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ORIGINAL RESEARCH

CONSERVATIVE MANAGEMENT OF 3C BICEPS FEMORIS INTRAMUSCULAR TENDON INJURY: A CASE REPORT OF AN ELITE-LEVEL INTER-COUNTY GAELIC FOOTBALL PLAYER

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ABSTRACT

Introduction: Hamstring injuries are one of the most common injuries across many field-sports, including Gaelic football. Hamstring injuries involving the intramuscular tendon (IMT) are becoming increasingly common, and are associated with longer return-to-play times and greater recurrence. Rehabilitation guidelines for IMT hamstring injuries are not well-documented. The aim of this study was to detail the return-to-play (RTP) process of a Gaelic football player after intramuscular tendon (IMT) hamstring injury.

Methods: This case report involves a male, inter-county level, Gaelic football player, who sustained a type 3c biceps femoris injury during a competitive match. Rehabilitation involved the implementation of an early isometric loading programme using a novel hamstring isometric assessment device (HRIG) which replicates the late swing/ early stance phase of running gait in an isometric position. In this unique rehabilitation approach, specific hamstring rehabilitation consisted of progressions in isometric loading alongside running progressions, as opposed to traditional programming involving hamstring-specific isotonic exercise.

Results: The player achieved a return-to-running (RTR) on day 19, return-to-training (RTT) on day 38, and RTP on day 48. Isometric hamstring force from the involved limb increased from 0.9 Nm/kg on clinical presentation, 2.13Nm/kg on RTR, 2.52Nm/kg on RTT, to 2.51Nm/kg on RTP. Additionally, isometric hamstring inter-limb asymmetry improved from 66% on clinical presentation (day 2), 20% on RTR, 4% on RTT, to 13% on RTP.

Conclusion: An early isometric loading programme restored isometric hamstring force and resulted in shorter a RTP time than typically reported for type 3c hamstring injuries.

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INTRODUCTION

Gaelic football is a muti-directional team-based field-sport, played predominantly in Ireland, and involves a high volume of high speed running, jumping, cutting and kicking.[1] Hamstring strain injuries are the most common injury in Gaelic football, accounting for 21-24% of all injuries, with an incidence of 2.2 per 1000 hours of exposure.[2, 3] An 8-year longitudinal study investigating injury trends within elite-level Gaelic football teams reported that each team sustains an average of 9 hamstring strain injuries each season, accounting for 31% of injury-related time-loss.[2, 3] In addition, hamstring strain injuries in Gaelic football are associated with a high risk of re-injury, with studies citing re-injury rates as high as 36-44%.[2, 3]

Hamstring injuries involving the intramuscular tendon (IMT) have recently been classified as a sub-type of hamstring muscle injury.[4] The IMT is an intramuscular continuation of the proximal and distal free tendons, which extends within the muscle belly, acting as a central support to which muscle fibres can attach.[5, 6] Research suggests disruption of the IMT is evident in 19-41% of all hamstring

injuries,[7-10] which presents a distinct rehabilitative challenge considering the morphology of the IMT. With known differences in the repair and regeneration processes between muscle and tendon,[11, 12] in addition to the unique structural and mechanical differences between the free tendon and the IMT,[5] it is not surprising that the precise process of IMT recovery is not well established.[13] Therefore, hamstring injuries involving the IMT are typically associated with longer return-to-play (RTP) times and higher rates of recurrence than hamstring injuries that do not involve the IMT, [9, 10, 13-16] although conflicting evidence on this exists.[7] Retrospective analysis of hamstring injuries in a mixed cohort of Australian rules football and rugby league players revealed hamstring injuries involving the IMT had mean recovery times (72 days) three times higher than biceps femoris injuries that did not involve the IMT (21 days).[9] The same authors also noted IMT injuries were significantly more likely to recur than other hamstring injuries.[9] Additionally, while hamstring injuries involving the IMT are classified as 'class c' under the British Athletics muscle injury classification (BAMIC) grading system,[4] higher grades of 'class c' injury are also associated with longer recovery times and higher recurrence rates. Specifically, time to return to full training has been reported as 27 + 6.8 days for type 2c hamstring injury and 84 + 49.4 days for type 3c hamstring injury, albeit in a cohort of track and field athletes.[10] With higher recurrence rates also associated with higher grade of 'class c' injury (57% recurrence for type 2c injury, 63% for type 3c injury), it is clear that type 3c hamstring injuries impose a significant burden on athletes.[10, 13]

Despite the prominence of IMT injuries and the associated time-loss, specific guidance on the most appropriate management and treatment of these injuries remains scarce.[13] While some studies have compared RTP times and injury recurrence rates between hamstring injuries with IMT involvement and those without,[9, 10, 14-16] fewer studies have documented and described the rehabilitation programmes utilised.[14, 17] Of those studies that have, an intramuscular tendon-oriented approach to rehabilitation[17] has proven effective in the management of IMT hamstring injuries in track and field athletes, with attributable low re-injury rates and shorter RTP times (48 ± 17 days for type 3c injury).[14] Elsewhere, a criteria-based rehabilitation programme for a professional soccer player with a type 2c hamstring injury has been described, with relatively short times reported for the player's return to full training (35 days) and RTP (40 days).[18] Notably, the authors reported the use of early isometric loading of the injured limb and tissue, along with continued load-response monitoring, within their rehabilitation programme.[18] Indeed, early isometric loading is advised when treating type 'c' hamstring injuries, when implemented within a structured and targeted rehabilitation programme.[17] In general, isometric exercise is typically used in early stage hamstring rehabilitation, as it has been shown to alter physiological characteristics, such as muscle architecture, tendon stiffness and tendon health.[19, 20] However, whilst a few studies have described general guidelines for the management and rehabilitation of type 'c' hamstring injuries, no study to date has detailed an early isometric loading approach for a type 'c' hamstring injury. In addition, reports on the management of type 3c hamstring injuries in multi-directional field-sport remains scarce, and would assist clinicians in their decision-making process when rehabilitating similar injuries.

Therefore, in this report, we present the case of an elite-level Gaelic football player who sustained an IMT hamstring injury (type 3c) in a competitive match, inclusive of clinical presentation, diagnosis and rehabilitation protocol. The aim of this case study is to detail the early isometric loading strategy implemented throughout the player's return-to-sport process.

METHODS

Case Scenario

The player was a male, 29-year-old, Gaelic football player, playing at the inter-county level. Both the club and player provided written consent for this case report, which is conducted in accordance with the Declaration of Helsinki. The player had 8+ years of experience playing at an inter-county level and had not sustained a time-loss hamstring injury prior to this. The injury was sustained during a competitive inter-county match, in the All-Ireland inter-county football championship. In the first half of the match, the player felt a sharp pain in the posterior thigh while running near maximal velocity. Upon subsequent video analysis, the injury occurred during the late swing phase of the running gait cycle, to the player's dominant limb (defined as their preferred limb when kicking a ball). The player was immediately removed from the field of play following the injury occurrence. A team physiotherapist assessed the player 36-hours post-match.

Clinical Presentation

36-hours post-match, the player presented with pain to the involved limb during normal walking gait (Visual Analog Scale (VAS) rating of 3/10) and pain on palpation of the biceps femoris muscle (VAS 3/10). Clinical examination revealed a positive straight leg raise test (SLR) and a positive active 90°/90° test, with a 30° deficit evident from the involved limb, in both tests. In addition, a 40° deficit was evident in the involved limb when assessed with the Maximum Hip Flexion Active Knee Extension test. A goniometer was used to assess range of motion assessments. The player also presented with pain (VAS 6/10) during unilateral prone and supine long-lever strength assessments of the posterior thigh, and a 66% deficit (inter-limb asymmetry) to the involved limb when assessed via the Isometric Hamstring Assessment Device (HRIG). The player was subsequently referred for a Magnetic Resonance Imaging (MRI) scan, which occurred 96-hours post injury. The MRI revealed an injury to the proximal biceps femoris intramuscular tendon, demonstrating high signal >15cm in longitudinal length and >5cm fibre disruption, classified as a grade 3c biceps femoris injury in accordance with the BAMIC grading system (Figure 1). In addition, pain ratings and range of motion assessments were in line with the expected presentation of a 3c hamstring injury.[17] Both the player and team provided informed written consent for the use of this information.

Rehabilitation Approach

RTP decisions require a strategic assessment of risk and risk tolerance.[21] Considering the elite playing level and team environment within which the player would be training, the multidisciplinary sports medicine team consisting of the team doctor, physiotherapist, strength and conditioning coach and sports performance coach – along with input and agreement from the player – decided to implement a unique early isometric loading approach to treat the injury, with an aim of reducing the typical RTP time for a type 3c hamstring injury. This unique approach included delaying any hamstring-specific dynamic exercise, until after the player had achieved a return-to-running (RTR). The early isometric loading was delivered within a structured rehabilitation process, inclusive of gradual exposure to running and sports-specific reconditioning, as has been shown to be effective in managing a type ‘c’ hamstring injury.[18] All rehabilitation sessions were supervised by a member of the sports medicine team, and all prescribed sessions were completed.

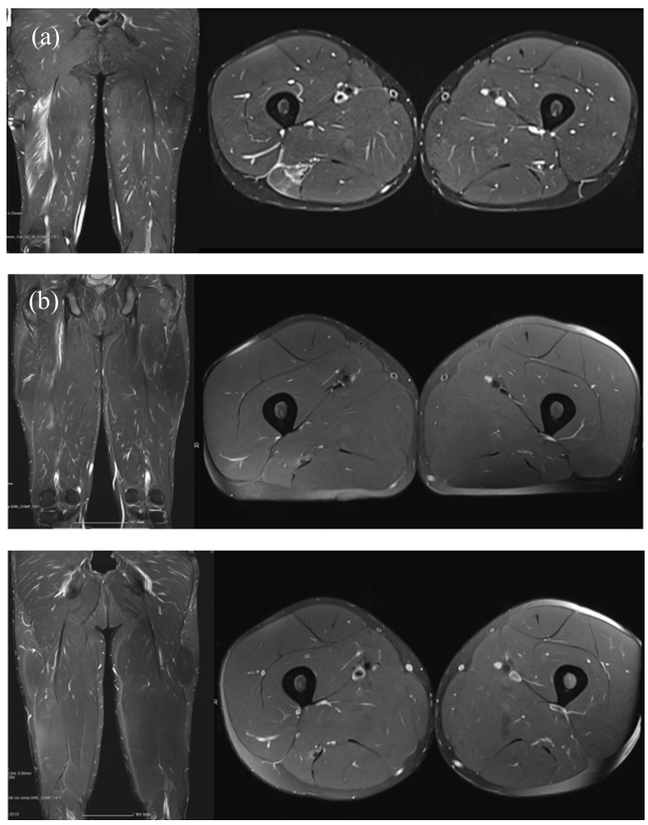

FIGURE 1. MRI findings from the posterior thigh throughout the return to sport process. MRI coronal and axial images taken on day 4 (a), day 31 (b) and day 40 (c).

Isometric Loading Programme via the HRIG Device

The initial four days post-injury acted as a protection phase, with the player instructed to avoid loading the injured tissue. On day four, the player presented as pain-free during walking gait, however this was not surprising as clinical symptoms can improve quickly in type 3c injuries.[17, 18] From day five onwards, the player performed an isometric loading programme, using a specialized, commercially available ‘Isometric Hamstring Assessment’ device (HRIG, Castlebar, Co Mayo, Ireland). The HRIG has demonstrated good-to-excellent test-retest reliability when assessing bilateral isometric hamstring force (ICC: 0.89 [95% CI: 0.79 – 0.94]) in male Gaelic football players.[22] The HRIG device positions the player’s involved limb in a position of 150° of knee extension, and 20° of contralateral hip flexion, replicating the late-swing/early-stance phase of running. The uninvolved limb is supported with the player’s knee rested on a support pad, while the player’s trunk is maintained in a neutral position. The isometric assessment is performed when the player isometrically contracts the hamstring muscles, by ‘pulling’ their lower posterior shin (distal aspect of the gastrocnemius) against a

load cell which wraps around the lower shin (Figure 2). This position places the hamstring muscles in a slightly lengthened position,[23-25] similar to the position in which the majority of hamstring injuries occur.[26] Considering that joint-angle specific isometric strength gains have previously been observed following isometric training at the knee joint,[27] this position is intended to strengthen the athlete's hamstrings specifically in the late swing/early stance phase.

FIGURE 2. HRIG Isometric Hamstring Assessment Device demonstrating the position used for isometric assessment and isometric loading throughout the rehabilitation process.

The isometric programme used a 'ramping' approach in the initial phase, with the player instructed to start each repetition by gradually increasing the intensity of the isometric contraction for a period of 3-seconds (towards the desired % of maximum voluntary contraction), and to end each repetition by gradually decreasing the intensity of the isometric contraction for a period of 3-seconds.[28] The isometric loading programme is detailed in Table 1. Given the level of uncertainty that exists around the optimal loading for IMT injuries,[13, 29] the isometric programme was constructed by the sports medicine team, with the intensity and volume of exercise prescription carefully monitored and progressed. Pre-determined targets for percentage of maximal voluntary isometric contraction (MVIC) were set to ensure high-intensity contractions (≥70%) were achieved, as these are associated with improved tendon structure and function.[28] The 'Ramping Isometric' phase began with long duration holds of 40-seconds, to promote collagen proliferation and reorganisation, without overloading the tendon[13]. Previously, a greater increase in tendon stiffness has been observed following isometric training using longer duration contractions (20-second repetitions) compared to shorter duration contractions (1-2 second durations).[30] The repetition duration was gradually decreased from 40-seconds to 30-seconds and 20-seconds, as the intensity of contraction increased across the first 2 weeks (day 5–18) of rehabilitation. The HRIG provided objective feedback on the player's 'load response' throughout the rehabilitation process, via force output in the involved limb relative to the uninvolved limb. Continuous isometric assessment has proven effective in guiding return-to-sport following IMT hamstring injuries.[18] Absolute force output, and % of limb asymmetry, were therefore used as key metrics to assess the player's strength progression.

On day 18, the player performed a 100% MVIC with no residual effects, and achieved the isometric force targets (inter-limb asymmetry of the involved limb ≤ 20%) pre-determined by the sports medicine team to return the player to running and progress towards maximal strength isometrics. In addition, the player presented with an absence of pain and restoration of full range of motion by day 18; criteria which have been viewed as important when returning an injured athlete to running.[31] These criteria informed the decision to progress the player to RTR on day 19. The player subsequently performed 8 on-pitch running sessions, on days 19, 22, 25, 27, 29, 32, 34 and 35 respectively, with running load targets and outputs recorded by global positions systems[32] (Stats Sports Technology) (Table 2). GPS assisted the progression of the running prescription towards normal game demands for an inter-county Gaelic footballer.[1] Isometric loading progression was adjusted in accordance with a return-to-running, with volume decreasing gradually from day 19-34 (repetition duration was generally 10-seconds, with volume ranging from 2-4 sets x 8 repetitions) and intensity of isometric contraction remaining at 100% MVIC (Table 1). This period of the isometric loading programme was intended to increase the maximum force capacity of the injured tissue, termed the 'Maximal Isometric Phase'. Objective measures of GPS data, and HRIG force data, alongside subjective feedback from the player, were key components used to inform the progression of rehabilitation as the player progressed through the prescribed running sessions.

Having achieved the pre-determined strength criteria for isometric force output, in addition to various running parameters (total distance, sprint distance, and high-speed running distance targets relative to previous workloads and training demands), the player's structural response to the rehabilitation was assessed via

TABLE 1. Early Loading Isometric Programme implemented throughout the rehabilitation and return to sport process.

Day	Phase	Rep Duration	Reps	Sets	MVIC (%)	HRIG Isometric Assessment	
						Force (affected limb)	Asymmetry (%)
2	***Assessment at Clinical Presentation***					0.9 Nm/kg	66%
5	Ramping Isometrics	40s	6	4	50%	1.08 Nm/kg	60%
6	Ramping Isometrics	30s	6	4	60%		
7	Ramping Isometrics	20s	8	5	70%	1.12 Nm/kg	58%
9 (a.m.)	Ramping Isometrics	20s	8	4	70%	1.52 Nm/kg	43%
9 (p.m.)	Ramping Isometrics	20s	8	4	70%		
11 (a.m.)	Ramping Isometrics	20s	8	4	80%	1.96 Nm/kg	26%
11 (p.m.)	Ramping Isometrics	20s	8	4	80%		
13	Ramping Isometrics	20s	8	6	80%		
14	Ramping Isometrics	20s	8	4	80%		
16 (a.m.)	Ramping Isometrics	20s	8	4	90%	1.96 Nm/kg	26%
16 (p.m.)	Ramping Isometrics	20s	8	4	90%		
18	Ramping Isometrics	20s	8	2	100%	2.13 Nm/kg	9%
19	***Return to Running***						
19	Maximum Isometrics	10s	8	1	100%		
20 (a.m.)	Maximum Isometrics	20s	8	3	100%		
20 (p.m.)	Maximum Isometrics	20s	8	3	100%		
22	Maximum Isometrics	10s	8	2	100%		
23 (a.m.)	Maximum Isometrics	20s	8	4	100%		
23 (p.m.)	Maximum Isometrics	20s	8	4	100%		
25	Maximum Isometrics	10s	8	3	100%		
27	Maximum Isometrics	10s	8	3	100%	2.46 Nm/kg	11%
29	Maximum Isometrics	10s	8	4	100%		
32	Maximum Isometrics	10s	8	4	100%		
35	Ballistic/Quasi-Isometric Phase	10s	8	2	100%		
		5s	10	2	100%		
		2s	10	2	100%	2.52 Nm/kg	5%
38	***Return to Training***						
42	Ballistic/Quasi-Isometric Phase	10s	8	1	100%		
		5s	10	2	100%		
		2s	10	2	100%		
		1s	10	1	100%		
45	***Assessment before RTP***					2.51 Nm/kg	13%
48	***Return to Play***						
49	Ballistic/Quasi-Isometric Phase	2s	10	2	100%		
		1s	10	2	100%		
52	Ballistic/Quasi-Isometric Phase	5s	10	2	100%		
		2s	10	2	100%		
		1s	10	2	100%		
55	Ballistic/Quasi-Isometric Phase	5s	10	2	100%		
		2s	10	2	100%		
		1s	10	2	100%		
58	***Assessment 10-days post RTP***					2.46 Nm/kg	11%
Assessment at start of following pre-season						2.56 Nm/kg	3%

Note: AM: Morning session; PM: Evening session; MVIC: Maximum Voluntary Isometric Contraction; Nm/kg: Newtons meters per kilogram of bodymass; RTP: Return-to-Play

TABLE 2. On-pitch running metrics during the return-to-play process.

Day	Session	Total Distance (m)	Sprint Distance (m)	HSR Distance (m)	HMLD**	Max Speed (km/hr)
19	Individual running session	6,371	0	1	427	20.04
22	Individual running session	6,733	0	41	482	23.88
25	Individual running session	7,994	0	85	802	23.02
27	Individual running session	8,247	*NR	*NR	*NR	*NR
29	Individual running session	8,500	*NR	*NR	*NR	*NR
32	Individual running session	10,621	195	2,058	2,671	28.80
34	Individual running session	8,500	229	1,682	2014	30.40
35	Individual running session	4,220	263	1,306	1,358	32.18
38	Collective team training	7,848	55	1,315	1,813	27.10
41	Collective team training	8,201	266	1,770	2,468	28.50
44	Collective team training	6,000	146	1,135	1,684	27.25
46	Collective team training	5,000	25	500	900	26.00
48	Competitive Match	13,500	49	1,250	2,758	29.46
51	Collective team training	9,595	93	705	1,977	30.13
54	Collective team training	8,507	201	885	1,795	33.50
57	Collective team training	6,000	207	2010	2604	30.01

Note: HSR: High-Speed Running; HMLD: High Metabolic Load Distance; km: kilometres; hr: hour. NR*: data not recorded due to equipment error. ** Calculated as the sum of the high-speed running distance, distance of accelerations, and distance of decelerations, throughout a session.

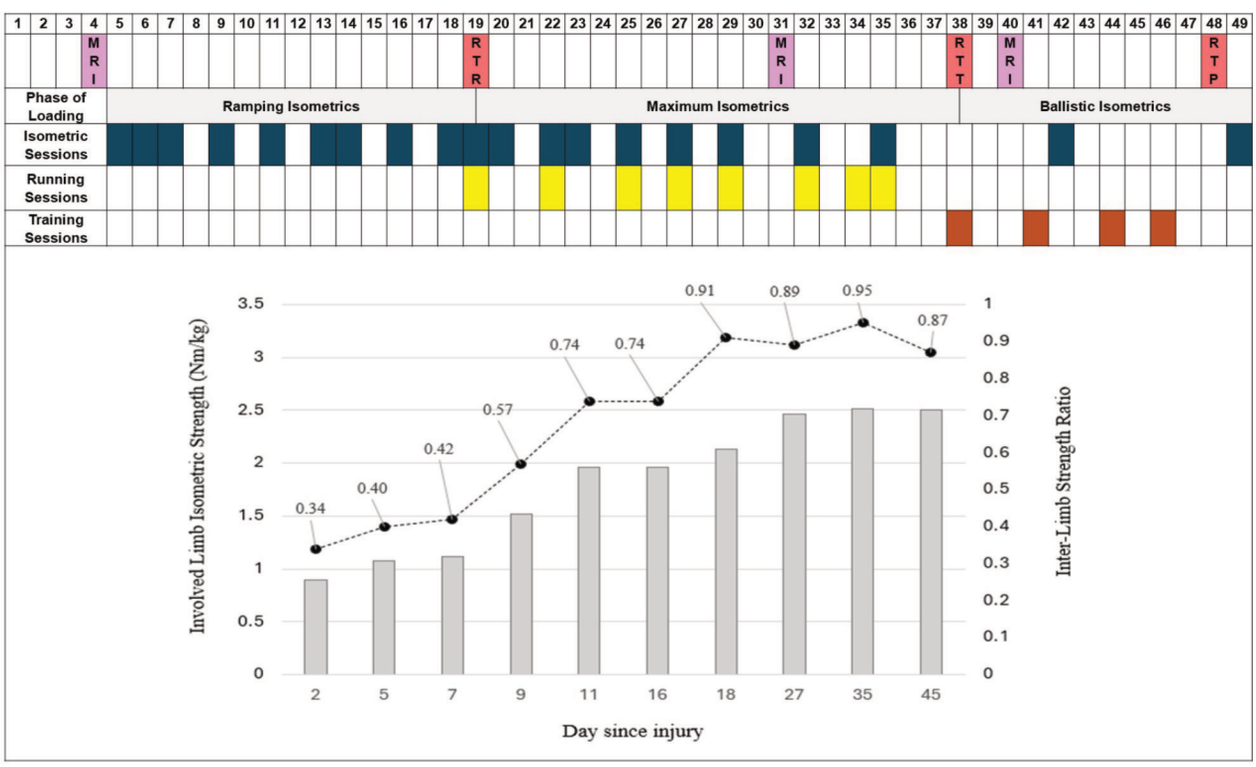

FIGURE 3. Overview of the rehabilitation process and accompanying changes in isometric hamstring strength.

Note: MRI: Magnetic Resonance Imaging; RTR: Return to Running; RTT: Return to Training; RTP: Return to Play.

MRI scan on day 31, which was used in conjunction with strength progression and performance evaluations to inform the decision-making process.[33] MRI revealed reduced high signal with evidence of ongoing scar tissue maturation, on coronal and axial views. Therefore, it was decided that the player progress and return to sports-specific training (RTT) on day 38. This coincided with a progression in isometric loading to a 'Ballistic Isometric Phase'.[28] During this phase, HRIG isometric repetition duration decreased (ranging from 10-seconds, 5-seconds, 2-seconds, and 1-second) and intensity of contraction remained at 100% MVIC. However, during this phase, the player was instructed not to perform 'ramping' repetitions, and instead to increase force output rapidly and instantly towards 100% MVIC at the start of each repetition, and reduced force rapidly at the end of each repetition. Ballistic isometric training has been shown to maximize the improvement of rate of force development.[34] Due to an increase in on-pitch rehabilitation, running demands and sports-specific training, coupled with an increase in the player's force production capacity and tissue recovery, isometric loading sessions were prescribed less frequently as the player progressed through sports-specific training (days 38, 41) and full team training (days 44 and 46). Another MRI scan (day 40) showing further reduced high signal and additional scar maturation informed the decision to RTP on day 48. The 'Ballistic Isometric' phase was continually prescribed after the player's RTP, with session timing tailored to the team's training and match schedule.

RESULTS

An overview of the rehabilitation and return-to-sport process is provided in Figure 3. The player achieved a RTR on day 19, RTT on day 38, returned to full team training on day 44, and RTP on day 48. In parallel, the player demonstrated isometric hamstring force inter-limb asymmetry of 66% on clinical presentation (day 2), 20% on RTR, 4% on RTT, and 13% on RTP, relative to the injured limb. In addition, isometric hamstring force output (Nm/kg) from the involved limb increased from 0.9 Nm/kg on clinical presentation, 2.13 Nm/kg on RTR, 2.52 Nm/kg on RTT, to 2.51 Nm/kg on RTP, and remained high 10 days post-RTP (2.46 Nm/kg, 11% asymmetry) and at the start of the following playing season (2.56 Nm/kg, 3% asymmetry). The player did not sustain a re-injury in the 1-year period after the initial injury, and has not sustained a recurrence at the time of writing. MRI imaging from days 2, 31 and 40 are presented in Figure 1.

DISCUSSION

Return-To-Play after Intramuscular Tendon Injury

The early isometric loading programme implemented in this case study was associated with a short RTP time (48 days) and no injury recurrence within the first year post-injury. With limited information available regarding the expected RTP time for a type 3c biceps femoris injury in a field-sport athlete, comparisons must be made with track and field cohorts.[10, 14] The RTP time in the present case is notably shorter than that reported for type 3c hamstring injuries in elite track and field athletes when conventional rehabilitation is implemented (84 ± 49 days).[10] Furthermore, the RTP time in the present case aligns with that reported for type 3c hamstring injuries in elite track and field athletes when a bespoke 'tendon-oriented rehabilitation'[17] programme is implemented (48 ±17 days).[14] In multidirectional field-sports similar to Gaelic football, an average RTP time of 72 days has been reported in a mixed cohort of Australian rules football and rugby league players, for biceps femoris injuries involving the IMT.[9] Elsewhere, a RTP time of 40 days has been reported in the case of an English premier league soccer player[18] – although the case study related to a type 2c hamstring injury, which is typically associated with a shorter RTP time than a type 3c injury.[10, 13, 14] Therefore, the isometric loading protocol implemented in the current case may act as a guide for clinicians in the treatment of type 3c hamstring injuries within multi-directional field-sports.

Early Isometric Loading

Whilst there is a scarcity of research documenting rehabilitation approaches for IMT hamstring injuries,[13] those that have documented such processes have advocated for the use of isometric exercises, especially in the early stages of rehabilitation.[17, 18] Research suggests that during dynamic exercise, an increase in muscle-tendon unit length occurs via the passive component (tendon) while the contractile component (muscle) remains isometric.[24, 35] Therefore, dynamic exercise encompassing eccentric loading and lengthening is not advised, and the principles of tendon healing should inform rehabilitation in the initial stages of IMT injuries.[17] Indeed, a unique aspect of this case is that dynamic (isotonic) exercise was not prescribed until after the athlete returned to running and progressed towards a RTT. One of

the few studies documenting the rehabilitation programme of a type 2c hamstring injury in a professional soccer player, implemented an isometric loading progression from sub-maximal to maximal intensity across the initial 11 days post-injury, before progressing to dynamic exercise alongside an isometric loading programme .[18] However, in the current study, isometric loading was introduced on day 5, and remained the primary source of hamstring stimulus throughout the rehabilitation process. Isometric loading was therefore performed with very high frequency (typically 12-48 hours between sessions) until a successful RTT was achieved on day 38. While the optimal loading frequency for tendon adaptation has been recommended as 36–72 hours between sessions,[36] the structural and mechanical differences between the free tendon and IMT mean the optimal loading frequency and stimulus progression for IMT injuries is unclear.[13] Our study therefore provides a guide towards suitable loading volumes, progressions and frequencies in the management of IMT hamstring injuries. Notably – although comparable data is difficult to source – the time under tension (TUT) prescribed across several of the rehabilitation sessions (960 seconds TUT on day 13) is significantly greater than typically prescribed when implementing rehabilitative exercise consisting of generalised isotonic exercise progressions. It is unclear whether the notably high volume or the unique isometric approach, or both, can be attributed to the fast RTP time observed in this case.

Position-Specific Isometric Rehabilitation

Another unique aspect of this study is the use of a specific exercise position replicating the late swing/early stance phase of running gait, as the position of isometric training. Much debate exists around the exact muscle action that occurs during late swing/early stance phase.[37-39] There is a growing body of evidence suggesting that the hamstring fascicles behave isometrically in the late-swing phase, immediately prior to ground contact.[40] This theory has been used as the primary basis for prescribing isometric hamstring exercises rather than eccentric hamstring exercises for athletes involved in sports that require sprinting.[37, 40, 41] The authors of this case study hypothesize that the position used within the HRIG device, replicates the quasi-isometric contraction of the hamstring muscles during late swing/early stance phase of running gait, where an explosive isometric action is performed as the athlete positions the limb for ground contact.[37] However, whilst the muscular action performed when using the HRIG device is isometric by nature, the force traces observed when using the HRIG device demonstrate an initial 'quais-concentric' contraction, before a fixed intensity is reached – depicting what could be considered as a true isometric contraction – followed by a 'quasi-eccentric' muscle contraction to attenuate the force at the end of the rep. This may closely replicate the muscle action observed in the early stance phase of running gait, where high muscle forces are required as the limb prepares for ground contact and exerts high ground reaction forces.[37] Therefore, we believe the joint angle-specific, and contraction-specific loading of the hamstring muscles in the rehabilitation programme detailed in this case study provides clinicians with a novel method of treating IMT hamstring injuries; and one that has proven successful and effective in this case.

CONCLUSION

While a general lack of guidance exists for the treatment and management of 3c hamstring injuries, this case detailed the implementation of a unique early loading isometric approach to rehabilitation, in an elite-level, male Gaelic football player. The early loading isometric approach progressed from ramping isometrics to maximum isometrics, to ballistic isometrics, alongside a progression in running prescription towards the game demands of an inter-county Gaelic football player. This approach resulted in the restoration of the player's isometric hamstring strength and a subsequent shorter RTT and RTP time than typically reported for a type 3c hamstring injury. It is proposed that the use of a unique testing and training device positioning the player in the late swing/early stance position, in addition to the prescription of a high volume of isometric contractions, can be attributed to the restoration of hamstring strength and inter-limb asymmetry. Joint angle-specific strengthening of the hamstring muscles may be an important aspect of intramuscular tendon hamstring injuries, and warrants further investigation.

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CONFLICTS OF INTEREST: The authors declare no conflicts of interest.

ETHICAL APPROVAL: The club and player provided written consent for this case report, which is conducted in accordance with the Declaration of Helsinki.

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