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Outpatient Physical Therapy Management of a Patient with Postoperative Patellar Tendon Rupture Repair Following ACL Reconstruction with a Patellar Tendon Autograft: A Case Study

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OUTPATIENT PHYSICAL THERAPY MANAGEMENT OF A PATIENT WITH POST-OPERATIVE PATELLAR TENDON RUPTURE REPAIR FOLLOWING ACL RECONSTRUCTION WITH A PATELLAR TENDON AUTOGRAFT: A CASE STUDY

by

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This Scholarly Project, submitted by Colin Renfandt 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.

(Graduate School Advisor)

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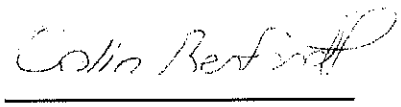
Signature 

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ABSTRACT

Background and Purpose: This article describes the 3-month outpatient physical therapy management of a patient who had his left patellar tendon reattached after a rupture and repair. Patient had a previous anterior cruciate ligament (ACL) reconstruction with a left patellar tendon autograft. Upon physical therapy (PT) evaluation, he presented with decreased left knee ROM, strength, moderate swelling, and pain involved all in the left knee. The purpose of this article will be to go into further depth with the interventions utilized for this particular patient. At the end, we will discuss the end results in comparison to the starting base line that this patient was at. Description: The treatment of this patient involved therapeutic exercises including strengthening, stretching, and ROM. We also focused on gait training with assistive devices, patellar mobilizations, and cryotherapy throughout the episode of care. Outcomes: Following PT intervention, patient demonstrated full and equal bilaterally knee flexion and extension AAROM, 5/5 and normal strength, equal bilaterally knee circumference (with visual inspection), zero pain at rest and during activities, and a normal and confident gait pattern. He was able to get back to work, ADL's, and weight training without any limitations or setbacks. Discussion: The rationale for the treatment of this patient was based off of multiple article sources relevant to similar surgeries, the protocol, and treating the patients presenting symptoms. His treatment interventions were adjusted accordingly to his response which was assessed frequently throughout this episode of care.

Key words: patellar tendon, ACL autograft, pop during jumping, infrapatellar tendon rupture, patellar tendon rupture, patellar ligament

CHAPTER I

BACKGROUND AND PURPOSE

A rarely seen surgical procedure following a patellar tendon rupture occurs most commonly in males under the age of 40 years old following the landing of jumps or falls both in occupation and sports activities.[1,2] When a person has to catch themselves with their legs, the primary anatomical structure that dissipates the kinetic energy created when landing during a jump ends up being the quadriceps musculature of both legs.[3] As shown in Figure 1, the quadriceps muscles are connected to the tibial tuberosity of the tibia and the patella via the patellar and quadriceps tendons. Therefore, given the anatomical layout of this system, the force is directly applied through the patellar tendon. When coming down from a jump, the quadriceps muscles end up getting elongated while contracting their muscle bellies in what is termed an eccentric contraction.[1]This is a reflexive act in order to catch ourselves and to prevent further injury from occurring. The

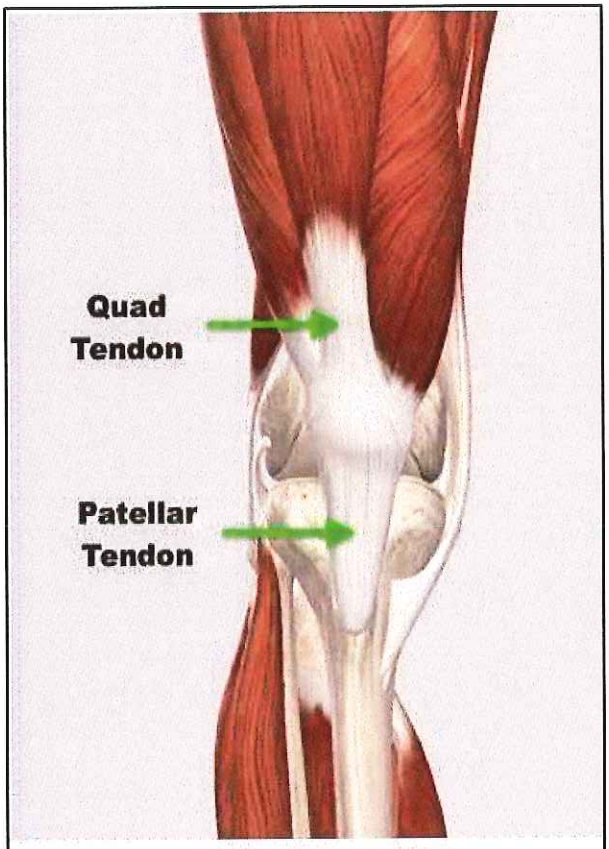

Figure 1. The Basic Knee Anatomy

average force that a patellar tendon can withstand is between 10 000 to 15 000 Newtons of force per patellar tendon, or 13 to 19 times the bodyweight of an individual that weighs 176 lb.[4]

Along with this, the patellar tendon is believed to be 30% to 40% less thick than the quadriceps tendon, therefore putting the patellar tendon at greater risk of tear from sheer force of a landing and eccentric contraction.[1] Later discussed, one of the big concerns of this patient was his weight as he was approximately 340 pounds and 6 ft 3 in. The patellar tendon can be exposed to a force as high as seven times an individual's body weight.[3] When analyzing the fact that seven times the body weight during a fall is potentially achievable and understanding that a patellar tendon can withstand up to 13 to 19 times the body weight of the individual, it is obvious there are other key factors involved. Therefore, we must explore other means that played an integral role in the rupture of this tendon. Risk factors that make an individual more likely to tear their patellar tendon include steroid usage, previous knee trauma, systemic diseases, and poor body mechanics during sporting and jumping activities. With previous knee trauma, this includes tears to the ACL, PCL, meniscus, patellar tendon, and any other traumatic injuries that occur to the involved knee.[5]

The patient for this case study sustained a patellar tendon rupture 17 years after having an ACL reconstruction with the same patellar tendon as a source of autograft to repair the torn ACL. In terms of rarity, only 0.24 percent, or 13 out of 5 364 patients had a patellar tendon rupture following an ACL reconstruction with the patellar tendon autograft.[6]

The patient's first injury, which occurred 17 years prior to the current injury, was an ACL tear with reconstruction. During this surgical procedure, they removed the middle one-third section of the patellar tendon to use as the new ACL.[7] This method has been shown to be one of

the most common ways alongside hamstring autografts and allografts to replace the torn ACL effectively. When a hamstring autograft approach is chosen, the semitendinosus and gracilis tendons are typically used for the ACL reconstruction.[8] Besides an autograft, some people will opt for utilizing an allograft approach, which is when they use donor tissue instead of harvesting a tendon from the patient's body. When considering each surgical approach, results after each of the three listed options are very similar, yet hamstring reconstructions tend to show slightly shorter rehabilitation times and less pain involved when compared to the other options.[9]

Switching focus to the patellar tendon rupture and repair 17 years later, according to a protocol for patellar and quadriceps tendon repair surgeries,[10] the surgeon will go in and suture back together the two ends of the patellar tendon thus making it one again. Due to the nature of splitting apart the patellar tendon, this has remained the primary surgical approach to this type of injury. After the surgery is complete, the knee will be locked into a brace at full knee extension and the patient will be instructed to remain non weight bearing (NWB) for 6 to 8 weeks after the surgical repair. The reasoning behind immobilization following surgery is because the tendon is now weak and the goal is to prevent any further stressors during the first 6 to 8 weeks to allow the healing process to occur. Any increase of force put through the tendon increases the chance of rupture which includes the significant force placed during weight bearing activities.

According to Belhaj et al,[11] patients 75 months post-operative reported significant improvements in pain, strength, ROM, quality of life, and overall functionality and independence when the surgery occurred in a timely manner. In the case of this report, his surgery was approximately 1 month after his patellar injury; therefore, it was done acutely and thus aiding a successful recovery.[11] Lastly, the significance of a case report on this topic is crucial and

important because of how little evidence is out there regarding the cause of rupture, the surgery, and the rehabilitation process. We hope to bridge the gap of knowledge regarding this topic and look forward to future research on the topic.

CHAPTER II

CASE DESCRIPTION

The patient was a 34-year-old male, 340 pounds, muscular, and approximately 6 ft 3 in. In terms of his body mass index he was 31.2, which places him at the obese level.[12] He had an ACL reconstruction on his left knee 17 years before he ended up tearing his left patellar tendon. Patient said that he was playing football in high school as a 17-year-old, and he was tackled and felt a popping sound as his leg twisted while he fell to the ground. He reported feeling unsteady and weak along with having lots of pain and edema in the involved knee consistent with an ACL tear. Therefore, he ended up getting an autograft from his same knees (left) patellar tendon. Recovery following his ACL reconstruction went perfectly and he was able to begin playing basketball again in college.

Fast forwarding 17 years later, he reported he was playing basketball when he tore his patellar tendon. As he was on the way down from a jump shot, he felt a popping sound with immediately not being able to support himself upright. He was unable to get up and extend his left leg, felt an immense amount of pain, and had considerable edema in his left knee following the tear. Approximately one month after rupture, he had his patellar tendon repaired with ends reattached together again to begin the rehabilitation process.

Prior to this injury he was a very active individual who was interested in powerlifting, playing sports such as football and basketball, and overall being healthy. For work, he was a

vocational rehabilitation specialist for a local company which did not require a lot of physically demanding work. Alongside his wife, they live in an apartment with an elevator to access their floor along with stairs if needed. His wife was very helpful in the entire process and helped him with ADLs, getting groceries, taking him to appointments, and anything else that he needed so that he could recover. He had no major previous medical history concerns other than the ACL tear and reconstruction relevant to this event. His family history, behavioral status, and psychological status were assessed at the time of history taking and there were no significant concerns noted. He was fully alert and cognizant of his surroundings and he stated he takes a multivitamin, fish oils, vitamin C tablets, and rarely hydrocodone. He was a firm believer in God, he did not drink or smoke, and he lived a normal and happy life with his wife.

At the time of his initial evaluation with us after surgery, he ambulated with bilateral axillary crutches that were properly fitted along with a hinged left knee brace locked at full knee extension. These two assistive devices were the only devices he stated that he owned at the time. Upon asking what positions increased pain and which decreased pain, lying supine flat on the couch had no pain while bending or applying weight onto the left leg caused increased pain. His current functional status at the time of evaluation fit into an ICF disablement model and can be seen in Figure 2. When we look at the activities, he was easily able to perform ADL's such as brushing teeth and eating while sitting down, while getting dressed or using stairs was difficult. In terms of participation and restrictions, he was able to perform some of his ADL's on his own if they were seated or easy to perform upright NWB on the left leg. He was able to go to work after about a month of therapy and could still attend church/social gatherings, but he had trouble with performing at full capacity at work along with not being able to participate in some leisure activities such as powerlifting.

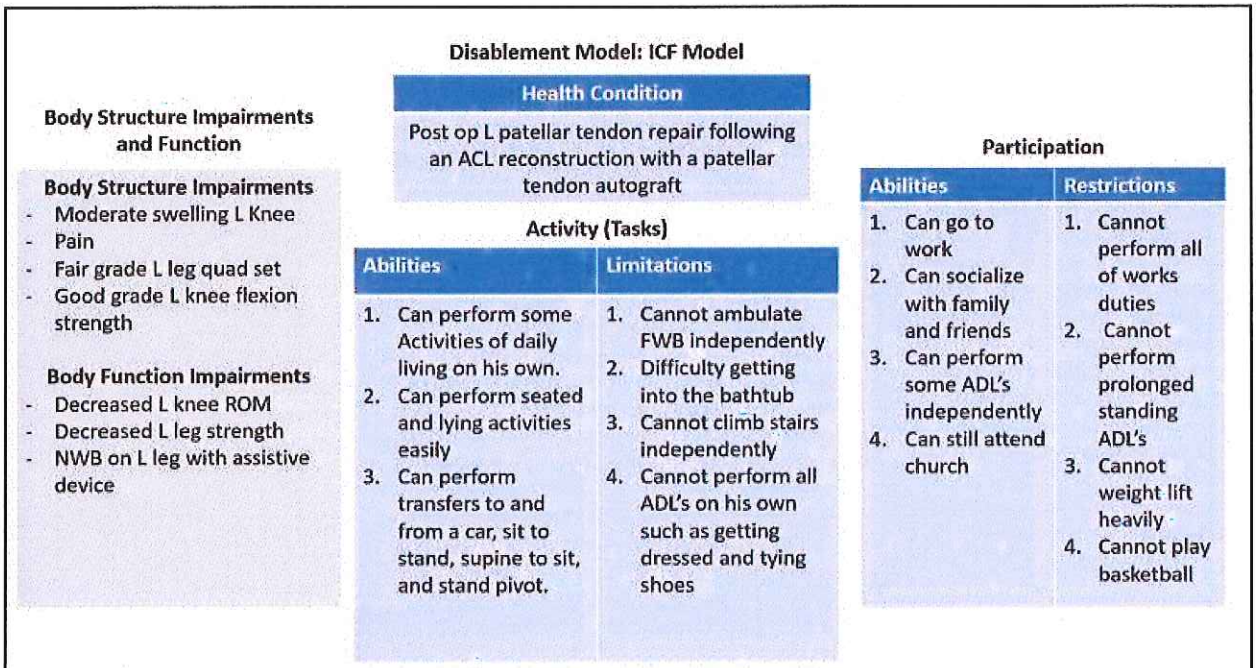

Figure 2. ICF Disablement Model

He was asked about numbness or tingling at the time of initial evaluation and he stated that he currently did not feel any symptoms such as numbness or tingling, to identify a neurological issue. He was told to describe his pain on a scale of 1 through 10, 10 being the worst, and he stated he had a 1 out of 10 pain level and that he was comfortable. The treatments that were performed prior to this initial evaluation consultation were minimal. This included the basic regimen that was instructed by the inpatient physical therapist and the physician and support staff that performed the surgery. This included ankle pumps, light quadriceps sets, gluteal sets, walks every other hour or so to promote blood flow and prevent skin breakdown, and lastly PRICE. This acronym stands for protection, rest, ice, compression, and elevation. He was told to ice as often as he needed throughout the day along with elevating his leg above his

heart whenever he was lying down. Other than this, no other previous treatments occurred in the 4-week period between surgery and the evaluation with us.

One important thing to note about this evaluation is that the physical therapist, or clinical instructor, was the clinician in charge of both his ACL rehabilitation process and the patellar tendon rehabilitation as well. Therefore, the patient and clinician relationship was well developed and defined. Throughout the entire history taking portion, no red flags came about that justified a clinical decision to refer out for further investigation. After the history taking, we planned on assessing strength, range of motion, observation, palpation, and gait pattern techniques. Since no red flags were noticed, we felt the patient was an ideal candidate for post-operative rehabilitation within our facility.

In terms of goals that were set, there were goals set by both the patient and the physical therapist, and they both intertwined homogeneously. As far as the patient's goals, he stated at the time of evaluation that he wanted to be able to get back to work in a reasonable amount of time while also being able to get back to doing things on his own independently. Along with this, he wanted to return to the gym to lift weights and play basketball as well as attend church.

Examination

Following the history taking and working our way into the examination process, a systems review was performed for this patient and only one of the systems was assessed as normal and that was the cardiovascular system. Heart rate was measured at 76 beats per minute, respiratory rate was 17 breaths per minute, and blood pressure was 134 over 80. The blood pressure was over the normal level, thus placing him at hypertension stage 1. This is characterized by a blood pressure reading in between 130 to 139 for systolic and 80 to 89 for

diastolic.[13] However, we termed this normal as he typically experiences white coat syndrome, which is when the blood pressure rises during clinic visits but is normal otherwise. The three areas that were not assessed as normal were the integumentary, neuromuscular, and musculoskeletal systems. The integumentary system had incision sites, moderate amounts of edema (no formal measurement taken, but visually compared bilaterally), and redness on the left knee. His neuromuscular system had weakness in his quadriceps contraction, likely inhibited by pain and confidence. Lastly, the largest system affected was the musculoskeletal system primarily due to the nature of the injury and repair.

Following the history and subjective information we now moved into the collection of objective data. As we went throughout the subjective history, we were reassessing our working hypothesis to confirm it was indeed a post operative patellar tendon rupture and repair. Furthermore, we continued the assessment to come up with a definite physical therapy diagnosis. The first thing assessed was the patient's gait pattern, appearance, posture, assistive device, and brace usage. He presented with bilateral axillary crutches and a left knee brace locked at full knee extension. He had a slightly flexed trunk posture and was leaning his weight onto the crutches as he stood up; however, he did show great adherence to the non-weight bearing status on the left leg. He walked with a 3-point orthopedic gait pattern with increased step lengths and velocity. This knowledge of proper ambulation technique was due to having gone through the rehabilitation process previously.

Following this, we assessed both his left and right legs' range of motion. According to McKay et al,[14] the 20 to 59-year-old age group had an average of 1 degree from full knee extension and 136 degrees of knee flexion. It is, however, to note that these are averaged norms

and that it is important to align with the patients contralateral limb's flexibility as long as it is ailment free. During our initial visit, we expected range of motion, whether passive or active, to be severely limited as it should be on the surgical limb. When assessed with active assistive range of motion (AAROM), he demonstrated 30 degrees of AAROM flexion in a supine position while doing a heel slide (limited per physical therapy orders). For AAROM left knee extension, he was able to get 0 degrees of extension. For the right knee, the measurements were assessed as 141 degrees of AAROM knee flexion supine while performing a heel slide and 1 degree of right knee hyperextension supine. To see a summary of initial AAROM goniometric measurements taken refer to Table 1. One important thing to note is that all goniometric measurements that were recorded were done by the same individual from initial evaluation to discharge of patient. According to Hancock et al,[15] the intra-rater reliability measurements with a long armed goniometer were highly reliable and accurate with an intra class correlation coefficient of 0.98. Another article similarly states that the inter- and intra-rater reliability was 0.97 to 0.98 both in terms of reliability and validity.[16]

Table 1. Initial Knee Range of Motion (AAROM)

Movements:	**Right Knee**	**Left Knee**
Extension in supine	1 degree of hyperextension (no pain notated)	0 degrees (no pain notated)
Flexion	141 degrees AAROM (No pain notated, supine)	30 degrees AAROM (supine with brace on, limited per PT orders)

Following this, we then checked his ability to perform a quadriceps contraction and a hamstring contraction and graded it accordingly. Knee extension contraction strength quality was assessed using a poor, fair, good, or normal scale and the left was fair quality and the right was normal quality both in a supine position. For hamstring strength, in a seated position we utilized resisted isometric tests with gradings 1 to 5, 5 being normal strength and 0 being no contraction palpable.[17] On the left side, we placed him seated but with the leg extended out to prevent pain, and he had a 3/5 knee flexion strength. On the right side, his knee was flexed to approximately 70 degrees, and he demonstrated a 5 out of 5 strength. On the left leg, both strength assessments were met with pain while there was no pain reported on the right. He also kept his knee brace on with it allowing only 0 degrees through 30 degrees of knee flexion to prevent injury. The information regarding strength testing can be found summarized on Table 2.

Table 2. Initial Strength Measurements

Area Assessed	Right Knee	Left Knee
Knee Flexion (Resisted Isometrics)	5/5 no Pain	3/5 with Pain
Knee Extension (Quality Grade)	Normal Quality	Fair Quality with Pain

It is important to note that the intrarater reliability for manual muscle testing and resisted isometrics had coefficients between 0.63 and 0.98. This means that this type of testing done by the same experienced clinician is a reliable means of data gathering.[18] When looking into the protocol that was utilized for this patient, a couple of the goals that were required to be met in the future include improvements in both knee ROM (active and passive) and strength to equal each other bilaterally and within the norms referenced above.[10] Therefore, this was our reasoning

behind gathering this objective data, as it provided us an initial assessment to track progress within these areas and develop a plan of care accordingly.

We performed sensation testing on this individual, and it was assessed as bilaterally intact to light touch on both lower extremities. This was performed using light finger touch with the patient's eyes closed while in a comfortable position. Then following this, palpation was performed. There was local tenderness noted over top of the incision site and in the anterior aspect of the kneecap down to the proximal tibia. Lastly, due to the nature of the traumatic injury and post operative rehabilitation referral, no special tests were performed as they would not have served us any useful knowledge for this episode of care. Some areas that were not assessed with this patient at initial evaluation include a peripheral joint scan and passive range of motion. Other tests and measures were not necessary to be performed due to the nature of the episode of care. Overall, he had limited strength, AROM, and an increased amount of swelling and pain. This is limiting his ability to work, perform ADLs and other daily tasks, along with being able to perform leisure activities such as lifting weights, playing basketball, and going for walks.

Evaluation, Diagnosis, and Prognosis

The initial examination shed some light and insight onto the problems that this patient was facing post operatively. The biggest problems and concerns were his limitations in strength and ROM of the left leg. This is significant because it severely limits his ability to ambulate, independently perform necessary daily tasks, and work efficiently. However, we needed to stay mindful of the healing process and allowing for the necessary time to go by before working on this area too much. It can take 6 to 8 weeks for the natural healing process to occur in a healthy adult when the tendon is torn.[19] After this, implementation of weight bearing activities and light

stretching and strengthening may occur. In regard to the acuteness of his injury, other problems faced by this patient included moderate amounts of left knee edema, slight aching pain, and tenderness when palpated. All of these things have been included and implemented into the problem list which can be seen in Table 3. When utilizing the Guide to Physical Therapy Practice 3.0, he was placed in the Practice Pattern of 4I: Impaired Joint Mobility, Motor Function, Muscle Performance, and Range of Motion Associated With Bony or Soft Tissue Surgery.[20]

Table 3. Problem List

Problem List:
1) Decreased left leg strength
2) Decreased left leg range of motion (Passive and Active)
3) Pain during rest, activity, and during palpation
4) Surgical Incision site
5) Decreased mobility and independence
6) Left knee edema
7) Non weight bearing on left lower extremity
8) Inability to work or drive

The expected time that it takes for complete return to normal activity with a similar patient is around 4 to 6 months with the ability to take up to one year depending on the patient.[10] The expected time in physical therapy was estimated at 12 to 16 weeks, which would be 4 to 6 months after surgery with 3 to 4 weeks off prior to starting therapy.[3] The 3 to 4 weeks spent prior to coming into physical therapy involves resting, PRICE, and performing the exercises given by the physician after surgery. From here on, we developed the following short term goals relative to the patient's problem list and personal goals to be met in 6 weeks which include demonstrating independence with the home exercise program, full left knee extension through 90 degrees of AROM flexion, and ambulating with only one crutch. For long term goals to be met in 16 weeks this included ambulating with a normal gait, going up and down stairs in a

reciprocating fashion, demonstrating a 4/5 quadriceps and hamstring strength, demonstrating bilaterally equal and normal knee range of motion flexion and extension, and lastly, returning to all normal activities of daily living without being limited by his left knee. These goals were based upon the protocol, my clinical instructor's knowledge and experience, and within context of the patient's personality and characteristics.

The patient is an appropriate candidate for the interventional program after evaluating the examination process because he remained consistent in findings for a typical post operative patellar tendon repair and he showed no conditions warranting concern. Likewise, he was a motivated, healthy, and young adult. The focus involved increasing the left knee's range of motion, strength, and mobility while decreasing pain and edema with the interventional program and plan of care developed and implemented. The primary treatments will include therapeutic exercise and manual therapy techniques. Lastly, a re-evaluation process was to be completed depending on patient's progression through the program.

CHAPTER III

INTERVENTIONS

The plan of care involved the patient being seen on a 1 day per week basis for 13 to 16 weeks. At the beginning of physical therapy interventions, we stressed lots of educational information with less towards the end of the episode of care. He was given patient education on the surgical procedure that occurred, how the outline of the physical therapy plan of care will look, and then education regarding new therapeutic exercises, gait training, and PRICE. Gait training education was given for the progression from two to one axillary crutch and when progressing from one crutch to independent ambulation. Since this was such a therapeutic exercise-based rehabilitation protocol, the progression of exercises along with descriptions for each are in Table 4.

The therapeutic exercises listed in Table 4 are plotted into each week and reflect the progressions made towards them. For every exercise we followed standard performance of each them and any differences are noted next to their names. The weights used were standard ankle weights wrapped around the patient's ankle. Likewise, the resistance band placement was mid-thigh area just above the knee for patient comfort.

The exercises chosen for this patient began with open chain lower extremity exercises such as ankle pumps, quadriceps sets, and heel slides. These all were included in order to prevent blood clots, regain mobility, and regain strength. This ended up preparing him for weight bearing

on the left leg to go up and down stairs, statically stand, and ambulate as needed. Once progressions were made, we began to implement closed chain exercises such as treadmill walking, mini squats, and step ups. These were slightly more aggressive and continued to improve strength and mobility of the left knee along with overall endurance. Along with this, it helped get his confidence up for taking longer walks and also independently ambulating and climbing up and down stairs of various heights. Lastly, towards the end of the episode of care we gave him exercises such as monster walks, side stepping with knees slightly bent, and mini lunges. These incorporate not only strength and mobility but multi angle forces acting on the knee to help with agility, stability, and rapid movement similar to back to sport programs. This was the final preparation to knowing he was safe to perform all activities independently and confidently at work, at home, and during leisure activities such as playing basketball.

Patellar mobilizations were performed from weeks 2 through 6 for 8 minutes per session, starting with oscillating medial to lateral movements at a grade two mobilization pressure while the patient was supine, and leg extended comfortably. This was to apply early post-operative mobilization of tendons after surgery to prevent adhesion.[21] Since the left leg was mostly extended out to avoid undue tendon stress, we performed these mobilizations in order to help prevent adhesions of the tendon to nearby tissues as it healed.

Table 4. Exercise Progression Throughout Episode of Care

Exercises	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13
Supine Ankle Pumps	20 reps (x)	20x	20x	20x	20x	20x	20x	20x					
Supine calf stretch with a rope bilaterally	10x	10x	10x	10x	10x	10x	10x	10x					
Quad sets supine with foam pad under knee bilaterally	20x	20x	20x	20x	20x	20x	20x	20x					
Glute Sets supine	20x	20x	20x	20x	20x	20x	20x	20x					
Seated active assistive flexion bilaterally	10x	10x	10x	10x	10x	10x	10x						
Heel slides supine with a rope (AA: AAROM, A: AROM, AAA: AAROM, AROM)	AA: 10x	AA: 10x	AA: 10x	AA: 10 reps	AAA: 10x	AAA: 10x	AAA: 10x	AAA: 15x	AAA: 15x	AAA: 10x	AAA: 10x	AAA: 10x	AAA: 10x
Calf raises standing bilaterally (hands on solid surface)	20x	20x	20x	20x	20x	20x	20x	25x	25x	25x	20x single	20x single	
Patellar Mobility manual therapy	Yes	Yes	Yes	Yes	Yes								
Mini Squats standing (hands on solid surface)				15x	20x	20x	20x	20x	20x	20x	20x	20x	20x
Sidelying Abduction on plinth				15x	15x	2 of 10x	15x, 2.5#	20x, 2.5#	20x, 4#	15x 7.5#	15x 7.5#	15x 7.5#	20x 10#
Supine Straight leg raise with contralateral leg hooklying				2 of 5x	2 of 5x	2 of 10x	15x, 2.5#	20x, 2.5#	20x, 4#	15x 7.5#	15x 7.5#	15x 7.5#	20x 10#
Step ups bilaterally (Right foot leads then left foot leads)				2" 10x	4" 10x	4" 15x	6" 15x	6" 15x	6" 20x	8" 10x	8" 10x		
Stationary recumbent bicycle (minute: m)							10m						
Standard Treadmill (minute: m)							5m 1.5 mph	7m 1.5mph	7m 1.7mph	5m 2mph	5m 2.5mph	5m 2.7mph	
Balance Board (AP: anterior <-> Posterior, L: back and forth)					AP, L 20x	AP, L 20x	AP, L 20x	AP, L 20x	AP, L 20x	AP, L 20x	AP, L 20x	AP, L 20x	
Boxes/Diamonds floor patterns (both counterlockwise and clockwise)								10x both	10x both	10x GTB	10x GTB	10x BLTB	
Mini Lunges (F: forwards, L: laterally, or B: backwards)								10x F	2 of 10x F	10x F, GTB	10x F, GTB	10x FLB BLTB	
Squating 3 meter side shuffles back and forth									4x GTB	4x GTB	4x BLTB		
Bridge Ups Supine (5 second holds on top)									15x	20x	20x	20x 10#	
Prone extension left leg overhang from the knee on (weight on ankle)									20x 4#	15x 7.5#	15x 7.5#	20x 10#	
Crouched Monster walks 3 meters forwards and backwards										4x GTB	4x GTB	4x BLTB	

GTB: Green Theraband BLTB: Black Theraband (Theraband manufactured by Performance Health in Akron, Ohio)

Due to the moderate amounts of edema, a standard compression sleeve was given for compression. Along with this, he was informed to continue to elevate and ice at least 3 to 4 times per day or as needed 15 minutes per time. This was done because there is a significantly better ability to reduce edema with cold compression or cold alone which agrees with our chosen treatment options.[22]

There were no treatment options being performed that we decided to discontinue through the course of treatment. We did, however, trial new exercises and progressions that the patient wasn't ready for at that time; we decided to wait a week or two to try again. For example, the first week when step ups on a 2-in box were attempted, patient felt unsteady and felt as if he was going to fall so we decided to wait until the following week to do these again. One thing we rarely did besides a stationary recumbent bicycle were isokinetic exercises towards the end of the episode of care. This was primarily due to the lack of isokinetic equipment in the gym area but this is a good treatment technique to perform to increase strength and mobility.[23] We also did not perform any scar tissue mobilization techniques during treatment because of a lack of time available, however, we strongly see the importance of maintaining a mobile incision site throughout the healing process.

Lastly, throughout the episode of care there was communication between us and the physician's office across the hall. We reported progress roughly every month and there were no adjustments made from these conversations throughout the care. Revaluation was not performed until the end of the patient's episode of care, which provided great insight to the overall progress made throughout the treatment sessions.

CHAPTER IV

OUTCOMES

The outcomes were very favorable considering the complexity of the patient's injury and the size of the individual. The subjective information was gathered prior to discharge along with the objective data such as knee strength, edema, ROM, ambulation, and stair performance. For subjective data, we collected only the pain levels and overall satisfaction rating with the results.

The first thing assessed on the final evaluation was ambulation, stairs, and visual inspection on edema and tenderness. He was able to ambulate independently for 100 feet total (length of hallway) with a completely normal gait pattern and velocity. Prior to this, at initial evaluation he was unable to go up and down stairs safely and he was able to ambulate 100 feet but needed axillary crutches while NWB on the left leg.

Following this, we walked over to the staircase and he was able to go up and down one floor of stairs and come back up in a normal reciprocating fashion independently. After this we assessed the knees while he was supine. He was equal bilaterally for knee circumference and size with visual inspection and had no redness or tenderness on his knee. For AAROM, we used a rope held by both hands that wrapped around the patients foot to help aid in pulling the knee into flexion during a heel slide while supine. Likewise, he had a fully enclosed incision that was completely healed. In terms of AAROM supine, he measured 140 degrees (comparable to 141 degrees on the right) on the left leg, whereas he used to be limited at 30 degrees of flexion on the

initial visit. For the strength of his knee extension and flexion, we used the same seated resisted isometric positions again. This time, he measured 5/5 bilaterally and for both flexion and extension, going above the long-term goal of 4/5 strength. This was an increase from a fair quality quadriceps contraction and 3/5 knee flexion measure assessed on the first day. Lastly, for the subjective information, he had a pain level of 1 out of 10 on the first day and he had no pain during any movement on the day of discharge. Likewise, he was extremely satisfied with the episode of care and was grateful to be back to a fully functioning state. This information has been summarized and put into Table 5.

Table 5. Outcomes of ROM, Strength, and Pain Levels

Area Assessed	Initial Evaluation	Discharge
AAROM Flexion of Left Knee Supine	Limited to 30 Degrees	140 Degrees of Flexion
Knee Flexion (Resisted Isometrics) Extension Strength (Quality)	Knee Flexion: 3/5 Knee Extension: Fair	Knee Flexion: 5/5 Knee Extension: Normal, 5/5
Pain (1 through 10, 10 worst)	1/10	0/10

Bilateral knee ROM measurements for flexion was measured every visit throughout the episode of care with a standard long arm goniometer. Extension was measured as well, however, always assessed as normal and 0 degrees plus or minus 2. For knee flexion, we used a rope to help assist the heel slide into knee and hip flexion while they were supine (AAROM) and we used AROM for measuring knee extension. Table 6 shows that there was limited pain throughout

and progressions in left knee ROM was made mostly during the first half of physical therapy sessions.

Table 6. ROM and Pain Progression Throughout Treatment

Visit	Right Knee ROM (Degrees)	Left Knee ROM Flexion (Degrees)	Pain Levels (1 through 10: Worst)
Week 1	-1 to 141	0 to 30 Limited Per Protocol	1
Week 2	0 to 140	0 to 55	1
Week 3	-1 to 140	0 to 65	1
Week 4	-2 to 141	0 to 81	1
Week 5	-1 to 141	0 to 92	0
Week 6	0 to 142	0 to 102	0
Week 7	-1 to 141	0 to 117	0
Week 8	-1 to 141	0 to 126	0
Week 9	-1 to 141	0 to 129	0
Week 10	-1 to 141	0 to 132	0
Week 11	-1 to 141	0 to 135	0
Week 12	-1 to 141	0 to 140	0
Week 13	-1 to 141	0 to 140	0

Throughout the entire episode of care, special note was taken considering the responses to the therapeutic exercises and manual therapy. We found that he had little to no complaints throughout the care given, other than a slight increase in pain after therapy which was to be expected as it never persisted longer than a day. Patient was also more than compliant throughout his entire episode of care and there were no issues in terms of safety. Strategies utilized included using gait belts when upright and education and demonstration of exercises prior to execution. In terms of patient satisfaction, he was extremely pleased with his overall results, as he was able to accomplish both his personal and physical therapy goals created for him in a timely manner to the fullest capability.

Lastly, throughout this episode of care there was no clinometric utilized; however, I did look into one that would have worked very well with our patient. This was the Lower Extremity

Functional Scale (LEFS). It looks into the functional impairment and ability to perform everyday tasks and can be utilized initially, ongoing, and at the discharge date for an overview view of progressions made throughout the episode of care.[24] The LEFS is rated very high in reliability, sensitivity, and efficiency in terms of change and timeliness to use as an assessment tool.[25]

CHAPTER V

DISCUSSION

During this episode of care at an outpatient orthopedic physical therapy clinic, we saw substantial amounts of improvements made in edema reduction, ROM increases, strength increases, and quality of life and functionality as a whole. One of the key things making this such a great feat to see was the success found in this patient due not only to his weight and size but also the complexity of his injury. We made sure to take extra caution throughout any of the weight bearing activities in order to prevent any adverse events from occurring along with during other treatments as well. The ability to gain functionality, climb up and down stairs, have leg strength to ambulate independently, and have ROM back to normal all were met and some above what we expected and wrote into the initial plan of care. We believe this is due to the overall motivation, fitness level, clinical expertise, and inter disciplinary teams focus for working together for the patient's full return back to normal. According to the protocol utilized, the major goals for physical therapy post operatively are to regain normal ROM, strength, independent walking, and performance of ADL's independently.[10] As noted above, this was all covered and achieved by the end of this physical therapy rehabilitation program. The initial 6 to 8 weeks spent in a brace limiting motion can cause problems in terms of overall leg strength and knee range of motion, however, we saw tremendous increases in motion early on and throughout the rest of care. We were able to tie all of these goals developed in a clinical standpoint into getting

the patient back to their personal goals, which was the main focus of this entire care episode. These include getting back to work and living independently again which were all achieved.

There are very few studies done on post-operative patellar tendon repairs following an ACL reconstruction with a patellar tendon autograft. In fact, there are so few in the given geographical region where this encounter occurred that the physician had to receive guidance from a bigger and more reputable hospital out of state, according to the patient himself. However, there was one article discussing the results of 38 cases, and at 7 months there was nearly full ROM recovered and at 9 years post-operative they had all returned to work and were all rated as extremely satisfied with the end result.[26] Likewise, another article discussed earlier had 25 patients involved, and at an average of 75 months they were all able to have ROM within functional limits and they had significantly increased strength, independence, and mobility.[11] The only downside this article noted is that they still noticed asymmetry between the operated leg and non-operated leg on overall knee extensor strength.[11] Although our patient achieved a 5/5 knee extension strength, he did still have atrophy on his left quadriceps. Otherwise, everything was similarly noted in our outcomes compared to other studies.

We speculate the positive results that occurred for this patient were because of implementing some key aspects of interventions into the patients plan of care. This included giving isometric resistance training exercises such as gluteal sets and quadriceps sets the very first day after surgery. Similarly, according to Vitale et al,[27] they performed early isometric training for a professional soccer player who was able to quickly regain strength, leg function, and overall patient mobility in a timely manner following an early rehabilitation process. This also allowed our patient to physically be able to handle the advancements made in weight

bearing status and removal of assistive devices on track and in a timely manner. Secondly, according to Enad et al,[28] early mobilization and range of motion performance initiated within 2 weeks after surgery for patellar tendon repairs shows adequate support for the restoration of function and mobility with proper strength and range of motion. Although we began early active assistive range of motion about 4 weeks after surgery, we still saw tremendous gains initially in range of motion along with a complete return to full knee flexion and extension motion bilaterally. We believe doing this right away helps prevent adhesions of the soft tissue structures as the patellar tendon heals.

Some things to consider in terms of risk factors that caused this rupture to occur could include poor body mechanics when landing from a jump, heavier bodyweight, and previous knee trauma. Poor body mechanics could occur in a variety of ways but could all place more pressure than normal on the patellar tendon as it tries to catch the landing from a jump. As stated prior in this case report, the patient's heavier weight could have been a key player in aiding the rupture of the patellar tendon which made the amount of force on the patellar tendon significantly greater. Perhaps the most important factor to speculate on, however, is that the patellar tendon had lost one third of its surface area 17 years before it tore. This was thought to be the main culprit behind why it tore in the first place as the surgeon believed that it did not scar down and heal properly, thus finally rupturing when enough force went upon it. In comparison to another study, during an 11 year follow up with 32 patients assessed with a patellar tendon autograft for ACL reconstruction, they had good subjective and objective findings for the quality and stability of the patellar tendon and ACL. Likewise, they only had 4 out of the 32 patellar tendons rupture, again restating the rarity of this to occur.[29]

A limitation worth noting for this article is that there was a significant time frame between the ACL reconstruction and the patellar tendon tear. This raises speculation as towards how much one had to play a role in the other as usually the patellar tendon rupture occurs much sooner after the patellar autograft procedure. However, perhaps this raises a great point to look into and have further research done looking for the long-term effects of reduced tendon integrity and the long-term risks associated with tendon autografts. Another limitation is that this only includes one patient's outcome following treatment due to the nature of this case report. In order to develop a greater ability to assess the effectiveness of the rehabilitation program, we would need to have a larger sample size. Unfortunately, with rarity of an injury, comes rarity in literature to back it up. Therefore, this brings up another important topic for future research to investigate. This would include performing more studies on post operative patellar tendon rupture and repair surgeries following an ACL reconstruction with a patellar tendon autograft. Lastly, the retrospective design of this case report may have limited the extent of detail on some aspects of this case report in that if it had been done in real time, information could have been more detailed and descriptive for a better overall understanding. This may indicate an important reason to complete functional assessments prior and after a physical therapy rehabilitation program, such as the LEFS.

Lastly, the interventional treatment program was developed for this patient in order to help regain his independent level of mobility and function to go on with life normally. This was based off the measurements collected during the examination and evaluation process and directly guided our plan of care. It helped us realize the impairments and limitations such as decreased strength and ROM which directly guided our plan of care. Utilizing the discussed interventions,

we were able to improve and regain his independence and overall function with ambulation, stair climbing, working, performing ADL's, and doing leisure activities again.

Reflective Practice

Looking back at this episode of care there are a few things that I would not include in the care of similar future patients. During the initial evaluation, I would have liked to be provided with more specifics regarding what his job duties entail to ensure a safe return to work when appropriate. While we did ask for his occupation, it would have been beneficial to know if there were stairs, how wide the hallways were, how close the bathrooms were, etc. Otherwise I think that the history and subjective information were thoroughly covered.

When reflecting on the objective data gathering, there are a few things I would change. First and foremost, I would include the LEFS for a solid functional measure prior and after the treatment was given. This would have allowed a much greater summative piece of information for assessing effectiveness of treatment plan and readiness to discharge. Secondly, I would have included doing passive range of motion of the knees and adjacent joints in order to have a better understanding of the initial basis. Furthermore, I would have completed passive range of motion every treatment session and then followed up on discharge day with a final passive range of motion and peripheral joint scan measurement for solid objective data describing progress.

I would make minimal changes to our plan of care. However, one thing I would do would include not worrying about giving him a compression stocking. This is because a study referenced above found that when looking at outpatient management of edema, cold compression and cold alone are both equally effective.[22] With this though, both are significantly more effective than giving no treatment alone for edema. Therefore, it would have saved education and

material on my end and less time and effort on the patients end for the same result. Another thing I would do differently would be to give the treadmill and recumbent bicycle as a home exercise program for him in order to save a lot of time in therapy sessions, as he had gym access. Lastly, I would have discontinued exercises such as ankle pumps, gluteal sets, and quadriceps sets more quickly, because once patients are performing progressed and higher level exercises the easier exercises really are not an effective time spent in physical therapy.

An area I would like to seek further evidence would be on the patellar mobilizations directly implicated for aiding a non adhesive patellar tendon healing process. I would be curious to know the effectiveness in technique, grade intensity of mobilization, and direction in terms of improving range of motion post operatively from a patellar tendon repair. This could allow me to know the most evidence based plan using patellar mobilizations in order to improve mobility as I did not have much background information in this area prior to this episode of care. Along with this, I would like to seek more information in general about the injury itself and how different therapists treated them. However, literature is limited; Therefore, this may be something to look for in the coming years when more time has passed for more research to be completed. This would help give a better basis of the most optimal treatment program and perhaps refine my current plan of care for a future patient with the same surgery performed.

Due to how well this patient responded and improved over the course of a 3-month physical therapy program, I would not plan to refer or seek other disciplines to aid in the rehabilitation process unless red flags warranted it. This could be due to the patients physical, mental, and emotional signs and symptoms.

When considering the cost of the physical therapy episode of care, the cost for this patient was approximately 2 038 dollars from start to finish. When taking into consideration the complexity of the patient's injury and the size of the individual, the completely successful return to all activities independently and functionally justifies this cost very well. He is back to work, performing leisure activities, and maintaining a high quality of life once again which is a hard area to put a price tag on. Plus, with the patient having good insurance, he only had to pay about 325 dollars in copayments. If we did need to reduce cost more than this, we could have considered doing a therapy visit every other week and base the rehabilitation process more off a home exercise program. However, I think that once every other week would have hindered progression due to lack of new exercises often and manual therapy performance. Therefore, I believe that this was a well-set price tag for the outcomes received without charging too much or too little.

This case highlights my professional development goals by reassuring that I am following evidence-based practice as often as I can. This episode of care was largely based off of evidence, protocols, and my CI's experience and knowledge which helped me grow as a professional clinician. With this, it definitely also made me realize how much there is to learn yet in order to be as successful as I can be at giving the care that my patients deserve. Therefore, I hope to continue to complete continuing education in the field of orthopedics and sports physical therapy as this is my area of interest and where I want to practice one day.

Conclusion

In conclusion, this was a very positive outcome for a patient who had a post operative patellar tendon rupture and repair following ACL reconstruction with a patellar tendon autograft. We implemented largely therapeutic exercises along with a few other treatment options and got the patient back to a completely functional and independent state. This case report describes a rare procedure and rehabilitation process and we look forward to seeing more literature come out on this topic to better enhance the quality of evidence and evidence-based practice for this given population of patients in their future care.

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