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Impact of Hamstring Tendon Graft on Hamstring Length Shortening and Its Influence on Post-Rehabilitation Functional Recovery After ACL Reconstruction: A Case Report

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Introduction

Anterior cruciate ligament (ACL) reconstruction is among the most common surgical procedures performed in sports medicine to restore knee stability and functional performance after ligament rupture [1, 2]. The hamstring tendon autograft is widely used because it provides strong fixation, fewer anterior knee complications, and good long-term outcomes compared with patellar tendon grafts [3, 4]. However, the harvest of the semitendinosus and gracilis tendons creates donor-site deficits that can influence postoperative recovery [5, 6].

Several studies have demonstrated loss of hamstring muscle length, reduced fascicle size, and decreased strength following tendon harvest [7-9]. The incomplete regeneration of the harvested tendons can lead to shortening of the hamstring muscle–tendon unit, altering its length-tension relationship and affecting functional performance [10, 11]. This shortening is often not specifically evaluated or addressed during rehabilitation. When progressive eccentric lengthening exercises are omitted, persistent tightness and reduced force generation may occur, resulting in asymmetry and poor return-to-sport outcomes [12-14].

Functional strength asymmetry after ACL reconstruction has been strongly associated with lower-limb kinetic imbalances, impaired power restoration, and increased risk of secondary injuries [15-17]. In particular, chronic hamstring tightness and strength deficits can produce compensatory loading on the ankle and hip, predisposing athletes to distal kinetic-chain problems [18, 19].

The present case report highlights how hamstring tendon graft harvesting and the lack of targeted length-restoration rehabilitation contributed to persistent functional deficits and distal joint overload in a recreational football player. The case proposes that tendon shortening secondary to graft harvesting can be a significant yet under-recognized contributor to post-rehabilitation functional limitations, emphasizing the need for individualized follow-up and eccentric lengthening-based rehabilitation strategies [20].

Case Description

A 32-year-old male recreational football player presented with persistent right-sided hamstring tightness, reduced power during sport participation, and recurrent ankle sprains, one year after anterior cruciate ligament (ACL) reconstruction. The injury occurred during a non-contact pivot while playing football in December 2023. He underwent ACL reconstruction using a hamstring tendon autograft (semitendinosus and gracilis) harvested from the right leg. The postoperative rehabilitation program included six months of supervised physiotherapy focusing on early range-of-motion recovery, progressive closed-chain strengthening, and proprioceptive training [1, 2].

After six months, the patient discontinued supervised sessions and continued unsupervised home exercises. Despite subjective improvement, he resumed football prematurely without structured late-phase or eccentric rehabilitation. Within weeks, he experienced tightness along the

posterior thigh after play, decreased sprint capacity, and occasional right ankle instability episodes. These complaints gradually worsened, prompting reassessment at our clinic in September 2024.

Objective evaluation revealed a functional leg-length discrepancy (LLD) of approximately 2 cm on the operated side, mild atrophy of the medial hamstring, and visible reduction in tendon bulk. Passive straight-leg-raise and active knee-flexion range were slightly restricted compared with the contralateral side.

Strength assessment using a handheld dynamometer at 60° knee flexion showed:

- Quadriceps (Right 20.2 kg, Left 22.8 kg)
- Hamstrings (Right 15.4 kg, Left 18.0 kg)

Indicating bilateral weakness with a greater deficit on the reconstructed limb and a hamstring-to-quadriceps ratio (H:Q) of 0.76 on the right compared with 0.79 on the left [3, 4].

Functional testing further demonstrated asymmetry. The single-leg hop test averaged 70.1 cm on the right and 129 cm on the left, exceeding the clinically accepted 10% deficit threshold for safe return to sport [5, 6]. The Star Excursion Balance Test (SEBT) reach distances were also reduced on the operated side (Anterior 56 cm; Posteromedial 80 cm; Posterolateral 70 cm) compared with the unaffected limb (65 cm, 88 cm, 74 cm respectively) [7, 8].

During sport-specific movements such as acceleration, kicking, and single-leg landing, increased ankle plantar-flexion and pronation moments were observed, indicating distal kinetic-chain compensation for deficient hamstring power [9, 10]. No graft failure or knee instability was noted on clinical testing (Lachman, pivot-shift). The findings collectively suggested that hamstring tendon shortening secondary to graft harvest, combined with incomplete eccentric length-restoration rehabilitation, contributed to the observed functional deficits and compensatory ankle loading [11, 12].

Discussion

The present case demonstrates how hamstring tendon graft harvesting, when combined with incomplete length-restoration rehabilitation, can lead to residual hamstring shortening, functional asymmetry, and distal kinetic-chain compensation following ACL reconstruction. Although hamstring grafts are widely used due to their high tensile strength and reduced anterior knee pain, donor-site morbidity remains an under-recognized issue [1, 2].

Studies have shown that harvesting the semitendinosus and gracilis tendons results in loss of muscle cross-sectional area, reduced fascicle length, and incomplete regeneration [3-5]. Eriksson et al. reported that the semitendinosus muscle may remain shortened by 10–15 % even after one year post-harvest [6]. This structural shortening modifies the hamstring's length-tension relationship, leading to decreased eccentric strength and altered neuromuscular control [7, 8]. The resulting tightness and reduced power generation are consistent with the findings in this case — lower single-leg hop performance, reduced SEBT reach, and compensatory ankle loading.

When rehabilitation focuses mainly on concentric strengthening and neglects eccentric lengthening work, the muscle–tendon unit remains mechanically shortened [9, 10]. Eccentric training promotes sarcomere addition, fascicle elongation, and improved muscle stiffness regulation — key adaptations for restoring optimal hamstring function [11, 12]. Opar et al. demonstrated that eccentric-based assessments such as the Nordic Hamstring Exercise can identify deficits that persist even after standard strength restoration [13]. Cuthbert et al. further confirmed that eccentric loading increases fascicle length and reduces recurrent tightness, reinforcing the need for targeted eccentric strategies in late-phase ACL rehabilitation [14].

The functional leg-length discrepancy (~2 cm) observed in this case likely represents a functional outcome of donor-site shortening rather than a true skeletal inequality. Shortened hamstrings restrict hip extension and knee flexion synergy, effectively reducing stride length and contributing to apparent limb asymmetry [15, 16]. Such asymmetry is clinically relevant: Thomas et al. found that deficits in lower-limb power after ACL reconstruction correlate with poorer performance and higher reinjury risk [17].

In this athlete, increased ankle involvement during dynamic activities likely reflects a kinetic-chain adaptation to compensate for reduced knee and hamstring contribution. This phenomenon aligns with Hewett et al., who demonstrated that proximal weakness or altered activation patterns at the knee can shift mechanical load to distal joints, elevating ankle and hip injury risk [18]. The recurrent ankle sprains observed support this compensatory mechanism.

Clinically, this case emphasizes the importance of early identification and correction of hamstring length deficits after graft harvest. Routine assessments of hamstring flexibility, fascicle length (via manual or imaging methods), and side-to-side comparison should be integrated into follow-up evaluations. Rehabilitation must include progressive eccentric lengthening and neuromuscular re-education to re-establish optimal length-tension characteristics [19].

Finally, the case introduces a novel clinical insight: each graft type has its own biomechanical consequence, and for hamstring tendon grafts, donor-site shortening is the predominant challenge. Addressing this specific adaptation through individualized, length-restoration-oriented rehabilitation could prevent chronic tightness, improve functional symmetry, and enhance return-to-sport success [20].

Conclusion

This case illustrates that **hamstring tendon graft harvesting** can produce **residual tendon shortening** and **functional asymmetry** if post-operative rehabilitation does not specifically target length restoration. The resultant shortening affects the **hamstring's length-tension relationship**, contributing to **power deficits, apparent leg-length discrepancy, and distal kinetic-chain overload** despite an intact graft and stable knee. Clinicians should routinely assess hamstring length recovery and integrate progressive **eccentric lengthening exercises** and **neuromuscular retraining** into late-phase rehabilitation. Recognizing donor-site shortening as a key limitation of hamstring grafts can help optimize return-to-sport outcomes.

Building on this observation, future research by the authors will focus on developing and validating a **structured eccentric lengthening protocol** for hamstring graft ACL reconstruction patients to enhance functional recovery and symmetry.

Conflict of Interest

The authors declare that there is no conflict of interest related to this case report.

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Ethical Considerations

Written informed consent was obtained from the patient for publication of this case report and associated clinical information. This case was conducted in accordance with the principles of the Declaration of Helsinki (2013 revision).

Author Contributions

- Ram Kumar .E – Concept development, data collection, clinical assessment, and manuscript preparation.
- Suvathi .R – Scientific review, clinical interpretation, and critical editing.
- Arthi .J – Clinical assistance and data interpretation.

All authors read and approved the final manuscript.

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