CASE REPORT

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# Posterior Oblique Chain Activation and Load Management for Gluteal Tendinopathy in A Badminton Player – A Case Study

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## ABSTRACT

***Background:*** This case study aimed to assess the efficacy of posterior oblique chain activation combined with load management strategies in the rehabilitation of gluteal tendinopathy in a badminton player, focusing on improvements in functional recovery and pain reduction.

***Case Summary:*** A 36-year-old male Badminton player, experiencing chronic lateral hip pain for 3 months, was diagnosed with gluteal tendinopathy. The patient underwent a structured rehabilitation program over 8 weeks, with a rehabilitation protocol that focused on activating the posterior oblique chain to enhance kinetic chain stability, alongside a progressive load management plan to promote tissue healing and strength. Outcome measures included the Single-Leg Squat (SLS) test to evaluate balance and stability, as well as the Victorian Institute of Sport Assessment – Gluteal Tendinopathy (VISA-G) questionnaire for functional capacity, and the Numerical Pain Rating Scale (NPRS) for pain assessment. Outcome metrics were documented at the initial evaluation (week 0) and subsequently at week 16, corresponding to two months post-treatment conclusion.

***Results:*** After therapeutic interventions, at week 16, the FPPA was 6.7º, the pain score on the NPRS was 2/10, and the VISA-G Questionnaire score was 73/100. There was a marked increase in frontal plane stability, with a difference from baseline of 13.6º to 6.7º of FPPA at week 16, and a significant reduction in pain score (NPRS) from baseline, from 7 to 2 points. In terms of function and disability, there is a marked difference from baseline, as indicated by the 34 to 73 score on the VISA-G Questionnaire.

***Conclusion:*** The combination of posterior oblique chain activation, progressive load management, and targeted rehabilitation effectively reduced pain, improved functional capacity, and significantly enhanced dynamic stability in this case of gluteal tendinopathy. This provides valuable insight and paves the way for future research to design robust treatment protocols and refine evaluation methodologies.

***Keywords:*** Gluteal Tendinopathy, Posterior oblique chain, Load management, SLS Test, VISA-G.

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## INTRODUCTION

Gluteal tendinopathy, a leading cause of lateral hip pain, typically involves degeneration of the gluteus medius (GMed) and gluteus minimus (GMin) tendons at their insertion on the greater trochanter. Contrary to previous beliefs that inflammation is central to tendinopathies, recent research now suggests that mechanical overload, rather than inflammation, underlies the tendon degeneration observed in this condition. The pain arises when the tendons undergo high tensile and compressive forces, particularly during eccentric contractions at the full range of joint motion. Such contractions, where the muscle lengthens under load, are common in weight-bearing activities, such as walking or stair climbing, which intensify the strain and compress the tendons against the greater trochanter. This repetitive stress weakens the tendon structure, making it prone to pain and injury. These insights underscore the need for targeted treatment strategies that focus on load management and strengthening, rather than traditional anti-inflammatory approaches [1].

Gluteal tendinopathy, a prevalent issue affecting 10-20% of patients with hip pain, presents a substantial challenge in sports that require rapid direction changes and explosive movements, such as badminton [2]. This condition is particularly impactful, as it compromises power generation in lateral movements and undermines rotational stability, both of which are critical for optimal performance in badminton. In badminton, players rely on dynamic lateral sidestepping, crossover steps, and frequent lunging to maintain rapid movement across the court. Lunging, in particular, constitutes approximately 15% to 18% (17.86 ± 4.83%) of their movement patterns during singles play, making it an essential component of high-performance movement. The mechanics of a lunge are influenced by key physical attributes such as strength, flexibility, and leg length, which determine a player's ability to generate force and achieve stability while changing direction. Proper force modulation during lunging not only optimizes movement execution but also minimizes excessive impact forces that could predispose players to injuries [3,4]. The resulting reduction in force output and stability can significantly impair an athlete's agility and reactive capability, thereby hindering performance. Given the demands of badminton, effective management and prevention strategies for gluteal tendinopathy are crucial to maintaining athletic performance and minimizing injury risk.

The Posterior Oblique Sling (POS) is a crucial myofascial and muscular chain that underpins lumbopelvic stability during high-intensity and dynamic movements. This chain includes the latissimus dorsi, erector spinae, thoracolumbar fascia, contralateral gluteus maximus, and biceps femoris, working synergistically to create an integrated pathway for force transfer [5]. This network of structures forms a muscular synergy that effectively redistributes forces throughout the lumbopelvic region, which is particularly vital in activities involving rotational dynamics, single-leg support, or heavy loading, such as sprinting, leaping, and lunging. The connection between the latissimus dorsi on one side and the opposite gluteus maximus, linked through the thoracolumbar fascia, establishes a stabilizing mechanism that controls pelvic motion and enhances movement efficiency. This coordinated force distribution is essential for maintaining postural alignment and biomechanical stability during complex, high-demand tasks, significantly contributing to both athletic performance and injury prevention [6].

Tendons adapt to mechanical loading through a process known as mechanotransduction, in which they remodel and strengthen in response to the applied forces. However, both excessive loading without adequate recovery and insufficient loading can disrupt this adaptive mechanism, leading to tendinopathy. In cases of repetitive overloading, the tendon may enter a reactive tendinopathy phase, characterized by acute inflammation and cellular changes aimed at strengthening; however, if prolonged, this can lead to degeneration. Conversely, underloading or prolonged inactivity results in tendon deconditioning, where collagen structure deteriorates, leading to reduced stiffness and compromised functional capacity. A strategic load management program is therefore crucial for tendon rehabilitation, requiring a careful balance of rest, gradual load progression, and sport-specific movements. This approach promotes collagen realignment, enhances load tolerance, and promotes tendon resilience, thereby ensuring sustainable recovery and long-term tendon health [7,8].

### Case Presentation

Informed consent was obtained from the patient, and their rights were respected throughout the treatment process. The individual, a 36-year-old male badminton player, reported experiencing pain localized to the lateral aspect of his right hip that had persisted for three months. The patient is an active, competitive badminton player who trains for a minimum of 3 days per week and has been practicing for almost 10 years. Pain typically begins after engaging in specific activities, such as weight-bearing single-leg exercises and hip abduction movements. No complaints of lumbar pain, stiffness, swelling, paraesthesia, or numbness to lower limbs. The patient had no personal or familial history of systemic conditions such as epilepsy, diabetes, cancer, or hypertension. Prior interventions included LASER therapy, interferential therapy, and ultrasound therapy, which were administered approximately two and a half months earlier, and provided only transient symptom relief.

### Physical Examination

A comprehensive global and regional assessment was conducted, incorporating observation, palpation, range-of-motion (ROM) analysis, Oxford Manual Muscle Testing (MMT), and orthopaedic evaluations, including the Passive Adduction (ADD) Test, Resisted Isometric ADD Position, FABER Test, and 30-second Single Leg Stance Test [1]. Significant findings are summarized in Table 1. A detailed postural analysis was performed to detect any deformities, revealing normal pelvic alignment, lumbar lordosis, and bilateral hip positioning. Passive movements of the knee and ankle were pain-free, with muscle strength rated at 5/5 on the Oxford scale.

The hip joint was examined for both passive mobility and resistance testing. Passive hip extension demonstrated full range of motion (ROM), absence of pain, and a normal end feel. However, passive hip flexion elicited mild discomfort near the greater trochanter, despite a full range of motion (ROM) and normal end feel. Resisted hip abduction revealed localized pain over the greater trochanter region, rated at 7/10 on the Numerical Pain Rating Scale (NPRS), with muscle strength measured at 3+/5 on the Oxford scale.

**Table 1: Patient Findings under Physical Examination**

| Patient Physical Examination | Reported Findings |
|---|---|
| On Inspection of the Hip, Knee, and Ankle joint areas | Unremarkable |
| Thoraco-Lumbar Spine: ROM testing | Full and pain-free |
| Knee and Ankle ROM: Active and passive | Full and pain-free |
| Location of symptoms | Right Lateral Hip area, surrounding the greater trochanter |
| On Palpation | Pain reproduction when the area surrounding the right greater trochanter was palpated |
| NPRS | 7/10 |
| Strength | Hip Abductors and Extensors: 3+/5 on Oxford scale with pain<br>Knee and Ankle muscles: 4+/5 on Oxford scale without pain |
| Orthopaedic Tests | Passive Adduction Test is +ve<br>Resisted isometrics in the Adduction position are +ve<br>FABER test is -ve<br>FADER-R test is +ve<br>Single Leg Stance for 30's is +ve |
| FPPA in Single Leg Squat Test | 13.6º |
| VISA-G Questionnaire | 34/100 |

ROM = Range of Motion
NPRS = Numerical Pain Rating Scale
FABER = Flexion, Abduction and External Rotation
FADER-R = Flexion, Adduction, and External Rotation with Resistance
FPPA = Frontal Plane Projection Angle
VISA-G = Victorian Institute of Sport Assessment – Gluteal Tendinopathy

Drawing from the patient's history and the physical examination findings, the clinical presentation aligned with the diagnostic criteria for gluteal tendinopathy. This included tenderness upon palpation of the affected region, pain during tendon-loading activities, and a characteristic reduction in discomfort with continued movement, commonly referred to as the "warm-up phenomenon" [1]. Consequently, the patient was diagnosed with gluteal tendinopathy. During flare-ups, the patient described the pain intensity as 7/10 on the Numerical Rating Scale for Pain.

**Therapeutic Approach**

The treatment plan was implemented over a total span of 8 weeks, during which a supervised exercise program was conducted 5 times a week. This program consisted of Posterior Oblique Sling activation exercises. Load management was carefully tailored to the patient, with intensity adjusted based on their reported pain levels and any sensations of discomfort [9,10].

The Posterior Oblique Sling activation exercises involved Prone Hip Extension (PHE) with knee flexion 90° + hip extension 10° + hip abduction 30° and shoulder abduction 125° with 1kg loading (Fig. 1). Progressive sequence till patient get familiar with exercise as follows: Active PHE, then progressed to Active PHE with Shoulder 125º Abduction, then progressed to Active PHE with Shoulder 125º Abduction with 1kg loading. The above exercises, consisting of 2-3 sets of 5 repetitions (reps), were performed with 30-second holds in each rep [11].

**Figure 1: Active PHE with Shoulder 125º Abduction with 1kg loading**

Progressive Resisted exercises for Posterior Oblique Sling exercises been included to the treatment regime gradually with following exercises: Unilateral Hip Bridge Exercises (UHBE) (Fig.2), Bird Dog Exercises which are performed with 2-3 sets of 5 reps been performed with 30 Seconds hold in each rep and Lunge Rowing Exercise and Lunge diagonal cable rotation Exercises (Fig.3) which are performed with 2-3 sets of 10-12 reps been performed with 1-2 minutes rest between each set [9,10].

**Figure 2: Unilateral Hip Bridge Exercise (UHBE)**

**Figure 3: Lunge Diagonal Cable Rotation Progression**

Load management consists of Patient Education, low-load, low-velocity isometric exercises, and moderate and functional loading exercises. Patient education mainly emphasizes controlling high compressive and Tensile Loads in the form of precautions and advice. Patient been instructed to avoid the activities which irritates the hip like, refrain from crossing the legs while seated (hip adduction beyond the midline), maintaining prolonged weight-bearing on a single leg, and resting on the affected side, Avoid Stretching the Piriformis muscle and also hip adduction stretches which puts combined compressive and passive tensile load. For better hip alignment during sleep, the patient was encouraged to place a pillow between the knees to minimize excessive adduction of the uppermost hip and to rest predominantly on the non-affected side [12].

Isometric hip abduction exercises are performed at low intensity and slow speed in the following pattern: side-lying banded isometrics (hip positioned either in a neutral position or in a slightly abducted position with a pillow in between), Supine banded isometrics (Abductors), and standing banded isometrics (Abductors). All the isometric contractions were maintained for a duration of 45 to 60 seconds and repeated 4 times. Moderate and Functional loading exercises has been done in the following steps: Banded Clamshell exercises (starting in midrange and then progressed to progressed to Inner range), Squats and Single Leg Squats, Single leg banded Abduction exercises (both mobility and stability bias) and Eccentric loading with Standing single leg sliders (towel) [11-13].

**Outcome Measures and Results**

The Single-Leg Squat (SLS) test, Victorian Institute of Sports Assessment – Gluteal Tendinopathy (VISA-G) Questionnaire, and Numerical Pain Rating Scale (NPRS) have been used as Outcome measures in this study. Outcome measures included the SLS test to evaluate balance and stability, the VISA-G questionnaire for functional capacity, and the NPRS for pain. Outcome measures were assessed at the start of the study (week 0) and again at week 16 (2 months after the end of treatment) follow-up.

**Single-Leg Squat Test: The FPPA was determined during the Single-Leg Squat** assessment. Participants positioned their arms crossed over the front of their chest, ensuring unobstructed visibility of the pelvic-hip complex, and balanced on one leg while flexing the opposite leg to a 90° angle. Utilizing the stance leg, they performed a controlled descent into a squat, reaching 60° of knee flexion, and subsequently returned to full knee extension. Five repetitions of the SLS were conducted for each participant. A metronome app, set to 60 beats per minute, provided a consistent rhythm, instructing participants to descend over 5 seconds and rise back to standing within the same duration. No specific guidelines regarding squat mechanics were provided, except to maintain the non-supporting leg off the ground and avoid assistance from the upper limbs. The process was repeated with the non-dominant leg serving as the stance leg. A digital camera was stationed 2 meters in front of the participants to record their movements during the SLS trials. The camera's height was aligned approximately with the level of the participants' pelvis, as outlined by Stickler et al. (2015). Video footage was captured at a resolution of 800 × 600 pixels and a frame rate of 25 frames per second for detailed motion analysis [14,15].

**Victorian Institute of Sports Assessment – Gluteal Tendinopathy (VISA-G) Questionnaire:**

The VISA-G is an eight-item questionnaire designed using a graded response format. It evaluates key aspects, including pain levels, daily activities, physical performance, and challenges associated with weight-bearing tasks. The questionnaire yields a total score out of 100, reflecting the patient's perception of pain-related disability. Lower scores signify greater disability, while higher scores indicate minimal impairment. Questions 1 through 7 are each weighted between 0 and 10 points, whereas question 8 carries a weight of 0 to 30 points. If a participant selected multiple responses for any of the items (1–7) or for different parts of question 8, the lowest value among the responses was recorded, as per the guidelines outlined by Fearon et al. [16, 17].

**Numerical Pain Rating Scale:** Patients rate their pain intensity on a scale from 0 to 10, where 0 represents no pain and 10 signifies the worst imaginable pain [18]. In this study, the patient was instructed to rate their average, highest, and lowest pain levels both before and after the intervention. The NPRS has demonstrated a strong correlation with other validated pain assessment tools [19]. A two-point change is regarded as clinically meaningful [20].

Outcome measures were documented and analyzed at baseline (week 0) and again at week 16, corresponding to a follow-up two months after treatment completion.

At the initial assessment, the patient reported a pain intensity of 7/10 on the NPRS, an FPPA measurement of 13.6°, and a VISA-G score of 34/100. Following the therapeutic interventions, these parameters were reevaluated during the week-16 follow-up. The outcomes included a pain score of 2/10 on the NPRS, an FPPA measurement of 6.7°, and a VISA-G Questionnaire score of 73/100, as detailed in Table 2 and illustrated in Figures 4, 5, and 6.

**Table 2: Results at week-0 and week-16**

| | FPPA | Pain (NPRS) | VISA-G Questionnaire |
|---|---|---|---|
| Week 0 | 13.6° | 7/10 | 34/100 |
| Week 16 | 6.7° | 2/10 | 73/100 |

FPPA = Frontal Plane Projection Angle; NPRS = Numerical Pain Rating Scale; VISA-G = Victorian Institute of Sports Assessment – Gluteal Tendinopathy

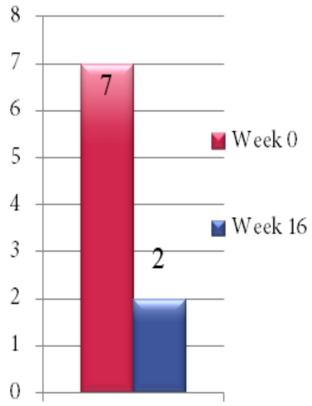



**Figure 4: NPRS**

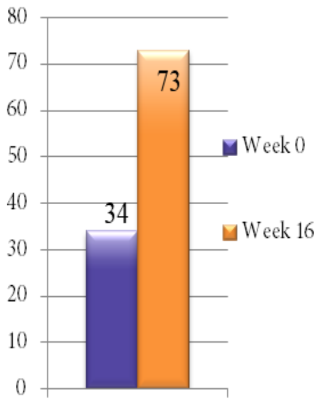
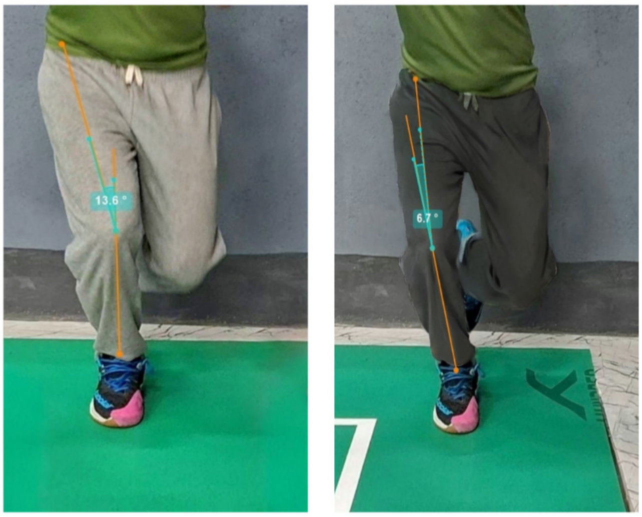



**Figure 5: VISA-G**



Week 0 of the treatment    Week 16 of the treatment

**Figure 6: Frontal Plane Projection Angle (FPPA) from the Single Leg Squat (SLS) Test.**

From baseline (Week 0), there was a marked reduction in FPPA from 13.6° to 6.7°, a marked reduction in pain score (NPRS) from 7/10 to 2/10, and a marked increase in functionality in the VISA-G Questionnaire from 34/100 to 73/100 at 16th week follow-up.

## DISCUSSION

This current study aims to investigate the impact of Posterior Oblique Chain (POC) activation exercises combined with load management strategies in addressing gluteal tendinopathy in a badminton player. To our knowledge, this is the first study to examine the FPPA in Gluteal Tendinopathy with POS exercises adjunct to load management. This case study also emphasizes the role of kinetic chain stability in rehabilitation by incorporating the POS activation and Progressive load management in treating Gluteal Tendinopathy.

The results of this case study demonstrate significant improvements across all outcome measures with the intervention, combining posterior oblique chain activation and load management for gluteal tendinopathy in a badminton player. The improvements in frontal plane projection angle (FPPA), pain levels (NPRS), and functional capacity (VISA-G) suggest that this comprehensive approach may be effective in managing gluteal tendinopathy in athletes involved in high-demand activities.

Biomechanical improvements, such as the reduction in FPPA from 13.6° to 6.7° during the Single-Leg Squat test, represent a substantial improvement in lower limb biomechanics. This finding aligns with research by Davor Vasiljevic et al. (2018), who suggested that FPPA values greater than 10° may indicate an increased risk of lower extremity dysfunction, particularly causing hip pain due to greater hip adduction and internal rotation [21]. This improvement is particularly relevant for badminton players, as proper lower limb alignment during rapid directional changes and lunging movements is crucial for both performance and injury prevention [4]. The reduction in FPPA may be explained by the enhanced gluteal muscle activation and timing, Improved load distribution through the posterior oblique chain, better core stability and control during dynamic movements, and enhanced proprioceptive awareness during single-leg loading tasks.

The improvement in VISA-G scores from 34/100 to 73/100 represents a substantial increase in functional capacity. This 39-point improvement exceeds the minimal detectable change (MDC) of 8 points reported by Fearon et al. (2015) for the VISA-G questionnaire [4]. The significant improvements observed indicate that the intervention effectively targeted both pain relief and functional recovery. By combining Posterior Oblique Chain activation with strategic load management, the approach successfully restored sport-specific capabilities. Additionally, the graduated return-to-activity protocol appeared well-suited for ensuring proper tissue loading and facilitating adaptation. These functional gains hold particular importance for badminton players, as the VISA-G questionnaire assesses activities directly related to their sport, including jumping, running, and rapid directional changes. This highlights the relevance and practicality of the intervention in addressing the unique demands of badminton performance.

These findings add to the growing body of evidence emphasizing the importance of addressing the entire kinetic chain in tendinopathy rehabilitation. They align with the research by Franettovich Smith et al. (2017), which highlighted altered muscle activation patterns in individuals with tendinopathy. This underscores the need for rehabilitation strategies that target both local issues and global movement patterns. This study makes a significant contribution, laying the foundation for the holistic approach employed in this case study. Our findings reinforce the notion that tendinopathy often involves impairments in muscle activation and coordination that extend beyond the affected tendon itself. This explains why the intervention in this case combined posterior oblique chain (POC) activation with strategic load management for gluteal tendinopathy, rather than isolating treatment to the gluteal region alone [22]. Additionally, a study by S. Almousa et al. (2023) provides compelling evidence that combining education with exercise yields greater pain relief and overall improvement compared to corticosteroid injections or no intervention within eight weeks. This supports the role of education and exercise as cornerstone treatments for managing gluteal tendinopathy [23]. An international survey by H.P. French et al. (2020), involving 361 physiotherapists across Australia, New Zealand, and Ireland, revealed that education paired with exercise is widely considered the first-line treatment for greater trochanteric pain syndrome (GTPS), in alignment with current evidence-based practice [24]. Furthermore, a consensus statement by Ashley Disantis et al. (2023) supports the role of load management in GTPS rehabilitation. The goal is to minimize excessive load and compression at the lateral hip. Their recommendations advocate starting with submaximal isometric exercises, which may have an analgesic effect by reducing cortical inhibition through the central nervous system. Progression to heavy-load and eccentric exercises is then guided by patient tolerance, offering a structured and individualized pathway to recovery [25].

A study by Christopher Clifford et al. (2019) highlights that both isometric and isotonic exercise programs are effective in alleviating pain and enhancing functional outcomes in individuals with greater trochanteric pain syndrome. Notably, the study found no significant difference in outcomes between the two exercise types after 12 weeks of progressive loading. This suggests that the specific type of loading—whether isometric or isotonic—might not be a decisive factor in the rehabilitation process. From a clinical perspective, both isometric and isotonic exercises can serve as valuable elements of a structured management plan for GTPS. The choice of exercise can be tailored based on the patient's preferences, comfort level, and specific rehabilitation goals. This personalized approach ensures comprehensive care that effectively addresses both pain relief and functional recovery [26]. Therapeutic interventions have shown significant promise in managing greater trochanteric pain syndrome. For instance, a recent study comparing extracorporeal shockwave therapy (ESWT) and ultrasound therapy demonstrated that both modalities effectively alleviated pain. However, ESWT provided greater pain relief at the 2-month and 6-month follow-ups. Interestingly, functional scores were comparable for both treatments across all follow-up intervals [27]. Another approach, dry needling, has also been explored for GTPS management. When evaluated against corticosteroid injections, corticosteroids initially showed superior improvements in pain and function at the 1- and 3-week follow-ups. By the 6-week mark, however, dry needling emerged as an equally effective alternative, proving noninferior in its ability to reduce pain and enhance function [28].

The results of this case study suggest several important clinical implications: The combination of posterior oblique chain activation and load management may be a practical approach for treating gluteal tendinopathy in athletes. Attention to the entire kinetic chain, particularly the posterior oblique system, may enhance outcomes in tendinopathy rehabilitation. Objective measures such as FPPA can provide valuable information about intervention effectiveness and guide progression. The 16-week intervention timeline appears appropriate for achieving meaningful improvements in both pain and function. While the results are promising, several limitations should be considered: As a single case study, the results may not be generalizable to all athletes with gluteal tendinopathy. The relative contributions of POC activation versus load management to the observed improvements cannot be determined. Long-term follow-up beyond 16 weeks would be valuable for assessing the sustainability of the improvements. Future research should emphasize larger sample sizes to validate these findings, investigate the optimal dosage and progression of POC activation exercises, examine the role of sport-specific factors in rehabilitation outcomes, consider the influence of training load on treatment response, and evaluate the long-term effectiveness of this approach.

## CONCLUSION

This case study demonstrates that a comprehensive rehabilitation program combining Posterior Oblique Chain (POC) activation and load management can lead to significant improvements in biomechanics, pain, and function in a badminton player with gluteal tendinopathy. The improvements across all outcome measures suggest that addressing both local and global movement patterns, while carefully managing load, may be a practical approach for athletes with gluteal tendinopathy. These findings contribute to the growing body of evidence supporting comprehensive rehabilitation approaches for tendinopathy in athletic populations.

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