

Case Reports

A Novel Dynamic Ultrasound Assessment of T-Junction Hamstring Injury during Gym-Based Exercises: A Case Report in an Elite Football Player

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Background

“T-Junction” or distal musculotendinous junction (DMTJ) hamstring injuries have become a true enigma for clinicians as demonstrated by the high recurrence rate. Magnetic Resonance Imaging (MRI) can sometimes fail to provide an accurate assessment of these injuries, probably because of the dynamic function that this structure provides to offer stability at the synchronous movement of the two heads of biceps femoris. The aim of the present case report was to describe a novel method for dynamic ultrasound evaluation of the DMTJ performed during functional loading exercises and to explore its potential role in return-to-play (RTP) decision-making.

Study design

Case Report

Case description

A 23-year-old male elite football player sustained a DMTJ injury. MRI revealed a complete rupture of the superficial portion (myotendinous) and the deep portion (myoaponeurotic) of the T-Junction. The injury occurred initially during high speed non-linear running action.

The initial diagnosis was made using a 3T MRI scan. Subsequently, three dynamic ultrasound evaluations were performed at weeks 3, 6 and 9 during two different gym-based exercises: the single-leg barbell Romanian deadlift and the single-leg hamstrings slider with ipsilateral trunk rotation. Additional 3Tesla MRIs were conducted to assess healing and structural changes at weeks 5, 8 and 14.

Outcomes

The player returned to competitive activity 10 weeks after the injury and experienced no re-injury during the subsequent 4-month follow-up period. Improvements in the synchronous movement between BF_{lh} and BF_{sh} were seen on the progressive evaluations as well as the scar healing progression. Dynamic ultrasound assessment during the SL-RDL appeared to provide clearer visualization of interhead hamstring movement than during the slider exercise. Further investigation in larger cohorts is warranted to

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establish the reliability, validity, and prognostic utility of this novel assessment modality for athletes with this injury.

Conclusions

In this single case, dynamic ultrasound of the DMTJ provided valuable information regarding interhead synchrony of the biceps femoris. This approach may complement MRI and support informed return to play decision-making following T-Junction hamstring injuries.

Level of Evidence

5

INTRODUCTION

Hamstring injuries involving the so-called “T-junction” or distal musculotendinous junction (DMTJ) remain a true enigma for clinicians in sports medicine, as demonstrated by recurrence rates reported to be as high as 54%.¹ The challenge in managing these injuries arises from the complex anatomy of this structure, the high inter-individual anatomical variability, and the different innervations of the biceps femoris long head (sciatic nerve) and short head (peroneal nerve), which can lead to asynchronous movement of the two heads and place significant mechanical stress on the DMTJ.^{2,3} Magnetic Resonance Imaging (MRI) is the gold standard for muscle injuries assessment but may sometimes underestimate DMTJ injuries. For instance, Kayani et al. reported a 35% discrepancy rate between MRI and intraoperative findings.⁴ The static nature of MRI may limit its ability to assess structures such as the DMTJ, which demonstrates its true functional relevance under dynamic conditions, where it must manage the opposite force vectors generated by the two heads of the biceps femoris.^{1,3} Dynamic ultrasound has been proposed as a complementary tool to detect dissociative movement between the two heads of biceps femoris, although assessments in previous work were performed only during isometric knee flexion and not under functional multi-joint loading conditions.⁵ The aim of the present case report was to describe a novel method for dynamic ultrasound evaluation of the DMTJ performed during functional loading exercises and to explore its potential role in return-to-play (RTP) decision-making.

CASE DESCRIPTION

A 23-year-old male elite football (soccer) player sustained a DMTJ injury. The athlete’s pre-injury characteristics were as follows: height 190 cm; body mass 100 kg; sum of six skinfolds 40 mm; 30–15 Intermittent Fitness Test (IFT) velocity 21 km/h; and maximal sprinting speed 34.5 km/h. MRI revealed a complete rupture of the superficial portion (myotendinous) and the deep portion (myoaponeurotic) of the T-junction. When interpreted within existing classification systems, the present injury could be considered consistent with a grade 3c lesion according to the British Athletic Muscle Injury Classification (BAMIC) classification.⁶ This classification should be regarded as an academic categorization rather than a comprehensive radiological de-

scription, as such classification may obscure some of the lesion-specific imaging details observed in this case.⁷

The injury occurred initially during a high-speed nonlinear running action. The player continued to play and felt another acute pain at the same point after a pass leading to removal from competitive match participation for 10 weeks. An expert musculoskeletal radiologist made the initial diagnosis using a 3T MRI scan. Subsequently, three dynamic ultrasound evaluations were performed at weeks 3, 6 and 9 to monitor the RTP process. Dynamic ultrasound assessment of the healthy side was also performed to detect any abnormalities and identify potential asynchronous movements between the two heads of the biceps femoris, serving as a comparative reference (at week 6). A follow-up 3T MRI was conducted in the middle of the rehabilitation process (week 5) and another one before the reintroduction of high-speed running (HSR) & sprinting (week 8). A final MRI was performed 4 weeks after RTP (week 14) to check the evolution of the scar. (Table 1)

PROCEDURES

Ultrasound assessments were performed using a Versana Active ultrasound system (GE HealthCare, Italy), with the transducer positioned over the injury site and stabilized using a ProbeFix Dynamic device (PFD) (Usono, Netherlands).

For the dynamic assessment of both exercises, a 12L-RS linear transducer (4–13 MHz) was used. The probe was placed transversely over the distal third of the biceps femoris muscle until the myoaponeurotic tissue of the T-Junction between long and short heads was visualized at the center of the image, with the myotendinous portion visualized as horizontal echogenic striation in the upper part.⁹ At this point, the probe was fixed to the player’s thigh using PFD (Figure 1).

Each evaluation included dynamic imaging performed during two gym-based exercises:

- Single-leg barbell Romanian deadlift (SL-RDL): The athlete was instructed to grasp the barbell with both hands and perform a SL-RDL on the affected limb. The stance knee was kept slightly flexed while the barbell was lowered along the anterior aspect of the knee toward the tibial tuberosity, with the contralateral foot lightly in contact with the ground for balance purposes. The athlete then performed a 1-second isometric pause at the bottom position. This was followed by ascent through a controlled hip-hinge

Table 1. Overview of rehabilitation phases with corresponding imaging monitoring.⁸

Weeks after injury	Imaging type	Main findings	Rehab phase (Zanovello et al.) ⁸	Activities
0	MRI	Complete rupture of the superficial portion (myotendinous) and the deep portion (myoaponeurotic) of the T-junction	-	-
3	Dynamic US	Edema in the superficial portion. Clear intermuscular hematoma and lack of smooth interhead movement. Highly heterogeneous tension distribution in the tissue surrounding the scar	Regeneration phase	Low load hamstrings exercises. High load eccentrics avoided
5	MRI	Hypertrophic, not fully mature scar with persistent surrounding edema	S&C sub-phase	Progression in loading of gym-based hamstrings exercises
6	Dynamic US	Reduction in superficial portion edema. Resolution of the intermuscular hematoma. Reduced edema around the scar. Smoother interhead movement and more homogeneous tension	Return to run & soccer drills	Run & soccer activities <70% of MSS
8	MRI	Hypertrophic mature scar with less surrounding edema	Return to HSR & Sprint	Partial team training. HSR & Sprint exposure
9	Dynamic US	Superficial portion edema resolution. Hypertrophic scar with functional and mechanical properties. Almost normal inter-head movement	Return to Full Team Training	Full team training. Clearance for RTP
14	MRI	Hypertrophic scar, minor residual edema	Returned to Play	Regularly playing matches since week 10

MRI: Magnetic Resonance Imaging; US: Ultrasound; S&C: Strength & Conditioning; MSS: Maximal Sprinting Speed.



Figure 1. Ultrasound probe positioning with external fixation device (PFD, Usono, Netherlands).

movement (Figure 2). The external load was set at 30 kg during the first assessment and increased to 40 kg for both the second and third evaluations. The progression during rehabilitation from 30 to 40 kg was based on symptom response, movement quality, and an estimated repetitions-in-reserve approach, with progression allowed when the player completed the

prescribed sets without symptom exacerbation and with approximately two repetitions in reserve. The load was not increased beyond 40 kg to maintain a submaximal rehabilitation stimulus while preserving movement quality and symptom control.

- Single-leg hamstring slider with ipsilateral trunk rotation: the exercise was performed using a commercial slider device (Battle4run, Spain). The contralateral knee was positioned on a static plate, whereas the limb under evaluation was placed on a sliding plate and moved progressively into knee extension with simultaneous hip flexion. Simultaneously, the athlete performed ipsilateral trunk rotation while holding a 5-kg weight plate (Figure 3).

The athlete was familiar with and had previously trained using both exercises. Each exercise was performed for three repetitions with 3-second eccentric and concentric phases. Dynamic ultrasound videos were recorded for each trial (Supplemental File 1) and also for the uninjured limb evaluation (Supplemental File 2).

OUTCOMES

The player returned to running and soccer-specific activities at intensities below 70% of maximal sprint speed (MSS) after 6 weeks. At week 8, he progressed to HSR and sprint exposure, and at week 9 he was cleared for full team training. The player successfully returned to play, according to the adopted return-to-play definition,^{10,11} 10 weeks post-



Figure 2. Dynamic ultrasound evaluation during single-leg barbell Romanian deadlift.

injury with no re-injury at 4 months follow-up. Across serial evaluations, progressive changes were observed in both tissue appearance and movement behavior at the distal myotendinous T-junction. Dynamic ultrasound demonstrated a gradual reduction in visible interhead asymmetry and progressive restoration of synchronous movement between the BFLh and BFsh during functional tasks. In parallel, ultrasound imaging showed progressive maturation of the scar tissue and improvement in tissue continuity over time.

DISCUSSION

Previous studies have shown that MRI may have limitations in detecting DMTJ injuries and that ultrasound evaluation can assist clinicians in completing the diagnosis and monitoring the healing process during RTP phases.^{4,5,12} Rapid symptom resolution despite persisting structural damage is characteristic of T-junction injuries, making it unreliable to rely solely on patient-reported feedback to guide rehabilitation decisions.^{1,12} Cronin et al. demonstrated that dynamic ultrasound evaluation during isometric knee flexion can detect gap widening between the short and long heads of the biceps femoris, monitor hematoma evolution, and identify asynchronous movement of the two heads.¹² Normal dynamic movement of the T-shaped hamstring region is characterized by synchronous motion, in which mechanical and temporal coordination between the long and short heads ensures uniform distal force transmission without in-



Figure 3. Dynamic ultrasound evaluation during hamstring slider exercise with ipsilateral trunk rotation.

trastendinous shear during contraction. The key indicator of normal function is the absence of “dissociative movement” (sliding or separation) between the long and short heads during contraction.^{1,3}

In the described approach, dynamic ultrasound evaluation was performed during gym-based exercises, which impose greater demands on muscle tissue than a simple isometric contraction. The SL-RDL and slider exercises with ipsilateral trunk rotation were selected primarily because they provide mechanical stress on the biceps femoris, allow progressive loading, and offer sufficient space to secure the device without interfering with movement. This setup helped enhance the precision and reliability of dynamic ultrasound evaluation. Ipsilateral rotation was added to the slider exercise because this movement pattern is commonly involved in the mechanism of DMTJ injuries.¹³ As suggested by Kerin, a multiplanar evaluation approach may represent a clinically relevant advancement, offering a

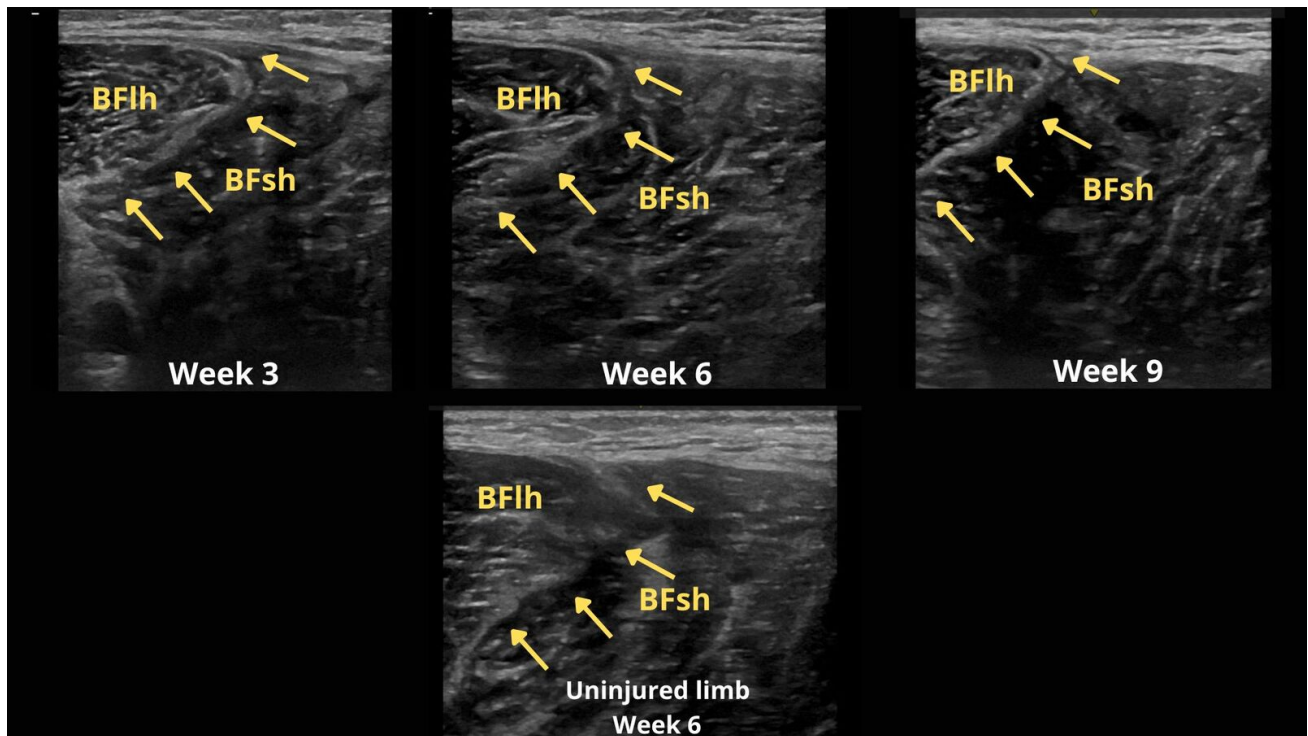


Figure 4. Dynamic ultrasound evaluation during single leg barbell Romanian deadlift. Yellow arrows highlight the T-junction to facilitate anatomical orientation.

BFlh: Biceps Femoris long head. BFsh: Biceps Femoris short head.

more functionally meaningful assessment compared with traditional static or linear imaging assessments.¹²

In the present study, tissue healing was monitored using dynamic ultrasound evaluations at three different time points. The first evaluation was conducted at week 3 (Figure 4), when the athlete had already begun performing the assessed exercises with low loads during rehabilitation sessions and was able to execute them without symptoms. During the first assessment in addition to superficial edema and intermuscular hematoma, interhead movement was not smooth and contraction appeared predominantly localized around the scar tissue. At week 6 (Figure 4), a second evaluation was conducted while the athlete was engaged in an intensive gym-based strength and conditioning phase and running at <70% of maximal sprinting speed (MSS).⁸ Resolution of the intermuscular hematoma was observed, with residual edema around the scar. Interhead movement appeared smoother and more synchronous. The final evaluation (week 9; Figure 4) was performed during the last week before RTP, when the athlete had progressed to high-speed running (>70% MSS) and partial team training. Dynamic ultrasound assessment showed reduced edema and near-normal movement between the two heads of the biceps femoris (Supplemental File 1). These findings were consistent with the week 8 MRI results (Figure 5). Following these evaluations, the player was cleared for full team training (week 9) and subsequently returned to play at week 10. At the 4-month follow-up, no reinjury was reported.

Healing progression, particularly the normalization of the synchronous movement between the two heads of the biceps femoris, was observed primarily during the SL-RDL

exercise, whereas it was less easily seen during the slider exercise. This difference may reflect the higher contraction demands of the deadlift exercise, which allows greater loading and more targeted stress on the affected tissue.

CONCLUSIONS

This case report highlights the potential value of dynamic assessment of the DMTJ in hamstring injuries. Dynamic ultrasound performed under progressive functional loading may provide clinically relevant information during the return-to-play process, particularly in evaluating the movement synchrony between the long and short heads of the biceps femoris. Among the exercises tested, the SL-RDL appeared to allow clearer visualization of the restoration of coordinated interhead movement, likely due to its higher loading demands. Further research is needed to establish the reliability, validity, and prognostic utility of this novel assessment modality.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

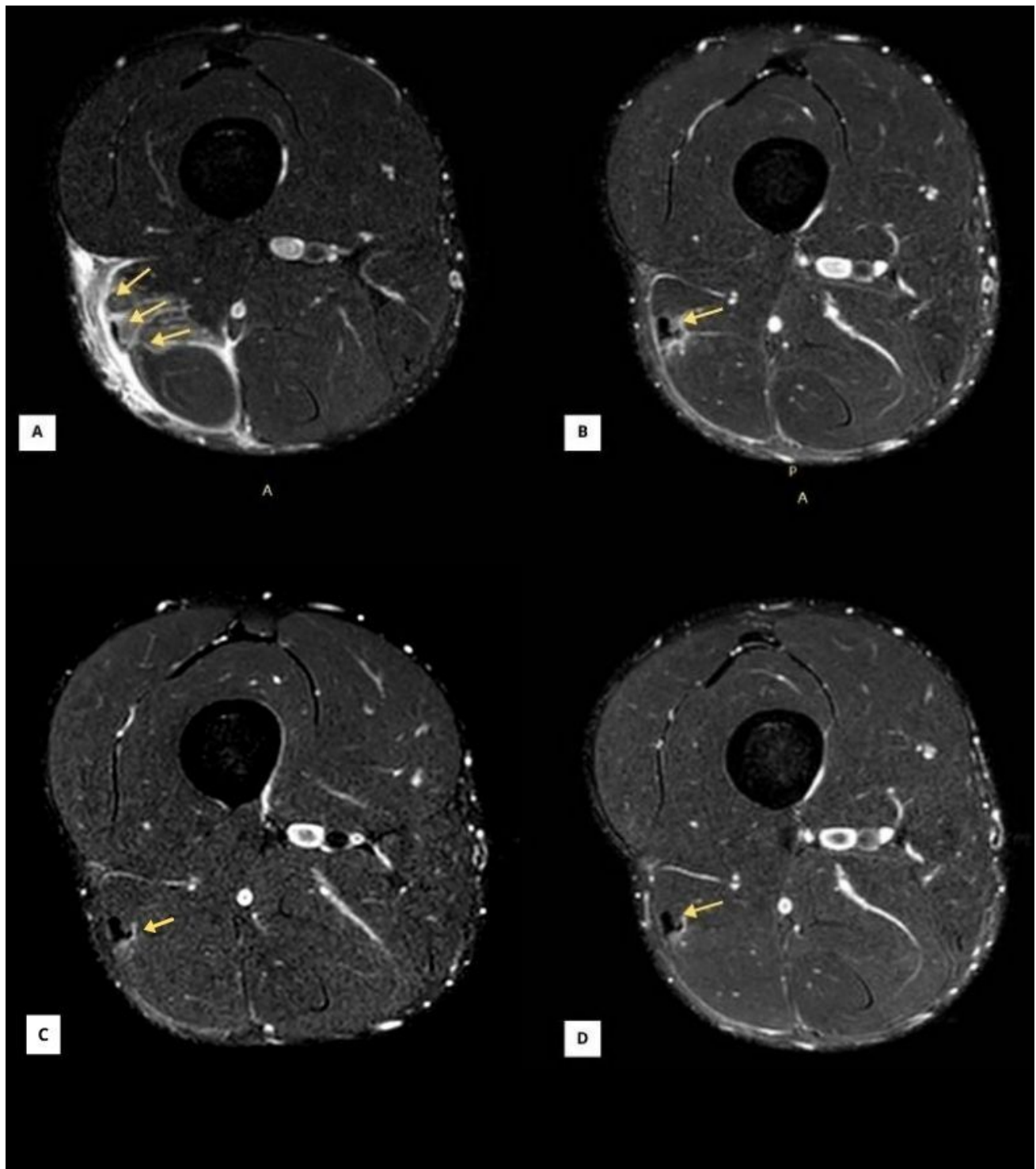


Figure 5. MRI evaluation at 4 different timepoints. Yellow arrows identify the area of scar formation corresponding to the injury site. A: week 0 B: week 5 C: week 8 D: week 14

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SUPPLEMENTARY MATERIALS

Supplemental video file 1

Download: <https://ijspt.scholasticahq.com/article/165041-a-novel-dynamic-ultrasound-assessment-of-t-junction-hamstring-injury-during-gym-based-exercises-a-case-report-in-an-elite-football-player/attachment/353609.mov>

Supplemental video file 2

Download: <https://ijspt.scholasticahq.com/article/165041-a-novel-dynamic-ultrasound-assessment-of-t-junction-hamstring-injury-during-gym-based-exercises-a-case-report-in-an-elite-football-player/attachment/353608.mov>
