A Rehabilitation program for a Grade 1 hamstring strain in a hockey player

The situation

*A 27 year old male hockey player with a suspected right hamstring muscle strain. The injury occurred today, approximately 6 hours ago. The patient is concerned because he has a major tournament in 4 weeks, which involves playing 4 matches in 10 days. The player indicates that it is his one big tournament for the year and is desperate to play. He has 4 months of no hockey after this tournament.*

### The clinical picture;

* Subjective findings *(what we ask the patient);*
  + Developed acute posterior thigh pain whilst sprinting (75% effort) at a training session as part of his fitness training
  + He felt a sudden mild grabbing pain mid-hamstring and came off the field immediately. He was able to jog but had pain and decided to go off the ground, taking no further part in training.
  + He was able to walk off the ground with a minimal limp and now has no pain with daily activities
  + His playing position is on the ‘wing’, which he states requires a high aerobic capacity and his style of play also involves regular, hard sprinting bursts during matches.
* Physical examination *(specific tests and movements we perform on our patient)*
  + Walking no limp
  + Can jog up to 50% of maximum effort with no pain. Moderate running speed (70% of maximum effort) causes mild pain but can do it. Was not tested at higher running intensity.
  + Restricted straight leg raise;
    - Right = 70°, restricted by mild posterior thigh pain (no increase pain intensity with dorsiflexion and cervical flexion)
    - Left = 90°, no pain
  + Pain (2/10 Visual Analogue Scale) with single leg hamstring bridge (strength test) on right leg only, but can do it
  + Resisted knee flexion in prone
    - Minimal pain with moderate resistance at 30o knee flexion. Strength R = 130Nm L = 212Nm (hand held dynamometer)
  + Tender on palpation just lateral to the midline, at the junction between the middle and upper 1/3 of the hamstring muscle group (possibly biceps femoris)
  + Lumbar spine is assessed (summary)
    - Flexion – full range restricted by right ‘hamstring’ pain
    - Extension – full unrestricted

SLUMP – R) No pain. Full range (0º Knee flexion)

L) No pain. Full range (0º Knee flexion)

* + - Palpation – hypomobile R mid-low lumbar facets. Overactive right paraspinal erector spinae / quadratus lumborum muscles
    - Real time ultrasound – good activation – transversus abdominus, pelvic floor muscles, quadratus femoris, multifidus
  + Assessment of ‘pelvic stability’ using a single leg squat indicates poor control
  + Unable to hop as he lacks confidence
* Past History
  + Two minor hamstring strains last season (missed 1 week both times). This time seems worse.
  + One episodes ‘acute’ low back pain last 3 months. No games missed.
  + Low back ‘stiff’ last one week before hamstring injury
* Investigations
  + MRI – 1 hour ago – reported as grade 1 biceps femoris strain

### Diagnosis;

*Low grade biceps femoris muscle strain injury.*

This player appears highly motivated to recover in time for a major tournament in 4 weeks. It is important to consider firstly whether returning to tournament-intensity function in this time frame is achievable, and secondly, whether recurrence of injury is likely within the tournament period of 10 days. This knowledge will serve to encourage the player to adhere to the rehab plan, and give him confidence in the lead up to the tournament.

Clinically, he has sustained a minor lateral muscle strain, perhaps precipitated by an adverse loading on the hamstrings subsequent to lumbo-pelvic stiffness and proprioceptive deficits. He does not appear to have any adverse neuromeningeal contribution, or core weakness contributing to his injury, but he does have a past history of recurrent hamstring injury.

Warren, Gabbe, Schneider-Kolsky & Bennell (2010) found that players able to achieve pain-free walking within 24 hours following hamstring strain were less likely to need longer than 3 weeks to return to competition compared with those who could not. However, they also found that lateral hamstring strains, and those with a past history are more likely to recur within the first 3 weeks of returning to competition, and recommended that a thorough rehabilitation be carried out in order to reduce the risk of recurrence.

Our hockey player should be reassured that as he is already jogging pain free, his prognosis for playing the tournament in 4 weeks is good, but that he must work hard to minimise the chance of breaking down during competition. This 4-week time frame should allow for the four stages of muscle healing described by Huard, Li, & Fu (2002) to occur adequately, namely degeneration, inflammation, repair, and scar tissue formation.

This rehab program will focus primarily on the trainable characteristics of strength, endurance and power (Kramer, et al., 2002), which are critical elements of the aerobic, but intermittently explosive requirements for playing in the position of wing. In order to optimise the training effect in a short timeframe, without overloading the muscles, periodised training programs can be used. This refers to “varying the training program at regular time intervals in an attempt to bring about optimal gains in strength, power, motor performance, and/or muscle hypertrophy” (Fleck, 1999, p.82).

Although a recent study by Apel, Lacey, & Kell (2011) found greater strength gains from traditional linear periodization compared to a weekly undulating regime, they concluded that this model suited a longer-term training program (>12 weeks). In the current setting of 4 weeks, a non-linear periodization will allow these different neuromuscular characteristics to be exercised in the same rehab phase, and should provide appropriate physiologic stimuli to the key muscle groups (Fees, Decker, Snyder-Mackler, & Axe, 1998). Only one characteristic is trained on a given day (e.g. strength, power, or endurance). The loading schedule (heavy, moderate or lighter resistance), along with alterations in volume and intensity can then be rotated over the course of the training sequence to address the remaining characteristics. (Kraemer et al., 2002)

Our program will consist of a 4-week mesocylce containing 4 microcycles, each of 1-week duration, with the aim of optimising neuromuscular adaptation, whilst limiting atrophy and scar formation at the injured area. Only key exercises to focus on the player’s main problems of decreased hamstring strength and pelvic stability are discussed. Functional stretching of the injured area, as well as lumbar mobility is included in the warm-up prior to each rehab session.

As the player will not have access to therapy during the course of rehab, no manual therapy or sports medicine intervention is included. The player will continue hockey skill training and aerobic conditioning with his coach, with instructions to maintain a sub-pain threshold for all activities, especially during stick drills, where his forward-flexed posture may adversely load the injured area.

Week 1

The week following injury is a transitional stage, allowing for “relearning”. Major aims include i) early minimisation of inflammation and fibrosis during the necrosis / inflammation stage (days 0-2); ii) to avoid disuse atrophy, encourage collagen organisation and promote neuromuscular adaptation by introducing light resistance training following onset of the repair stage (from day 2-3). Exercises will be light intensity, low volume to protect the regenerating muscle fibres from becoming more severely injured if the exercise or activity intensity is higher than the tolerated threshold (Taylor, Dalton Jr., Seaber, & Garrett Jr., 1993)

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| **Week 1** | | | |
| DAY | TRAINING TECHNIQUE | LOADING SCHEDULE | RATIONALE |
| 1 | Rest | R.I.C.E. | Resting immediately after trauma can prevent further retraction of the ruptured muscle stumps; Ice and compression is useful to reduce pain, oedema, the size of the hematoma and, subsequently, the size of the connective tissue scar (Jarvinen, Jarvinen, Kaariainen, Kalimo, & Jarvinen, 2005; Orchard et al., 2008) |
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| 2 | Rest | R.I.C.E. |
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| 3 | Light hockey skills  Pool session | Controlled movement within pain-free range | Maintaining cardio training and sport-specific skill load without stressing injured muscle beyond capacity helps avoid disuse atrophy |
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| 4 | Isometric heel-holds at varying degree of knee flexion | 2x20 reps; 5 second hold; within P1 | Jarvinen et al., (2005) recommends early commencement of isometric, isotonic and dynamic activity as soon as pain allows; Khan & Scott (2009) advocate mechanotherapy to load the injured muscle tissue to activate satellite cells, stimulate protein synthesis and improve alignment of regenerating myotubes |
|  | Concentric/Eccentric heel drop-catches | 2x 20 reps, varying speed limit P1 | Introduces eccentric hip-knee deceleration component involved in sprinting (Cameron, Adams & Maher 2003) |
|  | Theraband Hip/knee extension pulls in standing | 2x20; repeat bilaterally | Bilateral training allows for isometric element and introduces pelvic stability component |
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| 5 | Light hockey skills; Cardio session e.g. Bike |  |  |
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| 6 | Repeat as per DAY 4 | Loading adjusted by intensity & speed of contraction | Inflammatory stage should be completed by day 5, with the gap between injured parts of the muscle fibres becoming smaller; regenerated myofibrils are present (Hurme, Kalimo, Lehto, & Jarvinen, 1991) permitting small increase in resistance load |
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| 7 | Recovery Day |  |  |

Week 2

By day 7 there is significant reduction in inflammation with resolution of tissue oedema and haemorrhaging, and the gap between damaged muscle fibres is almost completely closed (Nikolau, McDonald, Glisson, Seaber, & Garrett, 1987; Hurme et al., 1991). Muscle force production should be between 80% and 90% of normal (Crisco, Joki, Heinen, Connell, & Panjabi, 1994; Nikolau et al., 1987). This allows for the introduction of more functional exercises, with more structured training loads. Running drills can be commenced at sub-pain threshold

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| **WEEK 2** | | | |
| DAY | TRAINING TECHNIQUE | LOADING SCHEDULE | RATIONALE |
| 1 | Warm up, including dynamic hamstring stretch & lumbar mobility |  |  |
|  | Dead Lift | 8-12 reps at 80% RM; 3 sets, 2-3 min rest | Recommended Strength training load (Kramer, et al., 2002) |
|  | Prone Curl |
|  | Arabesque |
|  | Interval Running Drill  *(accelerate / hold / decelerate)* | 65% Max pace  30m/20m/30m (x3)  25m/20m/25m (x3)  20m/20m/20m (x3)  15m/20m/15m (x3)  10m/20m/10m (x3) | Should be able to maintain good control in pain-free range; High degree of functional specificity as the drill mimics requirements of wing position with changes of speed and also requires aerobic fitness |
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| 2 | Hockey skills; Cardio |  |  |
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| 3 | Exercises as per Day 1 including warm-up | 15-20 reps at moderate velocity, 50% RM; 2 sets; 1-2 min rest | Recommended Muscular Endurance training load (Deschenes & Kraemer, 2002) |
|  | Running Drill *(as per Day 1)* | 70% max pace | Ensure sufficient rest time between exercise training and running (e.g. am rehab, pm running drill) |
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| 4 | Hockey skills; Cardio |  |  |
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| 5 | Exercises as per Day 1 including warm-up | 3-6 reps at 30-60%RM, with explosive velocity; 3 sets; 2-3 min rest | Recommended Power training load (Kramer, et al., 2002) |
|  | Running Drill *(as per Day 1)* | 75% max pace |  |
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| 6 | Pool recovery | Includes leg drills, kick-board and swimming |  |
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| 7 | Rest and recover |  |  |

Week 3

By day 14, scar tissue in the gap is more compact, and by the end of the week the gap between damaged fibers has virtually disappeared. (Hurme et al., 1991) The aim this week is to increase the training load by between 2-10% (larger increase for larger multi-joint exercises) and prepare the muscle for introduction of plyometric drills in the final week.

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| **WEEK 3** | | | |
| DAY | TRAINING TECHNIQUE | LOADING SCHEDULE | RATIONALE |
| 1 | Warm up, including dynamic hamstring stretch & lumbar mobility |  |  |
|  | Running Drill *(as per week 2)* | 75% Pace |  |
|  | Dead Lift | {Weight increased by 10% from week 2} 8-12 reps; 3 sets, 2-3 min rest | Multi-joint exercise should tolerate larger increase in load due to greater force production ability |
|  | Prone Curl | {Weight increased by 2% from week 2} 8-12 reps; 3 sets, 2-3 min rest | Single-joint, isolated muscle group needs care not to progress too quickly resulting in further injury, therefore only small incremental increase |
|  | Arabesque | {Weight increased by 5% from week 2} 8-12 reps; 3 sets, 2-3 min rest | Multi-joint exercise, but in unstable position with large leverage component, therefore only moderate increase |
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| 2 | Hockey skills; Cardio | Include lateral movements / agility drills |  |
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| 3 | Exercises as per Day 1 including warm-up | 15-20 reps at moderate velocity, 50% RM; 2 sets; 1-2 min rest | Strength Endurance - resistance proportionately increased |
|  | Running Drill *(as per week 2)* | 80% max pace |  |
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| 4 | Hockey skills; Cardio |  |  |
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| 5 | Exercises as per Day 1 including warm-up | 3-6 reps at 30-60%RM, with explosive velocity; 3 sets; 2-3 min rest |  |
|  | Running Drill *(as per week 2)* | 85% max pace |  |
|  | Plyometric Double-leg jumps | 6 reps, 3 sets; aim for max distance, minimal ground contact time | Kraemer et al. (2002) recommend inclusion of plyometrics to aid sprint ability; Double legged drill affords good control for early technique training |
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| 6 | Pool recovery |  |  |
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| 7 | Rest and recover |  |  |

Week 4

Increasing numbers of myofibers extend across, and very little scar tissue remains in the gap (Hurme et al., 1991). Although recovery of full strength after injury can take more than 40 days, muscle force production should be greater than 90% of normal by day 24 (Howell, Chelbourn, & Conaster, 1993; Crisco et al., 1994). In order to return to sport by day 29, high level running and power exercises need to be performed pain-free. Plyometric drills will be included in each running session, and running speed should aim for 95%. Given the pre-existing risk factors, and increased likelihood of recurrence within the first 3 weeks of return to sport, I would recommend maintaining a sub-maximal threshold for speed and power drills until the tournament is completed.

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| **WEEK 4** | | | |
| DAY | TRAINING TECHNIQUE | LOADING SCHEDULE | RATIONALE |
| 1 | Warm up, including dynamic hamstring stretch & lumbar mobility |  |  |
|  | Running Drill *(as per week 2)* | 90% Pace; carrying hockey stick |  |
|  | Plyometric single-leg hops | 6 reps, 3 sets; aim for max distance and speed |  |
|  | Dead Lift | {Weight increased by 10% from week 3} 8-12 reps; 3 sets, 2-3 min rest | Progressive loading, provided no increase in pain, and correct technique maintained |
|  | Prone Curl | {Weight increased by 2% from week 3} 8-12 reps; 3 sets, 2-3 min rest |
|  | Arabesque | {Weight increased by 5% from week 3} 8-12 reps; 3 sets, 2-3 min rest |
|  |  |  |  |
| 2 | Hockey skills; Cardio |  |  |
|  |  |  |  |
| 3 | Running Drill *(as per week 2)* | 95% Pace; carrying hockey stick |  |
|  | Plyometric single-leg hops | 6 reps, 3 sets; aim for max distance and speed |  |
|  | Dead Lift | 3-6 reps at 30-60%RM, with explosive velocity; 3 sets; 2-3 min rest | Power focus in preparation for return to sport |
|  | Prone Curl |
|  | Arabesque |
|  |  |  |  |
| 4 | Hockey skills; Cardio | Simulated match practice; submaximal intensity |  |
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| 5 | Running Drill | 95% Pace; carrying hockey stick |  |
|  | Exercises as per Day 3 | Load as per Day 3 | Power focus in preparation for return to sport |
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| 6 | Fitness test for return-to sport | Agility drills; change-of-pace running; Match intensity skill practice | Controlled environment allows for careful introduction of higher-risk activity |
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| 7 | Recovery Assessment following fitness test | Manual strength test; Muscle length test; palpatory assessment | Clearance to return to play, provided no latent pain or loss of function following fitness test |

CONCLUSION

This program, (although not exhaustive in its inclusions) demonstrates a periodised approach to rehabilitation that should facilitate adequate neuromuscular adaptive changes in the injured area to permit return to full function within the short timeframe available. Further assessment of complete lower limb biomechanics and strength should be undertaken in the off-season in order to identify and address any other potential risk factors for further injury recurrence.

1065 words

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