Delaware Physical Therapy Clinic

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Rehabilitation Practice Guidelines: Hamstring Strain

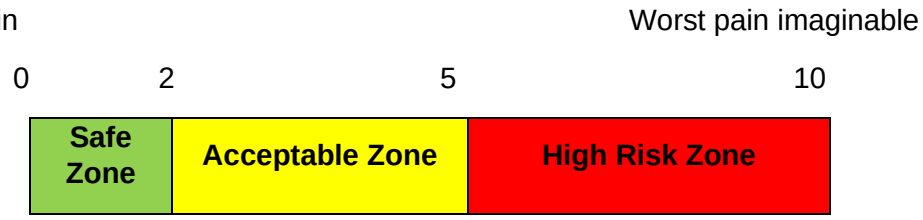
This is a protocol for a comprehensive rehabilitation and exercise progression that can be used for athletes who have sustained a hamstring strain. This program consists of acute management, a progressive strengthening program, running program, agility program, and recommendation for a return to sport.

Background:

- The muscle most commonly affected is long head of the biceps femoris.[1]
- The use of NSAIDS is controversial in the first few days because of the potential to impede healing; evidence suggests that NSAIDs have no additive effect on the healing rate.[1]
- Exercises (strengthening and early running progressions) may be performed in the presence of pain using a 5/10 pain threshold and modified if necessary.[2,3]
- The more proximal the site of maximal pain, the longer the time needed to return to pre-injury status[5]
- Median range for time to return to play is 15-58 days.[2,6]

Use of the Monitoring Model for Progression[4]:

- Numerical Pain Rating Scale (NPRS) 0/10 pain



- The pain is allowed to reach 5/10 on the NPRS during exercises
- The pain after the whole exercise program is allowed to reach 5/10 on the NPRS, but should subside to baseline by the following morning
- Baseline pain is not allowed to increase from week to week

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Phase I (Acute 0-2 days)	
Goals	• Minimize pain and swelling • Preserve hamstring length • Restore normal pain-free gait mechanics
Suggested Exercise Prescription and Education	• Rest and immobilization in a lengthened position, no longer than 24 hours[7] • If athlete demonstrates antalgic gait consider an assistive device • Ice in lengthened position 4-5 times a day (long sitting)[7] • Compression (thigh sleeve or ACE wrap with felt pad) and elevation until swelling stabilizes[7] • Modalities: sensory E-stim as needed • NSAIDS no sooner than 2-4 days after injury[1]
Progression Criteria	• Non-antalgic gait pattern • >48 hours post injury
Phase II (Sub acute >48 hours): Progressive loading phase	
Goals	• Continue to minimize pain and swelling • Improve hamstring length as needed • Improve hamstring strength • Initiate jogging and agilities activities

Suggested Exercise Prescription	• Warm up: bike 5 minutes
	• Manual therapy: soft tissue and neural mobilization pending examination findings
	• Initiate progressive strengthening program following the pain monitoring scale (< 5/10 on a 0-10 numeric rating scale),[2,3] See page 4,5
	  ○ Moderate to long length hip extension exercises
	  ○ Eccentrically biased knee flexion exercises
	• Initiate jogging or field/court or road running progression based on the athlete's sport following the pain monitoring scale, pending normal pain-free gait pattern,[2,7] See page 6 or 7
	• Initiate a progressive agility/plyometrics and trunk stabilization progression following the pain monitoring scale,[5,7] See page 8
	• Modalities: PRN

Progression Criteria	• Reducing intensity of pain with palpation • Symmetrical hamstring length • >90% knee flexion limb symmetry index via HHD or MVIC test at 50 deg knee flexion • >90% hip extension limb symmetry index (Supine 0 degs/0 degs)

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	• Have subjectively screened for apprehension with activity – Consider H testing[8]
Phase III: Return to sport phase	
Goals	• Maintain optimal level of strength/power/endurance/hamstring length • Progressively increase activity level to prepare athlete for full functional return to sport
Suggested Exercise Prescription	• Warm up: dynamic warm up • Continue progressive hamstring strengthening following the pain monitoring scale (< 5/10 on a 0-10 numeric rating scale) • Initate end stage of field/court running progression "sprinting greater than 90% perceived effort",[7,9] See Page 6 • Progress to sport specific movements at >90% speed, See page 8 • Modalities: PRN
Progression Criteria	• Achieve the following clinical criteria for return to sport:[2,5] ○ No tenderness with palpation ○ Pain-free and symmetrical ROM (active knee extension test) ○ No pain with maximal effort isometric hamstring resistance (Supine hip extension 0 degs/0 degs, Seated knee flexion edge of bed 90 degs/90 degs) ○ Hamstring index >90-100% with HHD / MVIC at 30 deg[13] or Isokinetic testing at 3 speed protocol (Concentric/Eccentric at 60, 180, & 300deg/sec)[14] ▪ Angle of testing for isometric might change on a case by case decision and which belly of hamstring is involved[14] ▪ Less flexion: More Biceps Femoris; More flexion: Less Biceps Femoris and more equal medial/lateral hamstring activity ○ Limb symmetry index >90-100% with the single straightleg bridge on 24 inch step[11] ○ Sport-specific movement (ex: straight line sprints, diagonal cuts) at maximum intensity (passed if completed without apprehension or pain) • Return to sports after clearance from appropriate medical personnel (MD, physical therapist, or athletic trainer)

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Progressive Strength Training

Listed below is a strengthening specific progression criteria and prescribed repetition ranges for each exercise variation in the rehabilitation protocol. An exercise is progressed if repetition range performed through full range of motion within the pain monitoring scale (less than 5/10). Progressions are meant to be made per exercises vs stage.[2,10] If a clinic does not have access to the bilateral 45-degree hip extension machine, the upright hip extension on the cable column or single leg RDL can serve as an alternative. For proximal hamstring injuries, consider exercises that bias hip extension vs knee flexion.

Early Stage

Exercise	Dosage	Progressions
Bilateral hamstring bridge	3 x 10-12 reps	Unilateral hamstring bridge
Bilateral 45-degree hip extension	3 x 8-10 reps	Unilateral 45-degree hip extension
Upright hip extension on cable column	3 x 8-10 reps each	Increase resistance or speed
Bilateral eccentric slider	3 x 6-8 reps each	Nordic hamstring exercise

Middle Stage

Exercise	Dosage	Progressions
Unilateral hamstring bridge	3 x 10-12 reps each	Progress with increased resistance or speed
Unilateral 45-degree hip extension	3 x 8-10 reps each	Add external resistance in 10-lbs increments
Upright hip extension on cable column	3 x 8-10 reps each	Increase resistance or speed
Nordic hamstring exercise	3 x 6-8 reps each	Add external resistance in 10-lbs increments
Single Leg Romanian Deadlift (RDL)	3 x 10-12 reps each	Add external resistance in 10-lbs increments or progress to single leg

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Late Stage

Exercise	Dosage	Progressions
Unilateral hamstring bridge	3 x 10-12 reps each	Progress with increased resistance or speed
Unilateral 45-degree hip extension	3 x 8-10 reps each	Add external resistance in 10-lbs increments or increase speed pending position/sport
Upright hip extension on cable column	3 x 8-10 reps each	Increase resistance or speed
Nordic hamstring exercise	3 x 6-8 reps	Add external resistance in 10-lbs increments
Single leg RDL	3 x 10-12 reps each	Add external resistance in 10-lbs increments

*See Appendix for exercise depictions

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Progressive Strength Training

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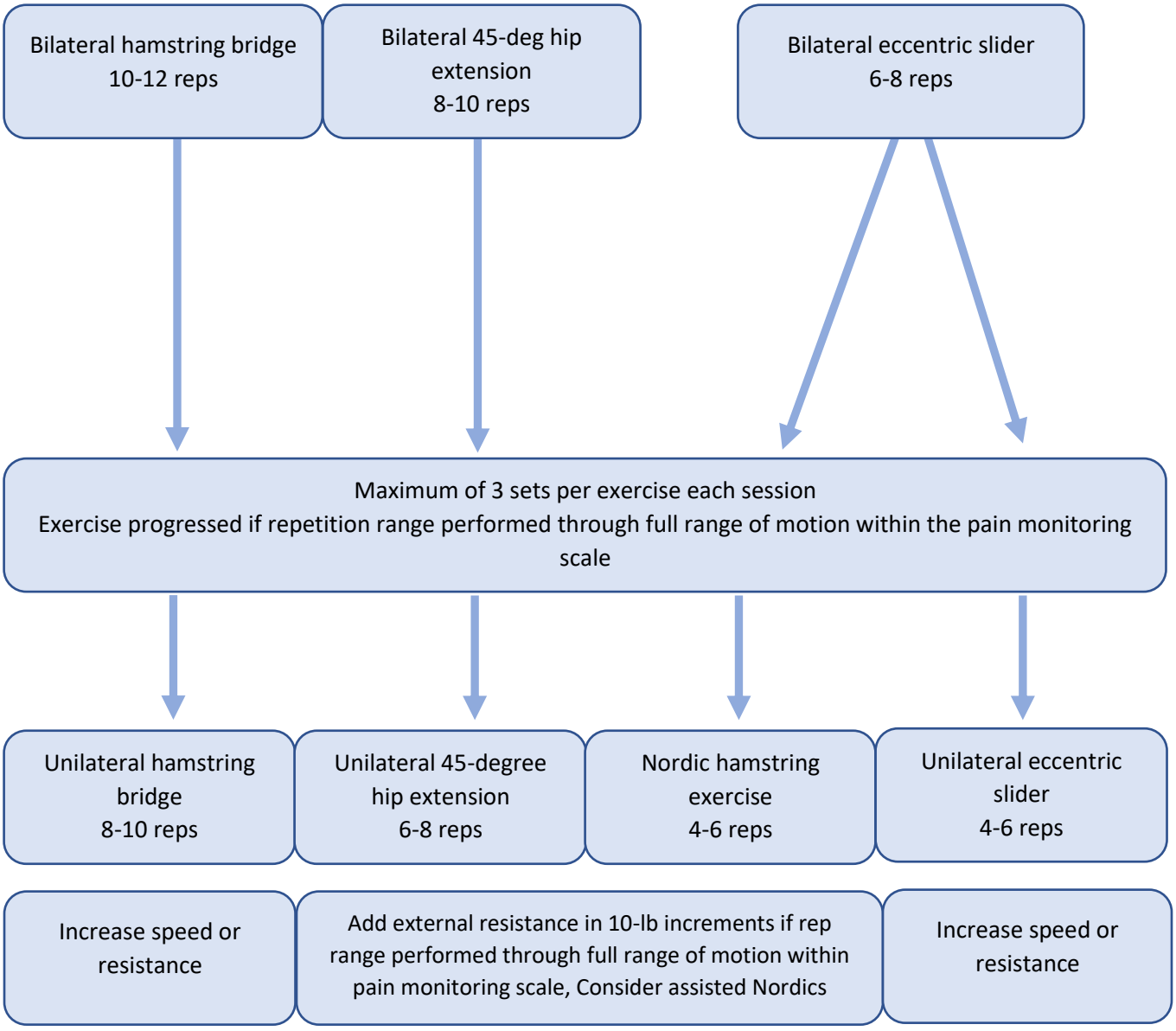
Strengthening progression:



*This flowchart was modified from Hickey 2019[2]

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UDPT Road/Treadmill Running Progression

This is a progressive road running program that is broken up into 8 stages. Once an athlete demonstrates they can walk with a normal gait pattern they can begin this progression. Progression from one stage to the next may be achieved once the athlete is able to perform activitiy for 2 miles without increased effusion or pain. Perform no more than 4 times in 1 week and no more frequent than every other day.

UDPT Running progression

	Treadmill	Track
Level 1	0.1 mile walk/0.1 mile jog repeat 10 times	Jog straights/Walk curves (2 miles)
Level 2	0.1 mile walk/0.2 mile jog repeat 10 times	Jog straights/Jog 1 curve every other lap (2 miles)
Level 3	0.1 mile walk/0.3 mile jog repeat 10 times	Jog straights/Jog 1 curve every lap (2 miles)
Level 4	0.1 mile walk/0.4 mile jog repeat 10 times	Jog 1 ¾ lap/Walk curve (2 miles)
Level 5	Jog full 2 miles	Jog all laps (2 miles)
Level 6	Increase workout to 2 ½ miles	Increase workout to 2 ½ miles
Level 7	Increase workout to 3 miles	Increase workout to 3 miles
Level 8	Alternate between running/jogging every 0.25 miles	Increase speed on straights/jog curves

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Field/Court Sports Running & Sprinting Progression

This is a progressive running program that is broken up into 3 stages. Once an athlete demonstrates they can walk with a normal gait pattern and is succesfully progressing through running program, they can begin this progression. Progression from one stage to the next may be achieved once the athlete can perform perform previous level without deficits and meets criteria listed below.

Considerations for sprinting progression: Demand on hamstring muscle group changes based on sprint distance and sprint intensity. Longer distance and higher intensity places higher demands on hamstring. Sprinting prooression may be modified to fit sports-specific demands of the patient. Maximum velocity, and likely maximum force on hamstrings, may be achieved at 50-60 yds, which should also be considered in programming of intensity and sprint distance[15].

Criteria-based Return to Sprinting Progression			
Stage 1: 50% Intensity (1:3 work to rest ratio)			
Objective: Build work capacity for anaerobic conditioning/endurance			
Step 1	**Step 2**	**Step 3**	**Step 4**
20 yd x 3 untimed	20 yd x 4 untimed	20 yd x 3	20 yd x 3
40 yd x 2 untimed	40 yd x 3 untimed	40 yd x 4	40 yd x 4
60 yd x 2 untimed	60 yd x 2 untimed	60 yd x 2	60 yd x 2
80 yd x 2 untimed	80 yd x 2 untimed	80 yd x 2	80 yd x 2
100 yd x 1 untimed	100 yd x 1 untimed	100 yd x 1	100 yd x 2
80 yd x 2 untimed	80 yd x 2 untimed	80 yd x 2	80 yd x 1
60 yd x 2 untimed	60 yd x 2 untimed	60 yd x 2	60 yd x 2
40 yd x 2 untimed	40 yd x 3 untimed	40 yd x 4	40 yd x 4
20 yd x 3 untimed	20 yd x 4 untimed	20 yd x 3	20 yd x 3
19 runs @ 940 yd	23 runs @ 1060 yd	23 runs @ 1100 yd	23 runs @ 1120 yd
Qualifier: Gradual build in acceleration from starting line with slow, controlled deceleration beyond end line			
Reprinted with permission by IJSPT. Lorenz D, Domzalski S. CRITERIA-BASED RETURN TO SPRINTING PROGRESSION FOLLOWING LOWER EXTREMITY INJURY. *Int J Sports Phys Ther*. 2020;15(2):326-332.			

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Criteria-based Return to Sprinting Progression			
Stage 2: 75% Intensity (1:5 work to rest ratio)			
Objective: Speed development, improve technique and build repeated sprint ability			
Step 1	**Step 2**	**Step 3**	**Step 4**
20 yd x 3	20 yd x 3	20 yd x 2	20 yd x 2
40 yd x 2	40 yd x 2	40 yd x 2	40 yd x 2
60 yd x 2	60 yd x 1	60 yd x 1	60 yd x 2
80 yd x 1	80 yd x 1	80 yd x 1	80 yd x 1
100 yd x 1	100 yd x 1	100 yd x 1	60 yd x 2
80 yd x 1	80 yd x 1	80 yd x 1	40 yd x 2
60 yd x 2	60 yd x 1	60 yd x 1	20 yd x 2
40 yd x 2	40 yd x 2	40 yd x 2	
20 yd x 3	20 yd x 3	20 yd x 2	
17 runs @ 780 yd	15 runs @ 660 yd	13 runs @ 620 yd	13 runs @ 560 yd
Qualifier: Rapid build in acceleration from starting line with moderate deceleartion beyond end line			
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Criteria-based Return to Sprinting Progression			
Stage 3: 90-100% Intensity (1:7 work to rest ratio)			
Objective: Achieve maximum effort. Work:rest ratio should replicate sport demands in step 3 & 4			
Step 1	**Step 2**	**Step 3**	**Step 4**
20 yd x 6	10 yd x 3	10 yd x 3	10 yd x 2
40 yd x 2	20 yd x 4	20 yd x 3	20 yd x 3
60 yd x 1	40 yd x 2	30 yd x 2	30 yd x 2
40 yd x 2	60 yd x 1	40 yd x 2	40 yd x 1
20 yd x 6	40 yd x 2	60 yd x 1	60 yd x 1
10 yd x 3	30 yd x 1	30 yd x 2	40 yd x 1
	20 yd x 1	20 yd x 3	30 yd x 2
	10 yd x 2	10 yd x 3	20 yd x 3
*Full subjective recovery	*Full subjective recovery		10 yd x 2
20 runs @ 490 yd	19 runs @ 460 yd	19 runs @ 440 yd	17 runs @ 420 yd
Qualifier: Maximal build in acceleration from starting line with moderate deceleartion beyond end line			
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Field/Court Sports Running & Sprinting Progression

This is a progressive running program that is broken up into 9 stages. Once an athlete demonstrates they can walk with a normal gait pattern they can begin this progression. Progression from one stage to the next may be achieved once the athlete can perform three repetitions at the intended intensity within the pain monitoring scale. It is recommended to complete no more than 9 reps per session.

Nine stage progressive running protocol based off Hickey et al[2]

Stage	Acceleration phase (Intensity/distance)	Hold phase (Intensity/distance)	Deceleration phase (Intensity/distance)
1	Walk / 20m	Jog / 10m	Walk / 200m
2	Walk / 15m	Jog / 20m	Walk / 15m
3	Walk / 10m	Jog / 30m	Walk / 10m
4	Jog / 20m	Run / 10m	Jog / 20m
5	Jog / 15m	Run / 20m	Jog / 15m
6	Jog / 10m	Run / 30m	Jog / 10m
7	Run / 20m	Sprint / 10m	Run / 20m
8	Run / 15m	Sprint / 20m	Run / 15m
9	Run / 10m	Sprint / 30m	Run / 10m

Walk = regular gait; Jog < 50% of perceived maximal running speed; Run < 70% of perceived maximal running speed; Sprint > 90% of perceived maximal running speed

*Progression from one stage to the next is determined when an athlete can perform three repetitions at the relevant upper limit intensity within pain guidelines

*Athlete should demonstrate 90% hamstring index prior to initiating sprint training[7]

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Agility Progression

Plyometric/Agility exercises can begin starting day 3 provided pain is not sharp and no greater than 1-2/10 and progressed pending the athlete's symptoms.[7] There are inconsistencies with the literature regarding the level of pain during agilities, therefore, clinical judgment should be used when progressing an athlete.[2,7] The incorporation of plyometrics and agility drills has been shown to increase hamstring peak torque and improve hamstring:quadriceps ratios.[7]

Agilities	
Exercise	**Dosage**
Butt kickers	50 yards x 2 sets
Carioca run	50 yards x 2 sets
Lateral shuffling	50 yards x 2 sets
4 Cone drill	Can vary per sport
Tuck jumps	8 jumps x 2 sets
Kangaroo hops (continuous)	15 x 2 sets
Bounding	10 hops x 2 sets
Ladder drills	Sets, reps may vary per athlete
Lunge walk with trunk rotation	10 yards x 2 sets
A skips	10 yards x 2 sets
B skips	10 yards x 2 sets

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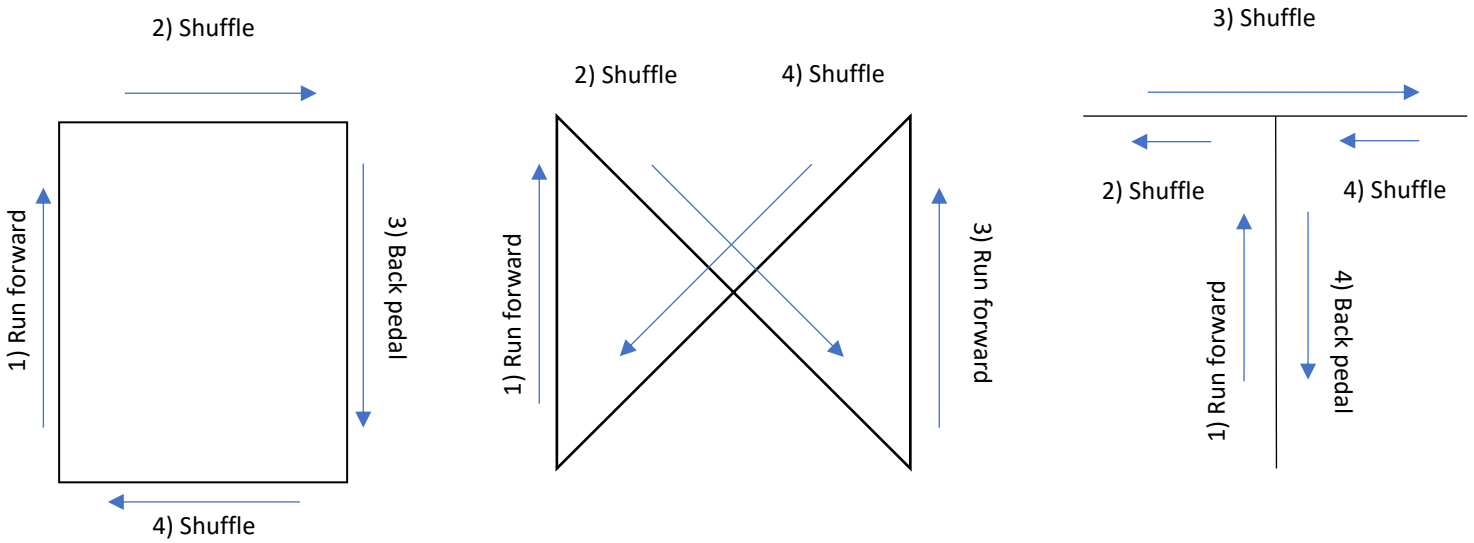
Example of 4 cone drills (5 yards apart):



As the patient's tolerance improves, distance between the cones can be increased to progress speed and volume. This will allow for increased stress demands and challenge deceleration control.

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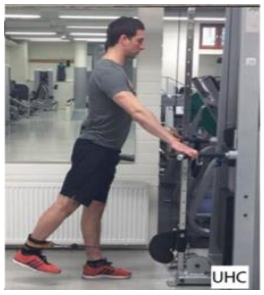
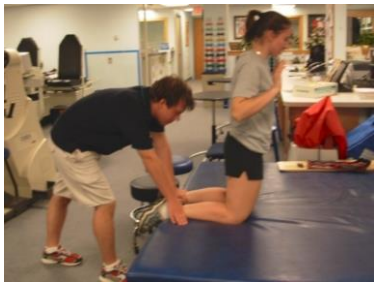
Appendix:

Bilateral hamstring bridge	Unilateral 45-degree hip extension	Upright hip extension conic-pully
		
Bilateral eccentric slider	**Nordic hamstring exercise**	**Single leg RDL**
		

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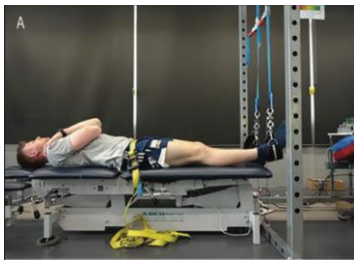
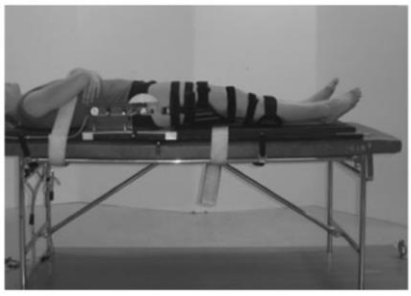
Return to sport testing:

Hip HHD at 0 degs/0 degs[11]	Single leg bridge test[12]	Active knee extension test[13]
		
Hip HHD at 90 degs/90 degs[11]	**H-Test[7]**	
	 	

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