Utilizing An Evidence-Based Practice Framework In Non-Operative ACL Rehabilitation - A Case Report

Eric Norman  
*University of New England*

Michael Madore  
*University of New England*

Kathryn Magee  
*University of New England*

Tyler Calimer  
*University of New England*

Parker Nally  
*University of New England*

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Utilizing An Evidence-Based Practice Framework In Non-Operative ACL Rehabilitation -

A Case Report

Eric Norman, B.S., Michael Madore, B.S., Kathryn Magee, B.S., Tyler Calimer, B.S., Parker Nally, B.S.

The authors are students in the Doctor of Physical Therapy Program at the University of New England, 716 Stevens Avenue, Portland, Maine, 04103.

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Abstract

Study Design: Case Report. Background: The patient was a 51-year-old female who tore her left anterior cruciate ligament (ACL) playing pickleball and opted for non-operative treatment. The clinicians involved treated the patient using the three pillars of practice: relevant scientific evidence, clinician experience, and patient perspective. Treatment: The patient’s treatment consisted of therapeutic exercises, neuromuscular re-education, soft tissue massage, and motivational interviewing. Therapeutic exercises were designed to strengthen the muscles surrounding her hip and knee. Neuromuscular re-education helped to improve the patient’s knee stability and balance, while soft tissue massage was used to decrease swelling. Motivational interviewing helped her better align her attitude toward her restrictions with the goals of the rehabilitation process. Outcome: The patient made progress and increased satisfaction throughout rehabilitation which was illustrated by objective tests and subjective reports. Improvements were noted with a 24% positive change in lower extremity functional scale (LEFS) score between initial and follow-up testing. Single leg hop tests by discharge revealed a 90% or higher right-to-left compatibility score. Discussion: This case highlighted the plausibility of a conservative treatment approach in a patient with an ACL tear. It introduced a clinical decision-making model that emphasized the importance of including relevant research in the form of Clinical Practice Guidelines (CPG’s), addressing the patient's perspective on the impact of her injury, and incorporating clinician expertise in observing movement impairments. During treatment, the patient demonstrated appropriate lower extremity strength and stability according to the clinician’s expertise and outcome measures, but she did not feel confident enough to return to previous lifestyle activities. Patient perspective played a large role in determining progressions and accomplishments.
Key Words: Non-operative ACL rehabilitation, Evidence-Based Practice

Background

One of the most commonly injured structures in the knee is the anterior cruciate ligament (ACL), with injuries occurring in approximately 1 in 3,500 people annually in the U.S.\textsuperscript{1} Over a nine-year span (2005-2013) the median cost of ACL reconstruction procedures was just over $9,000, with an overall cost per patient just over $13,400.\textsuperscript{2} As preventative and conservative treatments become more popular, it is important to consider the benefits and risks of each treatment. One study analyzed the quality of life for patients post-acute ACL rupture, comparing surgery versus conservative management. Results indicated no significant difference in patient’s quality of life between those that chose surgical reconstruction versus those who preferred conservative management.\textsuperscript{3}

Evidence-based practice (EBP), established by Sackett is the concept of incorporating the following three pillars into successful clinical decision-making in medicine: scientific evidence, patient’s values and preferences, and clinical judgement.\textsuperscript{4} According to Sackett, scientific evidence is the objective measurement which helps guide clinical practice. The patient's perspective allows us to understand how the patient views their injury and the effect it is having on their lives. Clinical expertise allows clinicians to use prior experiences to modify a plan of care as needed. These concepts together allow clinicians to create patient-centered goals that emphasize what the patient wishes to improve, while maintaining a focus on their main diagnosis.

Introduction
This report focuses on a patient with a recent ACL tear. Following an initial consultation with a surgeon, the patient elected conservative treatment for her injury. After her initial physical therapy examination, her therapist determined that she was deemed a good candidate for conservative treatment based on the following reasons: similar active range of motion (AROM) bilaterally, minimal swelling, and her motivation to succeed. Due to the lack of relevant non-operative treatment guidelines, aspects of the case report have incorporated the usage of post-operative clinical practice guidelines from Van Melic. During the time that the patient was seen for physical therapy, she made great strides towards her goals of returning to activities and hobbies, as seen in the exercise progression and four-stage hop test. With further discussion between the patient, physical therapist (PT), and student physical therapist (SPT), it was clear that the patient herself did not have full confidence in her affected limb. This influenced the clinicians to take a step back and observe the case not only through objective data but also from the lenses of the patient perspective and clinician expertise.

It is crucial to keep in mind all three pillars of evidence-based practice as it pertains to the case, in order for both the clinician and patient to effectively participate in the decision-making process. The importance of this is highlighted by the APTA which describes how the plan of care should be designed in collaboration with the patient, looking at specific patient goals. The purpose of this case report was to analyze the rehabilitation process and its effects on a patient with an ACL tear who opted for a conservative treatment plan, with clinicians utilizing evidence-based practice as a framework for clinical decision-making.

Case Presentation

History
The patient was a 51-year-old female who experienced a left ACL tear while playing recreational pickleball. She went to her doctor's office where she was scheduled for a magnetic resonance imaging (MRI) 5 days after the injury. The imaging showed a left knee ACL tear without other intra-articular or ligamentous involvement. She presented with no significant medical or surgical history, was not taking any medication, and was overall a healthy middle-aged woman. She presented to outpatient physical therapy over a month after her injury for an examination.

The patient was chosen for the case report due to her openness, reliability, initial adherence to the home exercise program (HEP), and willingness to be involved in the study. She worked as a secretary for an orthopedic surgeon’s office, where employees encouraged her to seek medical professional help for her knee injury. She had goals of returning to her normal activities of playing tennis, skiing, and running outdoors. She stated that she would participate in a conservative, physical therapy-based approach, once a week for eight weeks. She went on to state she did not know, or expect a large benefit from physical therapy but was willing to participate.

**Examination**

The patient’s chief complaints were mild weakness, pain (4/10 on the numeric pain rating scale) throughout the day, and the negative psychological impact due to not being able to participate in her normal activities. She denied locking, catching, or buckling of her left knee. Although the patient had imaging that confirmed a left ACL tear, the PT conducted special tests and measures that confirmed the diagnosis and ruled out other injuries. The Anterior Drawer Test and Lachman Test provided positive results, which confirmed the ACL tear diagnosis. Additional tests were also performed to rule out other possible ligament injuries, including the
Knee Varus and Valgus Stress Tests, McMurray Test, and the Posterior Drawer Test. All results were negative which supported the initial finding of an isolated ACL tear being present.

During the initial physical therapy examination, it was observed that the patient had mild effusion anterior to her left patella. Upon palpation, she reported tenderness to the anterior joint line. The patient’s knee range of motion was also assessed via the methods described by Norkin and colleagues. The PT assessed both right and left active range of motion at the knee joint, in a supine position, with the use of a goniometer. The patient achieved 139 degrees of active knee flexion bilaterally. Normal knee ROM will typically range from 130 to 140 degrees in adults; therefore, the patient demonstrated normal knee ROM despite her injury.

The PT performed manual muscle tests to examine the strength of the patient’s lower extremities. Strength was assessed via techniques for manual muscle testing described by Kendall and colleagues. Her lower extremity muscles, the quadriceps and hamstrings, were tested while she was supine on the bed. Manual muscle testing on her left leg was not able to be performed due to the patient’s fear and pain. The PT was able to observe a variety of functional movements from the patient which allowed the clinician to gain a better understanding of her strength and stability on the left leg. Weakness was observed as the patient performed squatting maneuvers, such as having a hard time getting up from a seated position with equal to or more than 90 degrees of hip flexion. The patient also reported pain with end-range knee flexion, unanticipated lateral movements, and pivoting on her left leg.

Based on the examination findings, the PT and SPT determined the patient had motor control deficits and impaired strength due to pain. In the first several weeks, her short-term goals were to increase her knowledge and ability to partake in therapeutic exercises, increase her confidence in ascending/descending stairs, improve her squat to pick objects up off the floor, and
utilize strategies to help reduce knee pain. In the following months to a year, she wanted to return to pain-free running, skiing, and recreational tennis. Given her pain, lack of strength, full ROM, increased motivation, enthusiasm to participate, and lack of comorbidities, she was given a fair to good prognosis for recovery.

**Treatment**

The patient agreed to attend physical therapy but did not want to come into the clinic more than once a week for personal reasons. She participated in physical therapy once a week for 60-minutes for 9 weeks, working with both the PT and SPT. Based on previous evidence, someone receiving rehabilitation for an ACL injury would typically attend physical therapy 2 to 3 times a week.\(^1\) The SPT led 6 out of 9 of the patient’s treatment sessions, while the PT treated the patient for the remaining 3 sessions. She received an initial plan of care which consisted of therapeutic exercises intended to strengthen and stabilize the muscles in her left lower extremity, along with soft tissue massage to manage edema around the knee. To optimize the patient’s outcomes, neuromuscular training was incorporated into the plan of care. The CPG for ACL post-operative rehabilitation suggests that both resistance training and neuromuscular training will result in the most optimal outcomes.\(^5\)

**Soft Tissue Massage**

During early treatment sessions, the PT performed soft tissue massage to her left knee to decrease pain and swelling, following a quick warm-up on the assault air bike (Model F-22, Advance Fitness, Made in Taiwan). The patient would sit at the edge of the bed with support under her thighs allowing her legs to hang dependently, which roughly allowed 90 degrees of knee flexion. The patient extended and flexed her left knee while the physical therapist performed distal to proximal stroking motion over the anterior knee joint for 10-minutes.
Therapeutic Exercises

It was important for the patient to strengthen her knee stabilizing muscles and improve balance, specifically single-leg stability, in order to recover, non-operatively, from her ACL injury. The selected exercises had been shown to improve overall lower extremity strength, improve motor control, and improve stability.\textsuperscript{10} During the first treatment session, the patient performed the following exercises: supine straight leg raises, supine hip extension with knees flexed (i.e. bridging exercise), side-lying hip abduction, single-leg hip extension, box squats, standing split squats, banded lateral walks, and standing heel raises. More challenging exercises were added to the patient’s plan of care during the fifth session, when she demonstrated progression with her lower extremity strength and stability. The additional exercises included standing on a wobble board, Peterson squats, step-ups, and Y-balance.\textsuperscript{11} See Table 1 and Appendix 1 for more details regarding the therapeutic exercise program. Neuromuscular re-education is an important aspect of knee stability, motor control and reduces risk of reinjury.\textsuperscript{12} Neuromuscular re-education techniques were used throughout her therapeutic exercises and home exercise program to enhance balance and stability. The neuromuscular re-education components included the following: the wobble board, single-leg Romanian deadlifts, Y-balance, single-leg balance, and T-balance. These exercises were chosen to challenge her single-leg stability and motor control, which helped to improve her overall strength, balance, and controlled movement patterns as seen in Table and Appendix 1.

Home Exercise Program

Due to the fact that the patient only attended physical therapy once a week, compliance with a home exercise program was vital for her recovery. The PT educated the patient on how important compliance was for the home exercise program. The patient was a self-motivated
individual and thoroughly enjoyed physical activity. Similar to the physical therapy sessions, her home exercise program included the following: bridges, side-lying hip abduction, chair squats, side lunges, and single-leg balance. See Table 2 for home exercise program dosage.

**Motivational Interviewing**

Several discussions with the patient throughout the course of treatment revealed that she was running several miles a week. Although this was not recommended by the orthopedic specialist or PT, it did not increase the patient’s left knee pain at first. However, she reported pain in her left hip and increased swelling around her knee. During these conversations, the SPT used motivational interviewing (MI) techniques to elicit a change in the patient's attitude toward her restrictions. A meta-analysis that included 119 research studies showcased revealed that MI was effective in producing statistically and clinically significant positive effects on a wide range of populations. MI delves into a patient’s personal reason for change within an environment of compassion and acceptance. In general, the guiding principles of MI are typically used to help a patient improve the level of motivation and personal commitment. After two sessions of MI, the patient reported she decreased her running mileage during the week. She subsequently experienced less swelling around the left knee joint and less pain in her hip.

**Results**

The patient was able to make remarkable improvements with bilateral lower extremity strength and stability throughout her rehabilitation with physical therapy. The patient was very compliant with her rehabilitation and attended physical therapy once a week for nine weeks, along with being compliant with her home exercise program. Specific results within each pillar of EBP are described below.
Scientific Evidence

Patient outcomes were measured using LEFS, Knee Outcome Survey (KOS), and the Fowler-Kennedy Hop tests. These outcome measures have been shown to be helpful in observing those with lower extremity injuries.\textsuperscript{15,16} The LEFS is used to assess the patient's perceived level of difficulty in performing a variety of activities.\textsuperscript{17} The LEFS is a 20 question, self-report form that has been shown to be reliable, valid, and sensitive to change.\textsuperscript{18} It is scored on a 0-4 scale, from extreme difficulty/unable to perform to no difficulty. A patient could score 0-80 points, 0 representing very low function and 80 representing very high function.\textsuperscript{17}

The KOS is a subjective questionnaire that aims to assess the effect of the patient’s self-reported symptoms on activities of daily living (ADL) and on their sports activities.\textsuperscript{15,16} The ADL section includes 6 questions designed to determine the ability to perform general daily activities and 8 questions designed to determine the ability to perform specific functional tasks.\textsuperscript{15,16} Each question is scored 0-5, indicating unable to perform to no difficulty. The total possible score for the ADL section is 70.\textsuperscript{15,16} The sports activities scale (SAS) section includes 7 questions on the ability to perform sports and recreational activities and 4 questions on the ability to perform specific sport activities.\textsuperscript{15,16} Similar to the ADL section, each question is scored 0-5, indicating unable to perform to no difficulty. The total possible score for the SAS section is 55.\textsuperscript{15,16} The total scores are calculated by finding a percentage for both the ADL and SAS sections. The ADL score would be divided by 70, multiplied by 100, and the SAS score would be divided by 55, multiplied by 100. The higher the percentage, the higher level of physical function.\textsuperscript{15,16} This patient-reported outcome measure has demonstrated excellent validity, reliability, and responsiveness to assess functional limitations throughout the rehabilitation process for a variety of knee injuries.\textsuperscript{15,16}
The primary objective assessment utilized was the series of Fowler-Kennedy hop tests. The four hop tests performed by the patient were as follows: single-leg hop test for distance, single-leg 6-meter hop test for time, single-leg triple hop test for distance, and the single-leg crossover hop test for distance. The Fowler-Kennedy Hop tests were followed per protocol and both legs were tested. These hop tests measure distance and time which are objective, but a clinician’s expertise is still able to identify any biomechanical abnormalities and limb asymmetries, which interventions can later focus on and address to improve function. Refer to Appendix 2 for a description and diagram of each outcome measure performed.

The patient demonstrated a 15-point change in the LEFS from Week 1 to Week 9. Both the minimal detectable change (MDC) and minimum clinically important difference (MCID) for the LEFS were reported to be a 9-point change. She exceeded both the MDC and MCID for the LEFS which indicates a meaningful change in her condition. She also demonstrated improvements within the KOS. She experienced a 5.7% increase in KOS-ADL and a 14% increase in KOS-Sport from Week 1 to Week 9. The MCID for the KOS is an increase of 7.1%, in both the ADL and sport categories. She already presented with a high and effective KOS-ADL score and therefore did not have as much room for improvement in this area. However, the patient was able to exceed the MCID for KOS-Sport, improving from 73% on Week 3 to 87% on Week 9. Refer to Table 4 for additional details regarding the patient outcomes for LEFS and KOS.

Lastly, the patient demonstrated improvements in all areas of the Fowler-Kennedy hop tests. The patient was originally tested on Week 6 and again on Week 9. The patient demonstrated more significant improvements on her left leg for the single-leg distance hop, single leg 6-meter hop, triple hop, and the crossover hop. Significant positive change to the
Fowler-Kennedy hop test is indicated by a 90% compatibility bilaterally, which she was able to achieve at discharge.\textsuperscript{20} According to prior research, it is suggested that if the patient is able to score 90% or above that they will have a lower risk for re-injury in the future.\textsuperscript{20} Refer to Table 4 for additional details regarding the patient outcomes for the Fowler-Kennedy Hop tests.

**Clinician Expertise**

As the PT and SPT observed the patient’s attempt at single leg hops, she still lacked motor control and coordination, although her objective data demonstrated appropriate levels for discharge. She was able to compare on average 87% side to side on the initial series of hop tests, but as shown in figure 2, her take-off mechanics in the left lower extremity revealed knee valgus and susceptibility to future injuries. In terms of strength development, several weeks into treatment she handled additional load to the lower extremities well, but only bilaterally, not unilaterally, as single leg exercises were still hard for her. This information influenced the PT and SPT to postpone discharge for a more appropriate time, knowing that there is still room for improvement in body mechanics despite the objective data.

**Patient Perspective**

During the patient’s time at physical therapy, her outlook of its purpose began to shift in a positive direction. As alluded to earlier, she did not have high expectations for the benefits of physical therapy, but she was willing to stay optimistic about the process. The patient expressed that she felt feelings of doubt and unsteadiness with her left knee during the initial 4-stage hop test and exercises. She reported contentment with her performance but did not feel fully confident to be discharged from physical therapy. Throughout treatment, she expressed a growing level of hope for conservative treatment and felt like she was making improvements in
her strength and pain, week to week. She felt the ongoing treatment sessions helped instill
confidence in herself and improve her left knee.

During a follow up encounter with the patient 5-weeks after discharge, she expressed her
appreciation to the conversations surrounding her activities outside of therapy. She appreciated
being listened to by the clinicians and felt grateful to have had an input in the rehab program.
She believed the reduction in activity outside of rehab, but not completely eliminating it, was
vital to her success both physically and mentally.

Discussion

ACL ruptures have been a common injury that has imposed a heavy burden on the
healthcare system in the past several years. Along with preventative treatment, conservative
rehabilitation within complete ACL ruptures has been increasingly popular in recent years. In
reference to knee joint stability, functional outcomes, and overall satisfaction from the patients,
studies have found similar outcomes versus surgical intervention in ACL management.
Furthermore, other articles also suggested that clinicians should not heavily rely on the results of
outcome measures and rather monitor function throughout rehab in order to make decisions
regarding progression and discharge.

On average, patients completed 16.90 ± 10.60 PT visits following ACL reconstruction.
The patient in this case report only completed 9 treatment sessions, under half the amount of
treatment sessions typically performed. Only completing half the average number of treatment
sessions meant this patient saved between $800 - $1200 on physical therapy alone, not
accounting for the median cost of ACL reconstruction surgery of $9000. This demonstrated the
reduced financial impact that a conservative treatment approach to an ACL repair can have.
Despite the lack of research evidence for her particular case, the PT and SPT used objective measurements to track change and give a degree of object framework for discharge. However, the clinicians found it vital to incorporate more of the patient's perspective and clinician expertise more so than scientific evidence. Compared to abiding by a strict rehab guideline from a post-surgical procedure, this allowed for a flexible rehabilitation program and for the patient to drive her own progress based on her perceived difficulty and pain. In this case study, the patient expressed a great deal of satisfaction with her rehab process. Lastly, the patient described an increase in confidence with her involved limb and was very impressed with the progress she made. The PT and SPT hypothesized, if it was not for utilizing all three pillars of evidence-based practice, the successful outcomes may not have been achieved.

Key Points

Findings
This case report found that physical therapy may still be effective for an intense rehabilitation program even in a situation with the patient coming in once a week for a limited number of weeks. The case report also supported the importance of the three pillars of practice, relevant scientific research, patient perspective, and clinician expertise.

Implications
There is a gap in the literature regarding non-operative ACL rehabilitation. This case report provides a potential treatment plan, incorporating all three pillars of EBP, for conservative ACL treatment. The plan could be beneficial for future cases and have an impact on clinical practice.

Caution
Limitations to this study included the lack of evidence and literature regarding best practice decisions for non-operative ACL tears. It should also be noted that interventions provided in this case were given to an individual with a high level of activity and may not be appropriate in all cases. Additionally, it can be difficult to quantify the importance of all three pillars of EBP in the terms of a case report.
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Table 1: Therapeutic Exercise Progression

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</thead>
<tbody>
<tr>
<td><strong>Banded Lateral Walks</strong></td>
<td>3 S x 15 R purple rb</td>
<td>3 S x 15 R purple rb</td>
<td>3 S x 15 R purple rb</td>
<td>3 S x 15 R purple rb</td>
<td>3 S x 15 R purple rb</td>
<td>3 S x 15 R purple rb</td>
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<tr>
<td>SL Hip Extension*</td>
<td>→</td>
<td>→</td>
<td>3 S x 15 R 2 lb aw</td>
<td>4 S x 12 R 2 lb aw</td>
<td>4 S x 12 R 3 lb aw</td>
<td>4 S x 12 R 3 lb aw</td>
<td>4 S x 12 R 3 lb aw</td>
<td>→</td>
</tr>
<tr>
<td>Bridge in supine</td>
<td>4 S x 10 R</td>
<td>4 S x 10 R</td>
<td>4 S x 12 R</td>
<td>4 S x 12 R</td>
<td>4 S x 15 R</td>
<td>4 S x 15 R</td>
<td>→</td>
<td>→</td>
</tr>
<tr>
<td>Supine SLR</td>
<td>4 S x 10 R</td>
<td>4 S x 10 R</td>
<td>4 S x 15 R</td>
<td>4 S x 10 R</td>
<td>4 S x 12 R</td>
<td>3 lb aw</td>
<td>4 S x 10 R</td>
<td>→</td>
</tr>
<tr>
<td>Side Lying Hip Abduction</td>
<td>4 S x 10 R</td>
<td>4 S x 12 R</td>
<td>3 S x 15 R</td>
<td>3 S x 15 R</td>
<td>3 S x 12 R</td>
<td>2 lb aw</td>
<td>3 S x 12 R</td>
<td>3 lb aw</td>
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<tr>
<td>16 in Box Squat</td>
<td>4 S x 8 R</td>
<td>4 S x 8 R</td>
<td>4 S x 10 R</td>
<td>4 S x 10 R</td>
<td>3 S x 12 R</td>
<td>10 lb</td>
<td>3 S x 12 R</td>
<td>15 lb</td>
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<td>Split Squat</td>
<td>3 S x 5 R</td>
<td>3 S x 5 R</td>
<td>4 S x 5 R</td>
<td>4 S x 5 R</td>
<td>4 S x 8 R</td>
<td>3 S x 8 R</td>
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<td>15 lb</td>
</tr>
<tr>
<td>Standing Calf Raises</td>
<td>4 S x 10 R</td>
<td>4 S x 12 R</td>
<td>4 S x 12 R</td>
<td>4 S x 12 R</td>
<td>4 S x 15 R</td>
<td>4 S x 15 R</td>
<td>→</td>
<td>→</td>
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<tr>
<td>Wobble board</td>
<td>→</td>
<td>→</td>
<td>→</td>
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<td>2 m x 2 S</td>
<td>2 m x 2 S</td>
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<tr>
<td>Peterson squats - 4 in box</td>
<td>→</td>
<td>→</td>
<td>→</td>
<td>→</td>
<td>→</td>
<td>3 S x 8 R</td>
<td>3 S x 8 R</td>
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<tr>
<td>SL Romanian deadlift</td>
<td>→</td>
<td>→</td>
<td>→</td>
<td>→</td>
<td>→</td>
<td>3 S x 5 R</td>
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<tr>
<td>Y-balance</td>
<td>→</td>
<td>→</td>
<td>→</td>
<td>→</td>
<td>→</td>
<td>3 S x 3-5 R</td>
<td>3 S x 3-5 R</td>
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<tr>
<td>Step-ups - 12 inch box</td>
<td>→</td>
<td>→</td>
<td>→</td>
<td>→</td>
<td>→</td>
<td>→</td>
<td>3 S x 12 R</td>
<td>3 S x 12 R</td>
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</table>

Abbreviations: S = sets, x = of, R = repetitions, aw = ankle weight, lb = pound, rb = resistance band, m = minute, → Arrows indicate exercise was not completed during this session. * = exercise performed in prone, SL = Single Leg, in = inch, SLR = Straight Leg Raise, ‘ = minutes
Table 2: Home Exercise Program Progression

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<th>Initial Home Exercises (Week 1):</th>
<th>Parameters:</th>
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<tr>
<td>Bridge</td>
<td>3-4 sets of 12-15 repetitions</td>
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<tr>
<td>Side-Lying Hip Abduction</td>
<td>3-4 sets of 12-15 repetitions (bilaterally)</td>
</tr>
<tr>
<td>Chair Squat</td>
<td>3-4 sets of 8-10 repetitions</td>
</tr>
<tr>
<td>Side Lunge</td>
<td>3-4 sets of 8-10 repetitions (bilaterally)</td>
</tr>
<tr>
<td>Single-Leg Balance</td>
<td>4 sets of 30 seconds (bilaterally)</td>
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</table>

<table>
<thead>
<tr>
<th>Discharge Home Exercises (Week 9):</th>
<th>Parameters:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Side steps (day 1)</td>
<td>3 sets of 10-15 repetitions</td>
</tr>
<tr>
<td>Split squats (day 1)</td>
<td>3-4 sets of 8-10 repetitions</td>
</tr>
<tr>
<td>Body weight squats (day 1)</td>
<td>3-4 sets of 8-12 repetitions</td>
</tr>
<tr>
<td>Y-Balance (day 1)</td>
<td>3 sets of 3-5 repetitions</td>
</tr>
<tr>
<td>Side steps (day 2)</td>
<td>3 sets of 10-15 repetitions</td>
</tr>
<tr>
<td>Peterson squats (day 2)</td>
<td>3-4 sets of 8-12 repetitions</td>
</tr>
<tr>
<td>Single leg Romanian deadlifts (day 2)</td>
<td>3-4 sets of 6-10 repetitions</td>
</tr>
<tr>
<td>T-Balance (day 2)</td>
<td>3 sets of 3-5 repetitions</td>
</tr>
</tbody>
</table>

Day 1: Patient performed these exercises on Monday and Wednesday, Day 2: Patient performed these exercises on Tuesday and Thursday. Refer to Appendix 1 for detailed descriptions of the exercises.
### Table 3: Timeline

<table>
<thead>
<tr>
<th>Pre-PT</th>
<th>- Patient tore her Left ACL while playing pickleball</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-PT</td>
<td>- MRI findings confirmed L. ACL tear</td>
</tr>
</tbody>
</table>
| Week 1 | - Physical therapy initial evaluation  
|        |   - Initial LEFS intake form and home exercise program (HEP) initiated (refer to table 2) |
| Week 3 | - Re-evaluated HEP and increased her progression  
|        |   - Patient signed consent form for case report participant  
|        |   - Patient took the KOS – ADL/Sport  
|        |   - Motivational interviewing initiated for behavior change around activity participation outside of therapy |
| Week 6 | - The 4-stage hop test performed                      |
| Week 7 | - Videos were taken of single-leg hop  
|        |   - Second Motivational interviewing session was performed for continual behavior change surrounding activity participation outside of therapy |
| Week 9 | - Final appointment  
|        |   - Final LEFS, KOS-ADLs & Sport were taken  
|        |   - The second 4-stage hop test was performed  
|        |   - Finalized HEP was given to the patient |
| Post-PT | - Follow up zoom meeting with the patient and student physical therapist |

Abbreviations: PT = physical therapy, L = left, HEP = home exercise program, KOS = knee outcome survey, ADL = activities of daily living, MRI = magnetic resonance imaging
### Table 4: Patient Outcome Measure Progression

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Week 1</th>
<th>Week 3</th>
<th>Week 6</th>
<th>Week 9</th>
<th>Percent change</th>
<th>R/L Comparability</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEFS</td>
<td>63/80</td>
<td>n/a</td>
<td>n/a</td>
<td>78/80</td>
<td>24%</td>
<td>n/a</td>
</tr>
<tr>
<td>KOS - ADL</td>
<td>n/a</td>
<td>92.8%</td>
<td>n/a</td>
<td>98.5%</td>
<td>5.7%</td>
<td>n/a</td>
</tr>
<tr>
<td>KOS - Sport</td>
<td>n/a</td>
<td>73%</td>
<td>n/a</td>
<td>87%</td>
<td>14%</td>
<td>n/a</td>
</tr>
<tr>
<td>SL Hop distance R leg</td>
<td>n/a</td>
<td>108.8 cm</td>
<td>n/a</td>
<td>133.5 cm</td>
<td>22.7%</td>
<td>99.6%</td>
</tr>
<tr>
<td>SL Hop distance L leg</td>
<td>n/a</td>
<td>101.25 cm</td>
<td>n/a</td>
<td>133 cm</td>
<td>31.3%</td>
<td>99.6%</td>
</tr>
<tr>
<td>SL 6m hop test R leg</td>
<td>n/a</td>
<td>2.79 s</td>
<td>n/a</td>
<td>2.51 s</td>
<td>11.2%</td>
<td>90%</td>
</tr>
<tr>
<td>SL 6m hop test L leg</td>
<td>n/a</td>
<td>3.22 s</td>
<td>n/a</td>
<td>2.77 s</td>
<td>16.3%</td>
<td>90%</td>
</tr>
<tr>
<td>Triple hop SL distance R leg</td>
<td>n/a</td>
<td>259.65 cm</td>
<td>n/a</td>
<td>379.5 cm</td>
<td>46.15%</td>
<td>94.9%</td>
</tr>
<tr>
<td>Triple hop SL distance L leg</td>
<td>n/a</td>
<td>300.9 cm</td>
<td>n/a</td>
<td>360.0 cm</td>
<td>19.64%</td>
<td>94.9%</td>
</tr>
<tr>
<td>Cross over hop distance R leg</td>
<td>n/a</td>
<td>262.35 cm</td>
<td>n/a</td>
<td>343.0 cm</td>
<td>30.74%</td>
<td>99.7%</td>
</tr>
<tr>
<td>Cross over hop distance L leg</td>
<td>n/a</td>
<td>221.45 cm</td>
<td>n/a</td>
<td>342.0 cm</td>
<td>54.44%</td>
<td>99.7%</td>
</tr>
</tbody>
</table>

Abbreviations: LEFS, Lower Extremity Functional Scale; KOS, Knee outcome survey; ADL, Activity of Daily Living; SL, Single leg; R, Right; L, Left; R/L, Right to left
**Figure 1:** Graphic visualization adapted from the three pillars of evidence-based practice (EBP).⁴
Figure 2: Visualization of eccentric phase during take-off on left lower extremity during 4-stage hop test, taken during the 5th week (initial hop test). The red line indicates valgus motion in a still frame as the patient prepares to jump off of their left lower extremity.
Appendix 1: Therapeutic Exercises and Home Exercise Program

**Straight Leg Raise**
The patient was in a supine position with both legs extended. She raised the left leg, keeping it straight to the best of her ability, up to about 60 degrees of hip flexion. She then slowly lowered her straight leg back to become symmetrical to the other.

**Bridging**
The patient lied in a supine position with her knees bent. She then extended her hips, squeezing and lifting her gluteus muscles upward and then back down to the table.

**Lateral Band Walk**
The patient stood with her feet hip distance apart with a purple theraband looped above her ankles. With a slight bend at her hips, she moved one leg to the side at a time, moving in one direction. She would side step 15 steps at a time before switching directions.

**Single-Leg Hip Extension**
The patient was in a prone position and allowed both lower extremities to hang off the plinth, with her knees extended, and feet in contact with the floor. From this position, the patient performed a single leg hip extension by squeezing her glutes and lifting the left leg posteriorly, while she maintained a neutral spine.

**Side-Lying Hip Abduction**
The patient was in a side-lying position on the plinth to perform hip abduction. The patient elevated her left leg 45 degrees, keeping the leg as straight as she could while attaining the appropriate form, and then lowered her leg back down to meet the other leg.

**16” Box Squat**
The patient was positioned with her feet hip-distance apart, feet facing forward, with a 16-inch box placed directly behind her. She performed a basic bodyweight squat, controlling her gluteus muscles down to the box and back up again. The clinician used both verbal and tactile cues to direct the patient to keep her torso upright, to control the eccentric movement down to the box, and to sit back onto the box.

**Split Squat**
The patient stood with one leg in front of the other, similar to a lunge position, and slowly lowered her back knee to the floor and back up.

**Standing Calf Raise**
The patient stood facing a wall, gently resting her hands on the wall for support. She raised up on her toes for two seconds and slowly descended her heels back to the ground for two seconds.

**Wobble Board**
The patient stood on the board facing forward and controlled her weight as she went forward and backward with her knees slightly bent. She performed this exercise two-minutes at a time for two sets.

**Peterson Squats**
The patient stood with both feet aligned next to each other on the four-inch box. She lifted one of her legs so it was outside the base of the box. She began to slowly flex her supporting knee, keeping the other knee extended and clear from the box. She eccentrically tapped her heel to the floor while she maintained a flexed knee on the supporting leg. She concentrically contracted her flexed knee and raised the extended knee to meet the other leg on top of the box.

**Single-Leg Romanian Deadlift**
The patient stood with feet hip distance apart, with her right knee slightly bent. She then hinged at her hips, extended her right hip, with a straight trunk coming almost parallel to the floor. She then eccentrically controlled her trunk upright with her right leg meeting her left leg in the starting position.

**Y-Balance**
The patient stood on her left leg. While maintaining balance, she reached the other leg straight out in front of her, to posteromedial of her, and posterolateral to her, as far as she could go.

**Step-Ups**
The patient started step-ups by flexing one knee and hip, raising the foot on top of a 12 inch box. She then contracted the hamstring, gluteus, and quadricep muscles of the supporting leg to lift the rest of her body on top of the box. She stepped back off the box backward, eccentrically controlling the supporting leg back into a flexed position.

**Chair squat**
The patient stood standing with her feet hip-distance apart, feet facing forward, with a standard height chair directly behind her. She performed a basic bodyweight squat, controlling her gluteus muscles down to the seat of the chair and back up again.

**Side Lunge**
The patient stood with both of her feet together to start. She then reached her left leg out to the side of her, resulting in a wide stance. She sat her gluteus muscles back, hips and knees flexed, with most of her weight on her left leg. She then contracted her left lower extremity muscles to return upright to the starting position.

**Single-Leg Balance**
The patient stood on her left leg, with both her hip and knee extended. Her right hip was extended and right knee was flexed so her foot was suspended off of the ground. The patient maintained this position for 30 seconds and then switched the stabilizing leg.
**T-Balance**
Similar to the Y-balance, the patient balanced her weight over one leg and reached her non-planted foot directly posteriorly, anteromedial, and anterolateral, touching at each of the three points.
Appendix 2: Hop tests used to determine discharge in this case report

- SL Hop distance
- SL 6m hop test
- Triple Hop SL distance
- Cross Over