



CASE STUDY: APPLICATION OF GROWTH FACTOR CONCENTRATION (GFC) IN THE PHYSIOTHERAPEUTIC MANAGEMENT OF A HAMSTRING INJURY IN A T47 PARA-ATHLETE

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Abstract

Background: Hamstring injuries are common among athletes and can be particularly challenging to manage in para-athletes with underlying medical conditions. Thalassaemia minor may influence tissue healing, necessitating specialized approaches in rehabilitation.

Aim: To evaluate the effectiveness of Growth Factor Concentration (GFC) therapy as a complementary intervention in the physiotherapeutic management of a hamstring injury in a T47 para-athlete with thalassaemia minor.

Methodology: This case study involved a 31-year-old female T47 para-athlete diagnosed with a semitendinosus tear confirmed via ultrasound. Initial conservative treatment showed limited improvement. GFC therapy was introduced alongside a structured physiotherapy regimen. Functional and clinical assessments were conducted before and after treatment, including range of motion tests, manual muscle testing, pain scales, and balance evaluation.

Results: Post-treatment results demonstrated significant improvement: hamstring strength improved from Grade 3/5 to 5/5, pain reduced from 8/10 to 1/10, and flexibility and stability were fully restored. The athlete returned to sport-specific activity without recurrence of symptoms.

Conclusion therapy, when combined with targeted physiotherapy, significantly enhanced the healing process and functional recovery in a para-athlete with complex clinical considerations. It may be considered a viable adjunct in sports rehabilitation protocols, particularly for cases with compromised healing potential.

Keywords: Hamstring strain, para-athlete, Growth Factor Concentration, thalassaemia minor, physiotherapy, soft tissue injury, sports rehabilitation

I. INTRODUCTION

Hamstring injuries are among the most prevalent musculoskeletal injuries in athletic populations, often leading to significant downtime, impaired performance, and a high risk of recurrence. Hamstring injuries result in an average time loss of 24 days (1). In the anatomical distribution of hamstring muscle group injuries, the biceps femoris was found to be the most commonly affected, accounting for approximately 53% of cases. Injuries to the semitendinosus occurred in 16% of cases, while the semimembranosus was involved in 13% of cases (7). These injuries, commonly resulting from high-speed running, overstretching, or sudden eccentric loading, pose a considerable challenge to physiotherapists working in sports rehabilitation. Effective management not only requires accurate assessment and tailored rehabilitation but also the integration of

advanced therapeutic modalities to accelerate healing and restore optimal function. One such advanced modality is Growth Factor Concentrate (GFC) Therapy, a cutting-edge, non-surgical treatment designed to repair and rejuvenate musculoskeletal tissues. GFC Therapy harnesses the body's natural healing mechanisms by concentrating growth factors—such as Platelet-Derived Growth Factor (PDGF), Transforming Growth Factor-beta (TGF- β), and Vascular Endothelial Growth Factor (VEGF)—from the patient's own blood (16,17). These concentrated growth factors are then injected into the injury site, promoting tissue regeneration, reducing inflammation, and enhancing recovery.

Compared to traditional Platelet-Rich Plasma (PRP) treatments, GFC Therapy offers a higher concentration of growth factors, potentially leading to more effective healing outcomes. Its autologous nature minimizes the risk of allergic reactions or infections, making it a safe and efficient option for managing sports-related injuries. Incorporating GFC Therapy into rehabilitation programs can significantly enhance the healing process, particularly for athletes aiming for a swift return to peak performance. By leveraging the body's intrinsic regenerative capabilities, GFC Therapy represents a promising advancement in the field of sports medicine (18,20).

HAMSTRING ANATOMY AND FUNCTION

The ischial tuberosity is a large, rounded projection located on the lower back part of the ischium, a component of the pelvic bone, and serves as the origin point for several strong muscle groups (4). The semimembranosus (SMB), long head of the biceps femoris (LHBF), and semitendinosus (ST) muscles—collectively comprising the hamstring muscle group (5)—muscles partially twisted around one another and interconnected through shared fibrous adhesions. The ST and BF contribute to a common musculotendinous head, with the ST providing the majority of fascicular input. These muscles exhibit a complex anatomical arrangement, with the ST and LHBF sharing a common tendinous origin on the medial facet of the ischial tuberosity, while the SM originates separately from the lateral facet (11). These ST fascicles extend approximately 9 cm distally from the ischial tuberosity and insert into the common tendon at a pronounced pennation angle—a feature that significantly affects the biomechanical load distribution (6). This intricate structural organization poses challenges in imaging diagnostics, particularly concerning proximal LHBF strains. The overlapping nature of these muscles and their tendinous connections can lead to misclassification or overdiagnosis of injuries if imaging resolution is inadequate or if there's a lack of understanding of the underlying anatomy.

In contrast, the initial BF fascicles begin originating from the common tendon only at around 6 cm from the ischial tuberosity, underscoring the asymmetrical contribution and arrangement of these muscles (6). This structural complexity has been proposed to contribute to diagnostic challenges in imaging, particularly in the context of proximal BF strains, which may often be misclassified or over diagnosed due to inadequate resolution or misunderstanding of the underlying anatomy (6). Understanding these anatomical nuances is crucial for accurate diagnosis and effective management of hamstring injuries. Advanced imaging techniques, such as high-resolution MRI, can aid in differentiating between the individual muscles and their respective tendons, thereby improving diagnostic accuracy and informing appropriate treatment strategies.

INJURIES MECHANISM AND TYPES

Muscle injuries represent a heterogeneous category, encompassing various types of tissue damage and often involving ambiguous terminology. Traditionally, these injuries have been broadly grouped into three categories: delayed-onset muscle soreness (DOMS), strains (or distraction injuries), and contusions (or compression injuries) (2,3). The typical mechanism of hamstring injuries is an eccentric muscle contraction accompanied by forced hyperflexion of the hip and extension of the knee (12). Patients often report a “popping” sensation when sustaining this injury (13). However, with advances in diagnostic and clinical understanding, more detailed classifications have been proposed. Functional injuries refer to minor, non-visible damage, typically resulting from fatigue-related or neurogenic factors, leading to muscle stiffness or tightness without actual fibre rupture (2). Functional assessments of knee flexion torque indicate that extending the knee joint elevates the risk of hamstring muscle strain, as maximal knee flexion torque is generated in this position. This risk is particularly pronounced in the long head of the biceps femoris (BF-L) and the semimembranosus (SM) muscles when the knee is fully extended (10).

Electromyographic (EMG) analyses, normalized to the physiological cross-sectional area (PCSA), provide further insight into muscle strain susceptibility. In high-risk muscles such as BF-L and SM, the EMG activity per Physiological Cross-Sectional Area (PCSA) was approximately 1.6 times greater in BF-L compared to SM, indicating a higher strain risk in BF-L.

These findings align with biomechanical studies demonstrating that during sprinting, particularly in the late swing phase, the hamstrings are subjected to significant lengthening and loading, increasing the likelihood of strain injuries. (8).

The unique anatomical features of the BF-L, including its short fascicle length and narrow proximal aponeurosis, may contribute to its increased vulnerability to strain injuries. (9)

In summary, the combination of functional torque data, EMG activity normalized to muscle size, and anatomical characteristics underscores the heightened risk of strain injuries in the BF-L, especially during activities involving knee extension.

While proximal hamstring injuries are commonly observed, the distal segments, particularly the distal semitendinosus (ST), are also susceptible to injury through distinct mechanisms. During high-speed running, the hamstrings are subjected to significant eccentric loading, especially in the late swing phase of the gait cycle. This phase involves the hamstrings actively lengthening to decelerate knee extension and prepare for foot contact. The transition from this eccentric contraction to a concentric contraction, as the muscles initiate hip extension and knee flexion, occurs when the muscles are near their peak length, rendering them particularly vulnerable to strain injuries (14).

The distal ST is especially at risk due to its anatomical positioning, spanning both the hip and knee joints, which move in opposing directions during dynamic activities. This biarticular arrangement subjects the distal ST to high tensile forces during simultaneous hip flexion and knee extension, common in sprinting and activities involving rapid acceleration and deceleration (15).

Understanding these injury mechanisms is crucial for developing effective prevention and rehabilitation strategies. Incorporating eccentric strengthening exercises and neuromuscular training that mimic the specific demands of high-speed running can enhance the resilience of the distal hamstring muscles, potentially reducing the incidence of such injuries.

METHODOLOGY

SUBJECT

This study presents the case of a 31-year-old female para-athlete classified under the T47 category. The athlete reported persistent pain in her lower hamstring region following a long jump training session. Initial clinical evaluation and imaging at Indira Gandhi Hospital confirmed a tear in the semitendinosus muscle of the hamstring.

The athlete has a known medical history of thalassaemia minor, a condition that may influence her healing response. Conservative management, including rest and cryotherapy, was initially recommended. However, after two weeks, the pain persisted and a follow-up ultrasound suggested a hamstring strain rather than a complete tear. Given the limited response to conventional therapy and the influence of her underlying condition, the treating physician recommended the use of Growth Factor Concentration (GFC) therapy.

This case study explores the integration of GFC treatment in the management plan, detailing the pre-treatment status, therapeutic interventions, and recovery outcomes. Emphasis is placed on the specific challenges faced due to her para-athlete classification and thalassaemia minor, as well as the comparative effectiveness of GFC over traditional modalities in promoting tissue repair and functional recovery.

Table 1: Demographic Data of the Patient

Characteristics	Values
Age	31 years
Gender	Female
Height	162 cm
Weight	58 kg
BMI	22.10

(BMI: Body Mass Index)

CLINICAL BACKGROUND

Hamstring injuries are prevalent among athletes, particularly those engaged in explosive activities such as sprinting and jumping. The semitendinosus, part of the medial hamstring group, plays a vital role in hip extension and knee flexion—movements essential to long jump performance. In this case, the athlete experienced a sharp pain in the posterior thigh during take-off, immediately followed by reduced strength and limited range of motion.

Upon clinical assessment and musculoskeletal ultrasound imaging at Indira Gandhi Hospital, a partial tear of the semitendinosus muscle was confirmed. The initial diagnosis led to conservative treatment protocols,

including cryotherapy, rest, and pain management strategies. However, due to persistent symptoms and the athlete's underlying condition of thalassaemia minor, which may impact oxygen delivery and tissue regeneration, her progress was slower than expected.

LIMITATIONS OF CONVENTIONAL TREATMENT

Despite the application of standard physiotherapy practices during the first two weeks post-injury, including:

- Cryotherapy (3x/day)
- Compression and elevation
- Therapeutic ultrasound
- Gradual isometric exercises

the athlete reported ongoing discomfort, especially during weight-bearing and passive stretching of the hamstring. Follow-up imaging identified sustained soft tissue inflammation and insufficient tissue repair. This suggested a need for a regenerative intervention, especially considering the athlete's aspiration to return to competition as soon as safely possible.

PRE-ASSESSMENT

Prior to the initiation of Growth Factor Concentration (GFC) therapy, a comprehensive clinical and diagnostic assessment was conducted. The patient, a 31-year-old female para-athlete classified under the T47 category, reported a sharp, localized pain in the lower posterior thigh sustained during a long jump training session. Her medical history included thalassaemia minor, a condition known to potentially impact tissue healing and recovery. On physical examination, tenderness was noted over the distal portion of the semitendinosus muscle, with visible discomfort during palpation and passive stretching.

Range of motion in the affected limb was significantly restricted, with knee flexion limited beyond 90 degrees and hip extension producing discomfort. Manual muscle testing revealed reduced strength in the hamstring (grade 3/5) on the injured side, while quadriceps strength remained relatively preserved. Functionally, the athlete was unable to perform high-demand tasks such as bounding, stair climbing, or single-leg stance on the affected limb without pain. Passive straight leg raise was limited to approximately 40 degrees compared to 80 degrees on the unaffected side.

Initial ultrasound imaging confirmed a partial tear of the semitendinosus muscle with localized enema, but no evidence of full-thickness rupture or avulsion. A follow-up scan conducted two weeks post-injury showed minimal signs of healing and persistent muscle strain, suggesting a delayed regenerative response likely influenced by her thalassaemia minor. Pain was reported as 3/10 at rest and up to 7–8/10 during activity, palpation, or stretching. Due to these findings and the limited progress following conservative treatment, the decision was made to proceed with GFC therapy to enhance tissue repair and facilitate a faster return to sport.

TABLE 2: Special Test (Pre)

Special Test	Purpose	Result
90/90 Straight Leg Raise Test	Assess hamstring flexibility	Positive (pain and tightness at ~40°)
Passive Straight Leg Raise (SLR)	Assess hamstring length and neural tension	Limited to 40° (affected side); 80° (unaffected side)
Resisted Hamstring Curl	Assess strength and pain response	Weak and painful (Grade 3/5)
Thompson Test	Rule out Achilles tendon rupture (screening)	Negative
Single Leg Stance (on affected side)	Assess balance and pain tolerance	Positive for pain and instability
Palpation over Semitendinosus	Identify site-specific tenderness and tear	Tenderness noted (distal portion)

REHABILITATION PROTOCOL

Weekly Breakdown (Pre- and Post-GFC Treatment)

1. Week 0 (Initial Injury Phase – Pre-GFC)

Focus: Pain control, inflammation reduction, protection of injured tissue Therapy:

- Cryotherapy (3x/day)
- Compression and elevation
- Rest from high-impact activity
- Isometric quadriceps and glute activation
- Gentle passive range of motion (ROM) within pain-free limits
- Non-weight-bearing mobility drills (e.g., heel slides, ankle pumps)

Week 1 (GFC Session 1)

Focus: Introduction of GFC therapy, maintain joint mobility, initiate early muscle activation

Therapy:

- First GFC injection under ultrasound guidance
- Continue cryotherapy as needed
- Gentle active-assisted ROM exercises for the knee and hip
- Isometric hamstring contractions (low intensity)
- Core stabilization and pelvic control exercises

Week 2 (post-GFC)

Focus: Build early strength and begin neuromuscular control

Therapy:

- Ultrasound Therapy
- Eccentric loading initiated (under supervision)
- Proprioception drills (e.g., single-leg stance on stable surface)
- Hydrotherapy for low-impact movement
- Light resistance hamstring strengthening (e.g., bridging with resistance band)

Week 3 (post-GFC)

Focus: Progressive loading, enhance flexibility and coordination

Therapy:

- Dynamic stretching and full ROM exercises
- Eccentric hamstring strengthening using body weight
- Balance and coordination work on unstable surfaces
- Introduction of treadmill walking (slow speed)
- Functional movement patterns (e.g., squats, lunges without load)

Week 4 (post-GFC)

Focus: Transition to sport-specific strength and endurance

Therapy:

- Resistance training with light external loads
- Plyometric prep drills (mini hops, low-level bounding)
- Lateral movement training
- Isokinetic hamstring testing for strength comparison
- Core and hip strengthening with added resistance
- Running mechanics and posture drills

Week 5–6 (Return-to-Sport Phase)

Focus: High-level function, confidence building, final performance testing

Therapy:

- Full-intensity plyometrics and bounding
- Acceleration drills and deceleration control
- Sport-specific agility drills (long jump simulations)
- Gradual reintroduction to full training volume

- Return-to-sport clearance based on strength, pain-free function

POST-ASSESSMENT

Following the completion of three sessions of Growth Factor Concentration (GFC) therapy administered over three consecutive weeks—alongside a structured physiotherapy protocol—the athlete demonstrated significant clinical improvement. Pain levels decreased notably, with Visual Analog Scale (VAS) scores reducing to 1/10 at rest and 2–3/10 during high-intensity movements. Palpation of the semitendinosus muscle no longer elicited pain, and there was a complete resolution of tenderness and swelling.

Range of motion in the affected limb returned to normal, with full, pain-free knee flexion and hip extension achieved. Manual muscle testing showed hamstring strength had improved to grade 5/5, equivalent to the unaffected side. Functional tests indicated strong recovery; the athlete was able to perform single-leg stance, bounding drills, and stair climbing without difficulty or discomfort. Passive straight leg raise reached 80 degrees, matching the uninjured side.

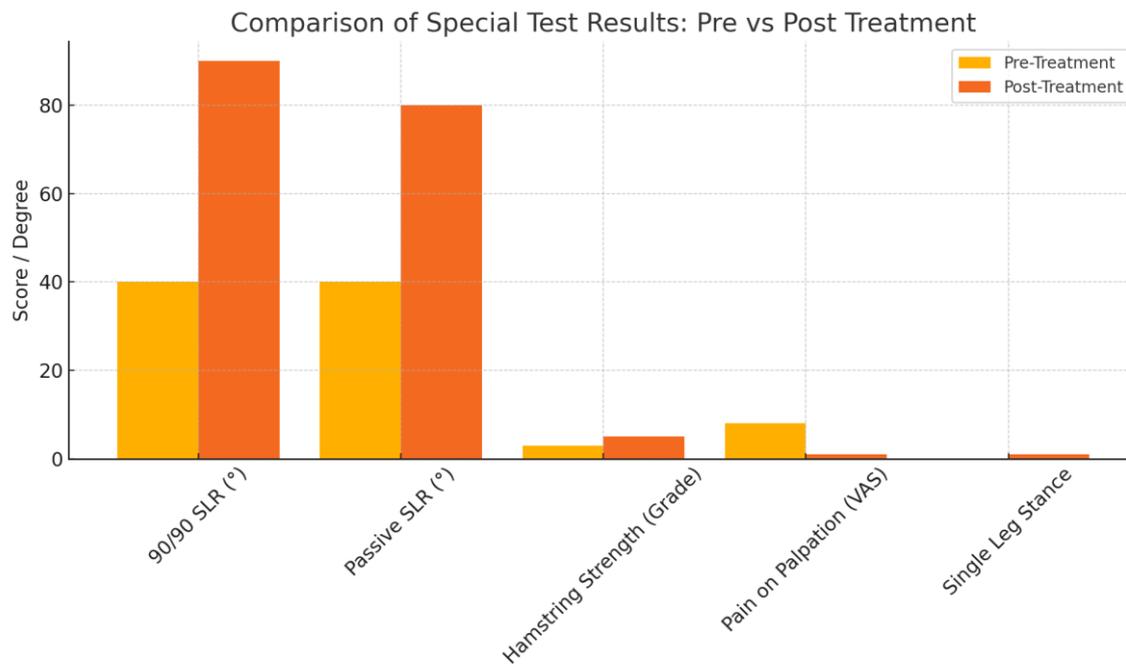
A follow-up ultrasound scan confirmed notable healing in the previously injured semitendinosus muscle, with resolution of edema and no residual signs of strain or tear. The muscle fibres showed signs of regeneration and reorganization, indicating effective tissue remodelling. Proprioception and neuromuscular control were restored, and the athlete demonstrated full confidence in her performance during sport-specific drills. She was subsequently cleared to return to competitive training under guided supervision. The post-assessment results reflected the effectiveness of GFC therapy in accelerating recovery and restoring optimal function in an athlete with a previously delayed healing profile.

RESULT

TABLE 3: Comparison of Special Test Results: Pre- and Post-Treatment

Special Test	Pre-Treatment Result	Post-Treatment Result
90/90 Straight Leg Raise	Pain and tightness at ~40°	Full range with no pain
Passive Straight Leg Raise (SLR)	Limited to 40°	80°; symmetrical with unaffected side
Hamstring Strength (MMT)	Grade 3/5	Grade 5/5
Pain on Palpation (VAS)	8/10	1/10
Single Leg Stance	Unable; painful and unstable	Stable and pain-free

The comparative table highlights significant improvements following GFC therapy. Hamstring flexibility increased, with the 90/90 and passive straight leg raise tests showing restored range of motion. Muscle strength improved from Grade 3/5 to 5/5, and pain levels reduced drastically from 8/10 to 1/10. Functional tests, such as the single leg stance, which were initially painful and unstable, became stable and pain-free post-treatment. These results demonstrate the effectiveness of GFC in enhancing recovery and restoring functional capacity in the athlete.

GRAPH 1: Visual Comparison of Special Test Results

The graph visually demonstrates a clear improvement in all measured parameters post-treatment. Range of motion and muscle strength increased significantly, while pain levels and functional limitations decreased. This indicates successful rehabilitation and the positive impact of GFC therapy on the athlete's hamstring recovery.

DISCUSSION

This case study highlights the clinical effectiveness of Growth Factor Concentration (GFC) therapy in the rehabilitation of a hamstring injury in a T47 para-athlete with thalassaemia minor. Traditional conservative management, including cryotherapy and rest, showed limited progress in the initial two weeks. The delayed tissue response, possibly influenced by the athlete's underlying thalassaemia minor, necessitated an advanced regenerative approach.

Following the initiation of GFC therapy, the athlete exhibited marked improvements in pain reduction, muscle strength, flexibility, and functional performance (17,19). These outcomes suggest that GFC played a critical role in accelerating tissue healing and neuromuscular recovery. The enhanced regeneration may be attributed to the concentrated bioactive factors in GFC, which are known to promote cellular repair, reduce inflammation, and improve vascularization in injured tissues (19).

Moreover, the integration of physiotherapy alongside GFC optimized functional outcomes and ensured a safe return to sport. The combination of evidence-based rehabilitation and regenerative medicine proved to be particularly beneficial in this case, especially given the physiological complexities associated with para-athletes and individuals with blood-related conditions.

Overall, this case underscores the potential value of GFC therapy as an adjunct to physiotherapy in managing soft tissue injuries, particularly in athletes with delayed or impaired healing profiles (20).

The application of Growth Factor Concentration (GFC) therapy, in conjunction with physiotherapy, proved to be an effective treatment modality for managing a hamstring strain in a T47 para-athlete with thalassaemia minor. The athlete demonstrated significant improvements in pain reduction, muscle strength, range of motion, and functional performance. This case supports the use of GFC as a valuable adjunct in physiotherapeutic rehabilitation, especially for athletes with conditions that may compromise natural healing. Early integration of regenerative techniques like GFC may enhance recovery timelines and facilitate a safe return to sport.

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