

The Effects of Mindfulness-Based Body Scan Meditation on Physical and Psychological Outcomes Following ACL Reconstruction in an Adolescent Volleyball Player: A Case Report

In addition, evidence has suggested that adolescents have poor health literacy, which further exacerbates their anxiety and fear around injury and surgery.⁹

Clinical practice guidelines (CPG) advocate for early mobilization following knee surgery,¹⁹ but there is a lack of literature that describes how mobilization should best be accomplished while addressing the psychological responses of the athlete. Current interventions target the decreased ROM but do not account for the patient's pain, anxiety, kinesiophobia, or mood. Several psychological interventions have demonstrated value in sport injury rehabilitation, such as goal setting, guided imagery, and mindfulness. Including psychological interventions in physical rehabilitation programs has demonstrated improvements in self-confidence, coping strategies, and treatment motivation and satisfaction.²⁷ Psychological interventions in physical rehabilitation have also decreased anxiety, depression, stress, negative cognitions, and muscular tension/activation.²⁷ However, it is not currently the standard of care to use psychological-based treatments in sport injury rehabilitation.

Recognizing the need for psychologically based treatments in sport injury rehabilitation, there has been a call for the use and research of psychologically informed physical therapy^{2,7} and mindfulness-based practices in physical therapy.³¹ Mindfulness is defined as being intentionally aware, moment-to-moment, without judgment.¹³ Jon Kabat-Zinn first introduced mindfulness in the United States in the 1970s when he founded the Mindfulness-Based Stress Reduction

■ **BACKGROUND:** This case report describes the use of a mindfulness-based body scan meditation on self-knee flexion range of motion following anterior cruciate ligament reconstruction surgery in an adolescent female. Secondary goals were to describe pain, anxiety, mood, and overall physical functioning during the first 6 weeks following surgery.

■ **CASE PRESENTATION:** A mindfulness intervention was added to the rehabilitation of an adolescent volleyball player.

■ **OUTCOME AND FOLLOW-UP:** Knee flexion range of motion and physical function improved through the acute phase of physical therapy. Pain, anxiety, and mood all responded positively. The participant

found the meditation helpful and enjoyable. The meditation required minimal time and training, and there was no added cost to the plan of care.

■ **DISCUSSION:** This case report describes the feasibility and effectiveness of mindfulness-based body scan meditation in an adolescent female participating in anterior cruciate ligament reconstruction rehabilitation to support physical and psychological well-being. *JOSPT Cases* 2025;5(4):218-225. Epub 7 October 2025. doi:10.2519/josptcases.2025.0156

■ **KEY WORDS:** case report, mindfulness, psychologically informed physical therapy, range of motion

Adolescent athletes commonly sustain anterior cruciate ligament (ACL) injuries that require surgery.²⁶ Following ACL injuries, ACL reconstruction (ACL-R) surgery is commonly recommended for adolescent athletes to regain the stability of their knees and return to their previous level of activity.²⁵ Following arthroscopic knee surgery, substantial tissue inflammation and joint effusion occur. Upon waking up from anesthesia, the patient will also experience pain, decreased knee range of motion (ROM), and arthrogenic muscle inhibition of the quadriceps. This decrease in knee function leads to an overall reduction in mobility.

In addition to physical responses, patients also experience psychological responses to surgery. Psychological re-

sponses during the perioperative period include increased state anxiety,¹⁰ increased kinesiophobia,²⁰ and fluctuations in mood and pain.⁴ This negative mood can lead to decreased adherence and motivation to participate in rehabilitation,⁵ prolonging physical recovery and returning to sport.²³

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(MBSR) clinic at the University of Massachusetts.¹³ Kabat-Zinn developed an 8-week intensive MBSR curriculum for patients with chronic medical problems. The program consists of participants meeting 3 hours weekly with an additional full-day silent retreat. Individuals participate in awareness of breath activities, yoga, meditations in various positions, and a specific type of mindfulness-based meditation called the body scan. Participants are also assigned 45 minutes of daily mindfulness meditation homework for the duration of the course.¹⁴

This original program helped manage chronic pain^{13,15} and anxiety²⁴ in adults. Over the years, the original MBSR program has been adapted to fit the needs of different populations and settings.³

One accessible and widely studied formal mindfulness practice is a guided body scan meditation.¹¹ During a guided body scan, a teacher guides the participant to direct attention to different regions of the body. The participant is asked to pay attention to the area non-judgmentally without moving or activating that body part. For example, the participant might notice that a specific region of their body has pain and is guided toward acknowledging the pain without attributing an emotion to the pain. The traditional MBSR course may not be feasible for all physical therapy patients due to the significant time requirements and the need for a qualified teacher. However, mindfulness-based body scan meditation (MBBSM) requires less time commitment for the patient and the therapist, can be delivered in person or as part of a home exercise program (HEP), and can introduce mindfulness into a physical therapy plan of care. Tatta et al³¹ suggested that physical therapists should develop competency in delivering mindfulness interventions with their patients to enhance the safety of these approaches. The knowledge to use

mindfulness with patients can be gained in entry-level educational programs or high-quality continuing education.³¹

There are currently limited demonstrations of PTs helping patients meet the critical milestone of knee flexion following ACL-R while also attenuating patient pain, negative moods, and anxiety. Therefore, the purpose of this case study is to describe the use of MBBSM on self-knee flexion ROM following ACL-R in an adolescent female. The secondary aims were to measure and describe pain, state anxiety, mood, and overall physical functioning during the first 6 weeks following ACL-R, and to gather data on the participant's satisfaction and perceived effectiveness of MBBSM.

CASE PRESENTATION

The participant was a 17-year-old female volleyball player who had left ACL-R and a lateral meniscectomy. She sustained her ACL and lateral meniscus tears during landing from a jump in a volleyball game 3 weeks prior to surgery. She did not participate in preoperative physical therapy. However, per the chart review from her orthopaedic surgeon's documentation, she had slightly decreased knee flexion and extension ROM and minimal swelling. She had a history of right knee ACL-R, partial medial meniscectomy, and lateral meniscus repair surgery 22 months ago. She also had a history of bilateral ankle sprains and bilateral medial tibial stress syndrome. She also did not have a history of a mental health diagnosis. The participant provided written assent, and her guardian provided written consent. The Research Institute's Regulatory Affairs department at Nicklaus Children's Hospital in Miami, FL, determined that this report qualifies as non-Human Subjects Research and is exempt from Institutional Review Board approval. Outcome measures, interview questions, and raw data can be viewed here: <https://osf.io/seyqb/>.

ASSESSMENTS

Pain

The numeric pain-rating scale (NPRS) is an 11-point Likert scale used to measure pain. The participant rated her pain from no pain (0) to worst possible pain (10). The NPRS is supported as a valid and reliable measure of pain in children and adolescents.⁶

State Anxiety

State anxiety is a noticeable but transient emotional condition characterized by feelings of apprehension and heightened autonomic nervous system activity.¹⁷ The Anxiety Thermometer was used to measure state anxiety. The thermometer is a 10-point Likert scale that ranges from calm and content (1) to extremely anxious-unable to function (10). The anxiety thermometer compares favorably to multiple-item inventories of state anxiety, like the state portion of the State-Trait Anxiety Inventory, supporting its reliability and validity using a single question.¹²

Mood

Moods are relatively enduring subjective internally experienced affective states that vary in intensity, valence, duration, and influence on cognition and behavior. Moods often lack a specific antecedent and reflect how an individual feels over a sustained period. Moods are longer-lasting, less intense, and frequently less clearly directed at a particular cause than emotions.²⁹ The Profile of Mood States: Brief Form (POMS-Brief) questionnaire was used to track mood throughout the acute phase of therapy. The 30-item questionnaire assesses total mood disturbance, negative mood states (anger-hostility, confusion-bewilderment, depression-dejection, fatigue-inertia, and tension-anxiety), and positive mood states (vigor-activity). The participant described how she felt in the past week by responding to a list of adjectives on a 5-point Likert scale, ranging from not at all (0) to extremely (4). The POMS-Brief has

demonstrated strong psychometric properties, indicating strong reliability and validity in adolescent populations.²²

Physical Function

The International Knee Documentation Committee Subjective Knee Form-Pediatric version (Pedi-IKDC) was used to monitor progress in physical function. The Pedi-IKDC asks questions about physical symptoms, function, and sports activities. Reliability, validity, and internal consistency were high.¹⁶

Knee Flexion ROM

Knee flexion ROM was collected using the Onform 2-dimensional video analysis software (<https://www.getonform.com>) installed on a tablet. The device was placed in the sagittal plane next to the participant at the height of her surgical leg. The participant was positioned in long-sitting, with her back supported by a wall. She was instructed to bend her knee as far as she could, as many times as possible, for 10 minutes. She was directed to hold each bend for 10 seconds. She was permitted to perform active ROM, passive ROM, or active-assisted ROM. Using another person, such as a parent, was prohibited. The iPad continuously recorded the 10-minute session of knee-bending so that the maximum degree of bending could be identified and measured. The maximum knee flexion achieved in a session was recorded using the OnForm software's angle tool. Research has demonstrated that 2-dimensional video analysis software is a valid way to measure ROM in the sagittal plane.²⁸

Participant Satisfaction and Social Validity

The first author and interventionist designed questions to assess the participant's satisfaction and perceived effectiveness of the MBBSM intervention based on her knowledge of the participant and her experience as a board-certified orthopaedic

clinical specialist physical therapist (PT) and as a mindfulness sport performance enhancement instructor (<https://www.mindfulnessportperformance.org/>; see **TABLE 1**). The researcher recorded the interviews between herself and the participant. The authors of this manuscript listened to the recordings for overall content, transcribed the interviews, and reported a summary of the results. Strategies to ensure methodological rigor and trustworthiness of findings included researcher reflexivity, peer debriefing, and member checking.

TREATMENT

A 10-minute MBBSM recording (<https://www.youtube.com/watch?v=obYJRmqrqOU>)⁸ and ongoing participant-therapist discussions were used to apply the 3 pillars of mindfulness: attention, intention, and awareness. The MBBSM recording focused mostly on the "attention" pillar (keywords: notice, focus, attention, awareness). The participant was instructed to listen to the same MBBSM daily immediately prior to a 10-minute bout of self-knee-bending. She was instructed to lie supine and close her eyes while she listened to the recording. A compliance check was completed by asking, "Did you listen to the meditation?" each time she completed the self-bending intervention. The participant and PT discussed the MBBSM throughout treatment as part of participant education. The PT reinforced the other 2 pillars of

mindfulness by encouraging the participant to adopt a nonjudgmental mindset by emphasizing that there was no wrong way to do the MBBSM (awareness) and that mindfulness was developing through deciding to participate in the intervention each day (intention).

Timeline

Postsurgery, Pre-Physical Therapy **TABLE 2** provides a visual representation of the overall timeline of this case (see **TABLE 2**). The participant communicated with the PT by telehealth until formal physical therapy was initiated. The PT collected baseline data (Pedi-IKDC, POMS-Brief) the day after surgery. The MBBSM and the self-knee flexion protocol were introduced to the participant 3 days after surgery. The single-question items of pain and anxiety were asked at the start of each bending session, after the mindfulness recording, and after the 10-minute knee-bending activity (see **FIGURE 1**).

Physical Therapy Examination The PT completed a full examination and evaluation of the participant 8 days after the operation. The American Physical Therapy Association's (APTA) clinical practice guideline for knee ligament sprains¹⁹ was used to select tests and measures. The PT assessed knee ROM, swelling, scar healing, quadriceps activation, gait, balance, transfers, and the ability to use the crutches and knee brace safely. The PT also readministered the Pedi-IKDC and POMS-Brief. Finally, the PT reviewed the

TABLE 1
Open-Ended Questions About the MBBSM Intervention
What are your thoughts on the MBBSM that you are listening to before knee-bending?
Do you feel that other patients would be open to using MBBSM in their rehabilitation?
During your last ACL-R rehabilitation, we did not use MBBSM. Do you feel that there is a difference in your rehabilitation this time due to the MBBSM?
Probe: Do you feel that the MBBSM helps the rehabilitation process, or does it just feel nice?
Do you think there is a different time point that the MBBSM would be more helpful during the rehabilitation process?
Abbreviations: ACL-R, anterior cruciate ligament reconstruction; MBBSM, mindfulness-based body scan meditation.

TABLE 2

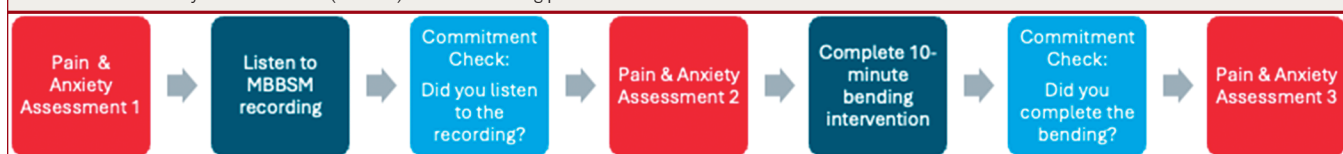
Timeline of the Acute Phase of the Case

	Tues	Wed	Thurs	Fri	Sat	Sun	Mon
Week 1	Surgery	IKDC, POMS, Mindfulness-Measurement #1		Introduced MBBSM and bending protocol Pain & Anxiety - Measurement #1			
Week 2		PT In-person examination; Flexion: 63° IKDC, POMS, Mindfulness-Measurement #2 Pain & Anxiety - Measurement #2					Pain & Anxiety - Measurement #3
Week 3	Pain & Anxiety - Measurement #4	Pain & Anxiety - Measurement #5		In-person PT; Flexion: 70° Qualitative interview #1			
Week 4		In-person PT; Flexion: 95° IKDC, POMS, Mindfulness-Measurement #3 Pain & Anxiety - Measurement #6		In-person PT; Flexion: 105°		Pain & Anxiety - Measurement #7	
Week 5	In-person PT; Flexion: 115° IKDC, POMS, Mindfulness-Measurement #4 Pain & Anxiety - Measurement #8						
Week 6	Pain & Anxiety - Measurement #9	In-person PT; Flexion: 115° IKDC, POMS, Mindfulness-Measurement #5		In-person PT; Flexion: 120° Qualitative interview #2			

Abbreviations: IKDC, International Knee Documentation Committee; MBBSM, mindfulness-based body scan meditation; POMS, Profile of Mood States; PT, physical therapy.

FIGURE 1

Mindfulness-based body scan meditation (MBBSM) and knee-bending protocol timeline.



HEP with the participant, which included knee ROM activities, quadriceps activations, weight shifting, and MBBSM.

Physical Therapy Treatment and Continued Data Collection The participant started her treatment sessions the week after the examination. She attended physical therapy once or twice weekly for 90 minutes each session. The PT encouraged continued use of the MBBSM during the HEP immediately before knee-bending. The MBBSM was reinforced weekly during therapy sessions to enhance treatment fidelity. In addition to the MBBSM, the standard of care was implemented to address all the participants' movement system impairments.

Function and mood were measured weekly, except in week 3, where a qualitative interview was conducted. A final qualitative interview was performed toward the end of week 6.

OUTCOMES

Compliance

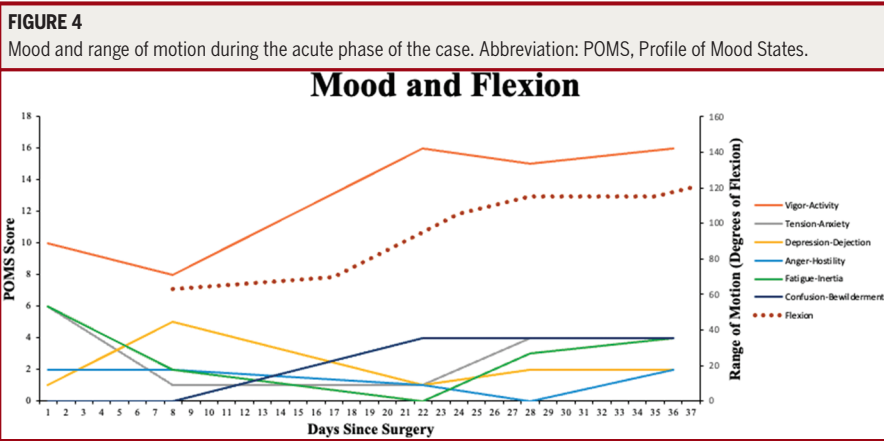
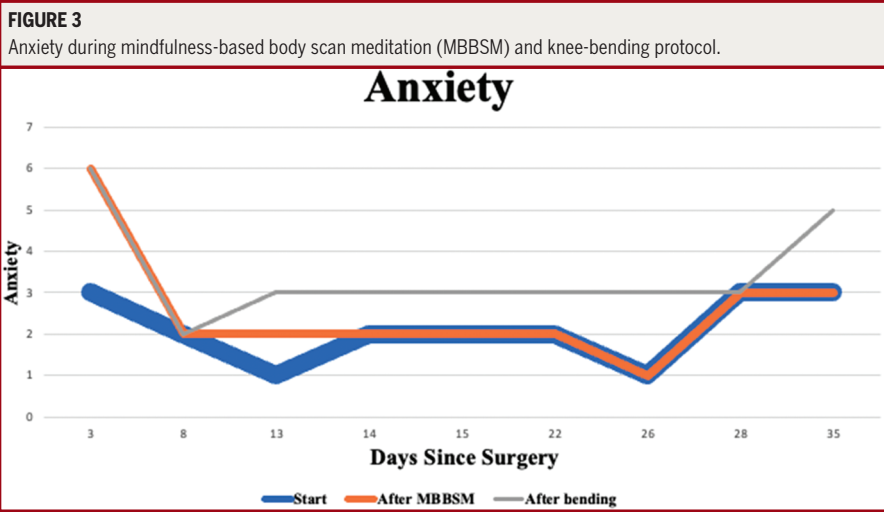
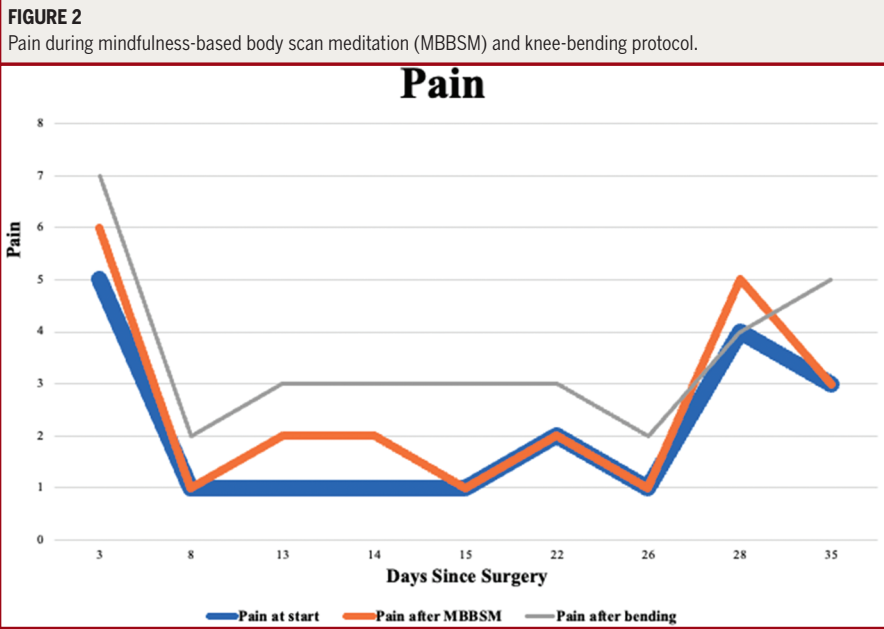
The participant attended 100% of scheduled treatment sessions (6 visits; see TABLE 2). She reported performing her HEP most days; however, she only completed the daily questionnaire 9 times in 6 weeks. She reported listening to the MBBSM 5 of the 9 times and performing the full 10 minutes of knee-bending 9 of the 9 times.

Pain

Overall, the participant reported minimal pain at rest. Her average pain rating (NPRS) before the MBBSM was 2.11 (SD = 1.54; range = 1-5) compared to 2.56 (SD = 1.81; range = 1-6) after the MBBSM, and her average pain score after bending was 3.56 (SD = 1.59; range = 2-7) (see FIGURE 2).

State Anxiety

The participant's average anxiety at the beginning of the sessions before MBBSM was 2.11 (SD = .78; range = "1. calm and content" to "3. little uneasy"). Following the MBBSM, her average anxiety increased to 2.56 (SD = 1.42; range =



1-6). Notably, in the session that was 4 days postoperation, her anxiety increased the most to “6. trouble thinking clearly, feeling physically uncomfortable,” following the MBBSM. Anxiety remained at a 6 after the knee-bending activity. The participant’s anxiety increased more after knee-bending, with average anxiety of 3.44 (SD = 1.23); she reported “2. fine” once (week 2), “3. little uneasy” 6 times (weeks 2-5) after knee-bending, and “5. feeling unfocused and stressed” once during the last data collection in week 6 (see **FIGURE 3**).

Mood

The participant demonstrated low total mood disturbance in the first 6 weeks following surgery (see **FIGURE 4**). Her raw total mood disturbance scores were 5, 2, -9, -2, and 0 in weeks 1 to 6, with higher scores indicating a greater degree of overall mood disturbance. The day after surgery, she scored highest in the domains of vigor-activity (10), tension-anxiety (6), and fatigue-inertia (6). Starting in the second week postoperation, she consistently scored highest weekly in the positive domain of vigor-activity (8, 16, 15, 16).

Physical Function

The participant reported a low level (below 40%) of function throughout the first 6 weeks following surgery. She reported her function to be 6.52% the day after surgery. She reported an increase in function to 38.04% 8 days after surgery. She then dropped 3% and another 4% in weeks 4 and 5 and returned to 38.04% function in week 6.

Knee Flexion ROM

The participant’s knee flexion active range of motion at the initial examination appointment was 63°. Flexion was measured at each subsequent treatment session and improved to 70°, 95°, 105°, 115°, 115°, and 120° (see **FIGURE 4**).

Participant Satisfaction and Social Validity

The participant reported the MBBSM to be both pleasant and effective. She reported that she enjoyed the intervention and found it helpful. She expressed hesitancy about MBBSM being an effective intervention for others recovering from ACL-R. She explained that other patients must be motivated to complete the meditation. When asked to compare this ACL rehabilitation with her last ACL therapy experience (without MBBSM), she reported that adding the mindfulness intervention before knee-bending resulted in more tolerable movement. She reported that bending is “easier when you’re relaxed instead of tense.” She acknowledged that bending continued to be painful even with the MBBSM but that “it’s not as bad.” Finally, when asked if there would be a better time to implement the MBBSM intervention into her treatment program, she reported, “I think before the bending is a good time.”

DISCUSSION

Overall, the participant progressed steadily through the acute phase of physical therapy, as demonstrated by her increased knee flexion ROM and Pedi-IKDC scores. Pain, anxiety, and mood all responded positively to the rehabilitative process, indicating successful treatment and integration of rehabilitative psychology. Due to the retrospective nature of this case, administration of outcome measures and treatment sessions was irregularly scheduled with an emphasis on ecological validity and client needs. Therefore, while the results of this case study are ecologically valid, their internal validity should be questioned and improved upon in future research.

The participant attended all scheduled physical therapy sessions and partially

complied with her HEP. She reported that she did perform the knee-bending activity every day but did not always answer the commitment check question or questions about pain and anxiety. She did not consistently complete the daily MBBSM before bending despite verbally reporting that the intervention was helpful and that she enjoyed it. She explained that she omitted the MBBSM and answered the outcome measures when she was limited on time (eg, having a lot of academic homework that day). Future research could enhance patient compliance with the protocol by sending a daily text message to the patient’s phone as a reminder to complete the intervention as prescribed. Ongoing in-person discussion between the therapist and patient can also be used to educate the patient about the purpose and importance of using mindfulness as part of the HEP to improve overall patient buy-in.

This case report demonstrated a gradual improvement in knee flexion ROM without hands-on therapist assistance during the first 6 weeks of rehabilitation following ACL-R. ROM progression in this case was compared to her first ACL rehabilitation. The patient was restricted to 90 degrees of flexion for the first 2 weeks after her first ACL-R, and she also did not start therapy until 17 days postoperation, which made direct comparison difficult. Her ROM at 6 weeks postoperation was similar after both surgeries; however, therapist-assisted PROM activities were utilized heavily during the first episode of care. In the patient’s second qualitative interview, she expressed that the PROM was a negative psychological experience. Physical therapists are expected to assist patients with regaining ROM following surgery,¹⁹ but the best way to achieve this motion, while supporting the psychological well-being of the patient is unknown. It is common for patients to cry, report high pain levels, and be very apprehen-

sive about ROM activities.³⁰ This case demonstrated that allowing the patient to perform self-knee flexion ROM versus PROM resulted in increased patient autonomy and may allow for reductions in anxiety and pain.

The participant’s pain and anxiety remained low throughout the acute phase of therapy, except for the session that was 4 days postoperation. During this session, her anxiety and pain increased to 6 or above on the Likert scales after the MBBSM and knee-bending interventions. This may be attributed to the proximity of the surgery and increased tissue inflammation and joint effusion typical after arthroscopic knee surgery. Interestingly, self-reported pain and anxiety increased slightly from baseline after the MBBSM; perhaps due to the proximity of the knee-bending activity itself. Although self-reported pain and anxiety increased, the participant reported that meditation helped calm her before starting knee-bending activities. Her self-reported pain, measured directly after knee-bending, increased from baseline. The pain would be expected to return to baseline shortly after cessation of knee-bending, but this was not measured in this report. A limitation of this case report is that pain is most significant during the knee-bending activity, but peak pain was not recorded, so the effect of MBBSM on peak pain is unknown. However, the participant described that knee-bending continued to be painful, even when performing the MBBSM before bending, but that the pain “was not as bad.” This is in line with the mindfulness pillar of nonjudgmental awareness; the participant was able to acknowledge the pain without assigning a negative emotion to the pain.

The participant’s mood remained positive throughout the first 6 weeks of care. The participant scored highest in the positive domain of vigor-activity at each time

point, even the day after surgery. Her total mood disturbance was low throughout the acute phase of rehabilitation, which contrasts with other sport injury rehabilitation literature.¹ However, the emergent profile, appears similar to the iceberg profile, which is commonly seen in successful athletes.¹⁸ There appears to be a relationship between her positive mood states and improvements in function, but the cause-and-effect relationship is unknown. Perhaps her overall positive mood throughout the rehabilitation period can be attributed to her successful recovery and return to sport following her first ACL-R less than 2 years ago. In her qualitative interview, when asked to compare this rehabilitation to her last course of care, she stated “...it feels not as bad, it is better than last time. I think it’s because I know what’s going on. I’m not, as like, not clueless, something like that.”

The treating therapist in this case report is a certified mindfulness sport performance enhancement instructor (<https://www.mindfulsportperformance.org/>) who also completed the full MBSR program as a participant. Although there are no formal published competencies for physical therapists using mindfulness with patients, the authors of this paper recommend that practitioners take formal training in mindfulness interventions before using this approach with their patients.

The participant made good progress both psychologically and physically in the acute phase of rehabilitation after ACL-R. She reported low levels of pain and anxiety and maintained a positive mood. Her physical function and knee flexion improved weekly, and she embraced using MBBSM in her treatment plan. She reported that she found the meditation helpful and enjoyable. The intervention also required minimal time, minimal training, and there was no added cost to include it in the plan of care.

Learning Points

- The APTA emphasizes the importance of evidence-based physical therapy practice²¹ and the use of psychologically informed physical therapy^{2,7} to help patients reach their goals. However, there is a scarcity of peer-reviewed published examples of tangible ways to help patients improve their movement while supporting their psychological well-being.
- This case report describes the feasibility and effectiveness of MBBSM on self-knee flexion ROM, physical function, and psychological well-being in an adolescent female during ACL-R rehabilitation. ■

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