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

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5

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8

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24 **Abstract**

25 **Study Design:** Case Report.**Background:** The patient was a 51-year-old female who tore her
26 left anterior cruciate ligament (ACL) playing pickleball and opted for non-operative treatment.
27 The clinicians involved treated the patient using the three pillars of practice: relevant scientific
28 evidence, clinician experience, and patient perspective. **Treatment:** The patient's treatment
29 consisted of therapeutic exercises, neuromuscular re-education, soft tissue massage, and
30 motivational interviewing. Therapeutic exercises were designed to strengthen the muscles
31 surrounding her hip and knee. Neuromuscular re-education helped to improve the patient's knee
32 stability and balance, while soft tissue massage was used to decrease swelling. Motivational
33 interviewing helped her better align her attitude toward her restrictions with the goals of the
34 rehabilitation process. **Outcome:** The patient made progress and increased satisfaction
35 throughout rehabilitation which was illustrated by objective tests and subjective reports.
36 Improvements were noted with a 24% positive change in lower extremity functional scale
37 (LEFS) score between initial and follow-up testing. Single leg hop tests by discharge revealed a
38 90% or higher right-to-left compatibility score. **Discussion:** This case highlighted the plausibility
39 of a conservative treatment approach in a patient with an ACL tear. It introduced a clinical
40 decision-making model that emphasized the importance of including relevant research in the
41 form of Clinical Practice Guidelines (CPG's), addressing the patient's perspective on the impact
42 of her injury, and incorporating clinician expertise in observing movement impairments. During
43 treatment, the patient demonstrated appropriate lower extremity strength and stability according
44 to the clinician's expertise and outcome measures, but she did not feel confident enough to return
45 to previous lifestyle activities. Patient perspective played a large role in determining progressions
46 and accomplishments.

47 **Key Words:** Non-operative ACL rehabilitation, Evidence-Based Practice

48 **Background**

49 One of the most commonly injured structures in the knee is the anterior cruciate ligament
50 (ACL), with injuries occurring in approximately 1 in 3,500 people annually in the U.S.¹ Over a
51 nine-year span (2005-2013) the median cost of ACL reconstruction procedures was just over
52 \$9,000, with an overall cost per patient just over \$13,400.² As preventative and conservative
53 treatments become more popular, it is important to consider the benefits and risks of each
54 treatment. One study analyzed the quality of life for patients post-acute ACL rupture, comparing
55 surgery versus conservative management. Results indicated no significant difference in patient's
56 quality of life between those that chose surgical reconstruction versus those who preferred
57 conservative management.³

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

67

68 **Introduction**

69 This report focuses on a patient with a recent ACL tear. Following an initial consultation
70 with a surgeon, the patient elected conservative treatment for her injury. After her initial physical
71 therapy examination, her therapist determined that she was deemed a good candidate for
72 conservative treatment based on the following reasons: similar active range of motion (AROM)
73 bilaterally, minimal swelling, and her motivation to succeed. Due to the lack of relevant non-
74 operative treatment guidelines, aspects of the case report have incorporated the usage of post-
75 operative clinical practice guidelines from Van Melic.⁵ During the time that the patient was seen
76 for physical therapy, she made great strides towards her goals of returning to activities and
77 hobbies, as seen in the exercise progression and four-stage hop test. With further discussion
78 between the patient, physical therapist (PT), and student physical therapist (SPT), it was clear
79 that the patient herself did not have full confidence in her affected limb. This influenced the
80 clinicians to take a step back and observe the case not only through objective data but also from
81 the lenses of the patient perspective and clinician expertise.

82 It is crucial to keep in mind all three pillars of evidence-based practice as it pertains to the
83 case, in order for both the clinician and patient to effectively participate in the decision-making
84 process. The importance of this is highlighted by the APTA which describes how the plan of care
85 should be designed in collaboration with the patient, looking at specific patient goals.⁶ The
86 purpose of this case report was to analyze the rehabilitation process and its effects on a patient
87 with an ACL tear who opted for a conservative treatment plan, with clinicians utilizing evidence-
88 based practice as a framework for clinical decision-making.

89

90 **Case Presentation**

91 *History*

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

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

107 ***Examination***

108 The patient's chief complaints were mild weakness, pain (4/10 on the numeric pain rating
109 scale) throughout the day, and the negative psychological impact due to not being able to
110 participate in her normal activities. She denied locking, catching, or buckling of her left knee.
111 Although the patient had imaging that confirmed a left ACL tear, the PT conducted special tests
112 and measures that confirmed the diagnosis and ruled out other injuries. The Anterior Drawer
113 Test and Lachman Test provided positive results, which confirmed the ACL tear diagnosis.⁷
114 Additional tests were also performed to rule out other possible ligament injuries, including the

115 Knee Varus and Valgus Stress Tests, McMurray Test, and the Posterior Drawer Test.⁷ All results
116 were negative which supported the initial finding of an isolated ACL tear being present.

117 During the initial physical therapy examination, it was observed that the patient had mild
118 effusion anterior to her left patella. Upon palpation, she reported tenderness to the anterior joint
119 line. The patient's knee range of motion was also assessed via the methods described by Norkin
120 and colleagues.⁸ The PT assessed both right and left active range of motion at the knee joint, in a
121 supine position, with the use of a goniometer. The patient achieved 139 degrees of active knee
122 flexion bilaterally. Normal knee ROM will typically range from 130 to 140 degrees in adults;
123 therefore, the patient demonstrated normal knee ROM despite her injury.⁸

124 The PT performed manual muscle tests to examine the strength of the patient's lower
125 extremities. Strength was assessed via techniques for manual muscle testing described by
126 Kendall and colleagues.⁹ Her lower extremity muscles, the quadriceps and hamstrings, were
127 tested while she was supine on the bed. Manual muscle testing on her left leg was not able to be
128 performed due to the patient's fear and pain. The PT was able to observe a variety of functional
129 movements from the patient which allowed the clinician to gain a better understanding of her
130 strength and stability on the left leg. Weakness was observed as the patient performed squatting
131 maneuvers, such as having a hard time getting up from a seated position with equal to or more
132 than 90 degrees of hip flexion. The patient also reported pain with end-range knee flexion,
133 unanticipated lateral movements, and pivoting on her left leg.

134 Based on the examination findings, the PT and SPT determined the patient had motor
135 control deficits and impaired strength due to pain. In the first several weeks, her short-term goals
136 were to increase her knowledge and ability to partake in therapeutic exercises, increase her
137 confidence in ascending/descending stairs, improve her squat to pick objects up off the floor, and

138 utilize strategies to help reduce knee pain. In the following months to a year, she wanted to
139 return to pain-free running, skiing, and recreational tennis. Given her pain, lack of strength, full
140 ROM, increased motivation, enthusiasm to participate, and lack of comorbidities, she was given
141 a fair to good prognosis for recovery.

142 ***Treatment***

143 The patient agreed to attend physical therapy but did not want to come into the clinic
144 more than once a week for personal reasons. She participated in physical therapy once a week for
145 60-minutes for 9 weeks, working with both the PT and SPT. Based on previous evidence,
146 someone receiving rehabilitation for an ACL injury would typically attend physical therapy 2 to
147 3 times a week.¹ The SPT led 6 out of 9 of the patient's treatment sessions, while the PT treated
148 the patient for the remaining 3 sessions. She received an initial plan of care which consisted of
149 therapeutic exercises intended to strengthen and stabilize the muscles in her left lower extremity,
150 along with soft tissue massage to manage edema around the knee. To optimize the patient's
151 outcomes, neuromuscular training was incorporated into the plan of care. The CPG for ACL
152 post-operative rehabilitation suggests that both resistance training and neuromuscular training
153 will result in the most optimal outcomes.⁵

154 *Soft Tissue Massage*

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

161 Therapeutic Exercises

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

180 Home Exercise Program

181 Due to the fact that the patient only attended physical therapy once a week, compliance
182 with a home exercise program was vital for her recovery. The PT educated the patient on how
183 important compliance was for the home exercise program. The patient was a self-motivated

184 individual and thoroughly enjoyed physical activity. Similar to the physical therapy sessions, her
185 home exercise program included the following: bridges, side-lying hip abduction, chair squats,
186 side lunges, and single-leg balance. See Table 2 for home exercise program dosage.

187 Motivational Interviewing

188 Several discussions with the patient throughout the course of treatment revealed that she
189 was running several miles a week. Although this was not recommended by the orthopedic
190 specialist or PT, it did not increase the patient's left knee pain at first. However, she reported
191 pain in her left hip and increased swelling around her knee. During these conversations, the SPT
192 used motivational interviewing (MI) techniques to elicit a change in the patient's attitude toward
193 her restrictions.¹³ A meta-analysis that included 119 research studies showcased revealed that MI
194 was effective in producing statistically and clinically significant positive effects on a wide range
195 of populations.¹⁴ MI delves into a patient's personal reason for change within an environment of
196 compassion and acceptance. In general, the guiding principles of MI are typically used to help a
197 patient improve the level of motivation and personal commitment.¹³ After two sessions of MI,
198 the patient reported she decreased her running mileage during the week. She subsequently
199 experienced less swelling around the left knee joint and less pain in her hip.

200

201 **Results**

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

207 *Scientific Evidence*

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

215 The KOS is a subjective questionnaire that aims to assess the effect of the patient's self-
216 reported symptoms on activities of daily living (ADL) and on their sports activities.^{15,16} The
217 ADL section includes 6 questions designed to determine the ability to perform general daily
218 activities and 8 questions designed to determine the ability to perform specific functional
219 tasks.^{15,16} Each question is scored 0-5, indicating unable to perform to no difficulty. The total
220 possible score for the ADL section is 70.^{15,16} The sports activities scale (SAS) section includes 7
221 questions on the ability to perform sports and recreational activities and 4 questions on the ability
222 to perform specific sport activities.^{15,16} Similar to the ADL section, each question is scored 0-5,
223 indicating unable to perform to no difficulty. The total possible score for the SAS section is
224 55.^{15,16} The total scores are calculated by finding a percentage for both the ADL and SAS
225 sections. The ADL score would be divided by 70, multiplied by 100, and the SAS score would
226 be divided by 55, multiplied by 100. The higher the percentage, the higher level of physical
227 function.^{15,16} This patient-reported outcome measure has demonstrated excellent validity,
228 reliability, and responsiveness to assess functional limitations throughout the rehabilitation
229 process for a variety of knee injuries.^{15,16}

230 The primary objective assessment utilized was the series of Fowler-Kennedy hop tests.
231 The four hop tests performed by the patient were as follows: single-leg hop test for distance,
232 single-leg 6-meter hop test for time, single-leg triple hop test for distance, and the single-leg
233 crossover hop test for distance. The Fowler-Kennedy Hop tests were followed per protocol and
234 both legs were tested. These hop tests measure distance and time which are objective, but a
235 clinician's expertise is still able to identify any biomechanical abnormalities and limb
236 asymmetries, which interventions can later focus on and address to improve function.¹⁹ Refer to
237 Appendix 2 for a description and diagram of each outcome measure performed.

238 The patient demonstrated a 15-point change in the LEFS from Week 1 to Week 9. Both
239 the minimal detectable change (MDC) and minimum clinically important difference (MCID) for
240 the LEFS were reported to be a 9-point change.^{17,18} She exceeded both the MDC and MCID for
241 the LEFS which indicates a meaningful change in her condition.^{17,18} She also demonstrated
242 improvements within the KOS. She experienced a 5.7% increase in KOS-ADL and a 14%
243 increase in KOS-Sport from Week 1 to Week 9. The MCID for the KOS is an increase of 7.1%,
244 in both the ADL and sport categories.^{17,18} She already presented with a high and effective KOS-
245 ADL score and therefore did not have as much room for improvement in this area. However, the
246 patient was able to exceed the MCID for KOS-Sport, improving from 73% on Week 3 to 87% on
247 Week 9. Refer to Table 4 for additional details regarding the patient outcomes for LEFS and
248 KOS.

249 Lastly, the patient demonstrated improvements in all areas of the Fowler-Kennedy hop
250 tests. The patient was originally tested on Week 6 and again on Week 9. The patient
251 demonstrated more significant improvements on her left leg for the single-leg distance hop,
252 single leg 6-meter hop, triple hop, and the crossover hop. Significant positive change to the

253 Fowler-Kennedy hop test is indicated by a 90% compatibility bilaterally, which she was able to
254 achieve at discharge.²⁰ According to prior research, it is suggested that if the patient is able to
255 score 90% or above that they will have a lower risk for re-injury in the future.²⁰ Refer to Table 4
256 for additional details regarding the patient outcomes for the Fowler-Kennedy Hop tests.

257 *Clinician Expertise*

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

267 *Patient Perspective*

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

275 her strength and pain, week to week. She felt the ongoing treatment sessions helped instill
276 confidence in herself and improve her left knee.

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

282

283 **Discussion**

284 ACL ruptures have been a common injury that has imposed a heavy burden on the
285 healthcare system in the past several years.²¹ Along with preventative treatment, conservative
286 rehabilitation within complete ACL ruptures has been increasingly popular in recent years.²² In
287 reference to knee joint stability, functional outcomes, and overall satisfaction from the patients,
288 studies have found similar outcomes versus surgical intervention in ACL management.²²
289 Furthermore, other articles also suggested that clinicians should not heavily rely on the results of
290 outcome measures and rather monitor function throughout rehab in order to make decisions
291 regarding progression and discharge.²³

292 On average, patients completed 16.90 ± 10.60 PT visits following ACL reconstruction.²⁴
293 The patient in this case report only completed 9 treatment sessions, under half the amount of
294 treatment sessions typically performed. Only completing half the average number of treatment
295 sessions meant this patient saved between \$800 - \$1200 on physical therapy alone, not
296 accounting for the median cost of ACL reconstruction surgery of \$9000.² This demonstrated the
297 reduced financial impact that a conservative treatment approach to an ACL repair can have.

298 Despite the lack of research evidence for her particular case, the PT and SPT used
299 objective measurements to track change and give a degree of object framework for discharge.
300 However, the clinicians found it vital to incorporate more of the patient's perspective and
301 clinician expertise more so than scientific evidence. Compared to abiding by a strict rehab
302 guideline from a post-surgical procedure, this allowed for a flexible rehabilitation program and
303 for the patient to drive her own progress based on her perceived difficulty and pain. In this case
304 study, the patient expressed a great deal of satisfaction with her rehab process. Lastly, the patient
305 described an increase in confidence with her involved limb and was very impressed with the
306 progress she made. The PT and SPT hypothesized, if it was not for utilizing all three pillars of
307 evidence-based practice, the successful outcomes may not have been achieved.

308

309 **Key Points**

310 *Findings*

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

315 *Implications*

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

320 *Caution*

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

326

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Table 1: Therapeutic Exercise Progression

Exercises:	7/7/21	7/14/21	7/21/21	7/27/21	8/4/21	8/10/21	8/19/21	8/26/21
Banded Lateral Walks	3 S x 15 R purple rb							
SL Hip Extension*	→	→	3 S x 15 R 2 lb aw	4 S x 12 R 2 lb aw	4 S x 12 R 3 lb aw	4 S x 12 R 3 lb aw	4 S x 12 R 3 lb aw	4 S x 12 R 4 lb aw
Bridge in supine	4 S x 10 R	4 S x 10 R	4 S x 12 R	4 S x 12 R	4 S x 15 R	4 S x 15 R	→	→
Supine SLR	4 S x 10 R	4 S x 10 R	4 S x 15 R	4 S x 10 R	4 S x 10 R 1 lb aw	4 S x 12 R 1 lb aw	4 S x 10 R 2 lb aw	→
Side Lying Hip Abduction	4 S x 10 R	4 S x 12 R	3 S x 15 R	3 S x 15 R	3 S x 12 R 2 lb aw	3 S x 15 R 2 lb aw	3 S x 12 R 3 lb aw	3 S x 12 R 3 lb aw
16 in Box Squat	4 S x 8 R	4 S x 8 R	4 S x 10 R	4 S x 10 R	3 S x 12 R 10 lb	3 S x 12 R 10 lb	3 S x 12 R 15 lb	3 S x 12 R 20 lb
Split Squat	3 S x 5 R	3 S x 5 R	4 S x 5 R	4 S x 5 R	4 S x 8 R	4 S x 8 R	4 S x 8 R 15 lb	4 S x 8 R 15 lb
Standing Calf Raises	4 S x 10 R	4 S x 12 R	4 S x 12 R	4 S x 12 R	4 S x 15 R	4 S x 15 R	→	→
Wobble board	→	→	→	→	2 m x 2 S	2 m x 2 S	2 m x 2 S	2 m x 2 S
Peterson squats - 4 in box	→	→	→	→	→	3 S x 8 R	3 S x 8 R	3 S x 8 R
SL Romanian deadlift	→	→	→	→	→	3 S x 5 R	3 S x 5 R 10 lb	3 S x 5 R 15 lb
Y-balance	→	→	→	→	→	3 S x 3-5 R	3 S x 3-5 R	3 S x 3-5 R
Step-ups - 12 inch box	→	→	→	→	→	→	3 S x 12 R	3 S x 12 R
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

Initial Home Exercises (Week 1):	Parameters:
Bridge	3-4 sets of 12-15 repetitions
Side-Lying Hip Abduction	3-4 sets of 12-15 repetitions (bilaterally)
Chair Squat	3-4 sets of 8-10 repetitions
Side Lunge	3-4 sets of 8-10 repetitions (bilaterally)
Single-Leg Balance	4 sets of 30 seconds (bilaterally)
Discharge Home Exercises (Week 9):	Parameters:
Side steps (day 1)	3 sets of 10-15 repetitions
Split squats (day 1)	3-4 sets of 8-10 repetitions
Body weight squats (day 1)	3-4 sets of 8-12 repetitions
Y-Balance (day 1)	3 sets of 3-5 repetitions
Side steps (day 2)	3 sets of 10-15 repetitions
Peterson squats (day 2)	3-4 sets of 8-12 repetitions
Single leg Romanian deadlifts (day 2)	3-4 sets of 6-10 repetitions
T-Balance (day 2)	3 sets of 3-5 repetitions
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

Pre-PT	<ul style="list-style-type: none">- Patient tore her Left ACL while playing pickleball
Pre-PT	<ul style="list-style-type: none">- MRI findings confirmed L. ACL tear
Week 1	<ul style="list-style-type: none">- Physical therapy initial evaluation<ul style="list-style-type: none">- Initial LEFS intake form and home exercise program (HEP) initiated (refer to table 2)
Week 3	<ul style="list-style-type: none">- 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	<ul style="list-style-type: none">- The 4-stage hop test performed
Week 7	<ul style="list-style-type: none">- 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	<ul style="list-style-type: none">- 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	<ul style="list-style-type: none">- 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

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

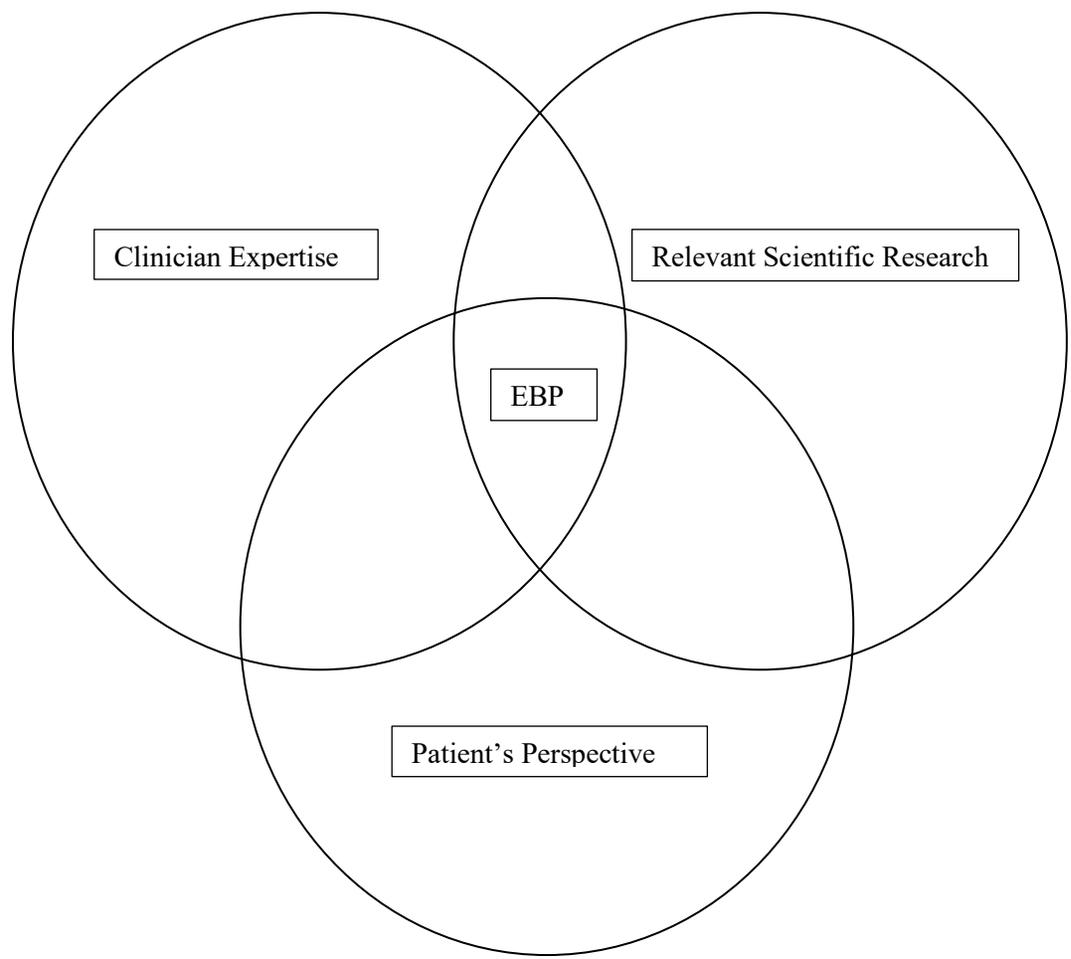


Figure 2: Visualization of eccentric phase during take-off on left lower extremity during 4-stage hop test, taken during the 5th week (initial hop test). The red line indicates valgus motion in a still frame as the patient prepares to jump off of their left lower extremity.



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

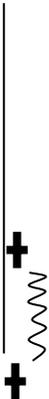
The patient stood on her left leg, with both her hip and knee extended. Her right hip was extended and right knee was flexed so her foot was suspended off of the ground. The patient maintained this position for 30 seconds and then switched the stabilizing leg.

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

