal