



PREVENTATIVE EXERCISE PROGRESSION FOR HAMSTRING STRAIN

There are 4 components of a proper hamstring prevention program. These are aimed to incorporate the many ways that the hamstring is used in sport where it is most commonly injured; the muscle has the ability to stretch statically and dynamically, contract concentrically and eccentrically and also performs in rapid changes between the concentric and eccentric motions as in plyometric activity.

Before any activity, including stretching, it is important to warm up properly to increase blood flow to the muscles for effective stretching and to reduce the risk of injury. Examples of proper warm up include jogging, biking, jump rope, jumping jacks, etc.

- Static stretching; should be performed for 30 seconds each with no ballistic movement at end range.
o Pike
o Hurdles left and right
o Straddle
o Supine Hamstring stretch with belt
o Standing Hamstring stretch with anterior pelvic tilt
o Splits (gymnasts, cheerleaders, figure skaters, dancers, etc)
• Dynamic stretching; walking dynamic stretches should be performed for as many stretches as possible within approximately 10 yards.

Walking quad stretch



Walking knee to chest



Frankensteins



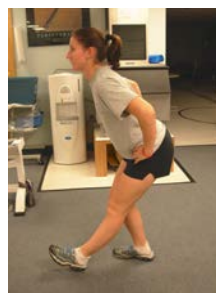
Side Lunges



Inch Worms



Walking hamstring stretch



Helicopters Stepping Backwards



High Knees
Butt Kicks

Leg swings – these are performed stationary with one hand supported for balance. Swing straight leg forward until stretch is felt and then repeat into hip extension, progressively increasing the range.



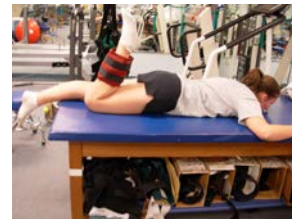
Plyometrics: These are important exercises for the prevention of hamstring strain due to their ability to use the hamstring muscle at its greatest length and highest force. Please see plyometric program embedded in this rehabilitative program.

- **Progressive Resistive Exercises** are also required to increase the strength of the hamstring to further prevent injury.

Standing Hamstring curls



Prone hamstring curls



Concentric hamstring curls



Eccentric Hamstring curls



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Romanian Dead Lifts



REHABILITATION AND EXERCISE PROGRESSION AFTER GRADE II HAMSTRING STRAIN

Notes:

- Muscle most commonly affected is long head of the biceps femoris, usually just proximal to the musculotendinous junction 6-16 cm proximal to the knee joint.
- Immobilization if required should be in the lengthened position and should not last longer than 1 week
- The use of NSAIDs is controversial in the first few days because of the potential for impeding healing; evidence suggests that NSAIDs have no additive effect on the healing rate.

Acute Phase (3-4 times a day)

- Rest (immobilization in a lengthened position for no longer than 1 week, then relative rest)
 - No antalgia with gait: if antalgic, supplement with assistive device
 - Gentle stretching (pain less than 3/10)
- Ice in lengthened position (in long sitting with as much active pain free knee flexion and extension as possible)
- Compression and elevation until thigh girth stabilizes
- NSAIDs no sooner than 2-4 days after injury
- Retrograde massage may be implemented for swelling control. DTM may begin when girth is stabilized
- Modalities- sensory Estim can be used

Criteria for progression: No increase in thigh girth measured 8 cm proximal to the patella; SLR to 80° with an estimation of 3 or less on a numeric rating scale where 0 = no pain and 10 = maximal pain

Test: The foot is plantar flexed and the examiner slowly (about 30°/s) raises the leg

Subacute Phase: day 3 to >3 weeks

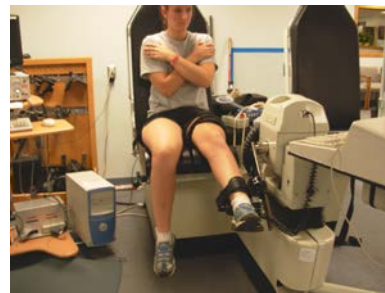
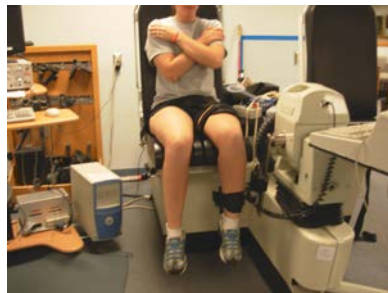
- Stretching (3-4 times/day)
 - Progressively increase stretch to full ROM (stretched across hip and knee) exercises.
 - Self stretching
 - Begin with standing technique with anterior pelvic tilt
 - Progress to aggressive self-stretching and partner stretches
- Strengthening progression (daily)
 - Isometric knee flexion
 - begin with sub-maximal isometric holds at multiple joint angles (0°, 30°, 60°, 90°) and progress to maximal holds



- Stool scoots
 - Athlete sits on wheeled stool and plants heel into floor and uses hamstring to propel forward. Progress with distance and to single leg.



- Start with Seated concentric isokinetic exercises (CON/ECC 50-75°/s or isotonic)
- Move towards higher and lower speeds with more force



- Seated hamstring curls
 - Begin at 30% of 1RM of contralateral hamstring 3-4 sets of 10 repetitions – progress to 60%

- Deep Tissue Massage (daily)
 - Depth and forcefulness may be increased as the need arises to reach the target tissue that may be deeper
- Cardiovascular fitness (up to 2 sessions per day)
 - UBE
 - stationary biking
 - other controlled activities
- Modalities prn



Criteria for progression within this phase: Complete the activity with estimation of 3 or less on a numeric rating scale where 0 = no pain and 10 = maximal pain.

Complete concentric seated strengthening progression and achieve full ROM with estimation of 3 or less on a numeric rating scale where 0 = no pain and 10 = maximal pain.

Remodeling Phase: 1-6 weeks

- **Stretching progression** (3-4 times/day)
 - Maintain or increase muscle length using aggressive frequent stretching (passive, self and partner stretches) encourage exercise through the full ROM
- **Strengthening progression** (daily to every other when at power volume)

- Begin more aggressive concentric strengthening

- Seated hamstring curls
 - 60-80% of 1RM of contralateral leg
 - Begin with strength volume (high weight, low reps) and move to power volume (faster speeds)



- Standing hamstring curls
 - Can be performed with machine or ankle weights.
 - Begin with strength volume (high weight, low reps) and move to power volume (faster speeds)



- Prone hamstring exercises (introduces eccentric component)

- Start with prone curls with ankle weights at 30% of 1RM of contralateral hamstring 3-4 sets of 10 repetitions.
- Progress to strength and power volumes
- Progress to eccentric contraction via ankle weights with concentric assistance or manual resistance.



- Manual prone eccentric/concentric hamstring curls

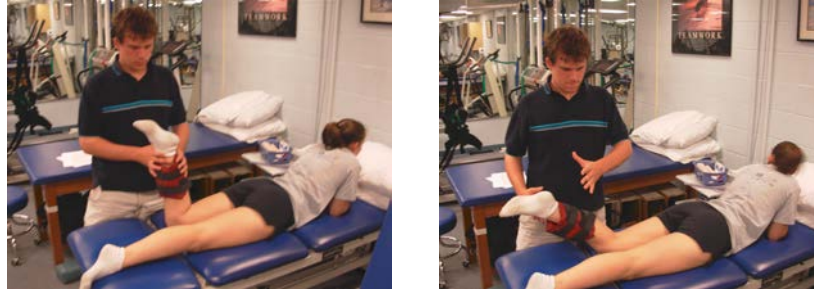
- Athlete lays prone while manual resistance is applied distally. He/She contracts the hamstrings concentrically against resistance and continues to contract as resistance increases to bring the foot down eccentrically.
- This allows for the athlete to be strengthened in pain free range and more focus can be paid to weakness in certain ranges, especially closer to full extension.



- Prone leg dropping

- Athlete lies prone with knee flexed and foot in air. Gently move foot back and forth to stimulate relaxation. Drop the foot suddenly and have athlete catch the foot as soon as they feel it released. Progress to 1 or 2 lbs and/or push leg instead of drop to increase loading.

- This helps the athlete regain their proprioceptive sense that may have been lost secondary to weakness and immobilization from injury. With a heightened proprioceptive sense the athlete may be able to better detect the position of the hamstring, which may decrease their risk of re-injury.

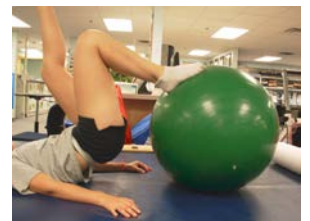


- Progress to seated eccentric hamstring curl
 - Load weights at 120 % of 1 RM of single leg hamstring curl. Use two legs for concentric motion. Release one leg and allow single leg to release weight in a controlled fashion. Progress weights appropriately.
 - Progress to prone position



- Progress to prone isokinetics (CON/ECC beginning at high speeds (240/240) and gradually decreasing the speed (120, 90, and 60), through pain free range.
 - Progress to strength and power volumes

- Hamstring ball rolls
 - The athlete lays supine with a ball under his/her leg(s).
 - Roll the ball towards the body by flexing the leg while maintaining trunk and hip stabilization.
 - This exercise can be progressed from
 - 2 feet using theraball
 - 1 foot using theraball
 - 1 foot using medball, other foot in air.



- Nordic hamstrings
 - Athletes are kneeling with feet fixed. Instruct athlete to fall forward and use hamstring to control descent for as long as possible then catch themselves on the table with their hands. Athlete forcefully pushes with hands to return to starting position to decrease concentric load to the hamstrings. With two people begin with maximum assistance using a belt around the athlete's waist to assist them when they lean forward. With one person place the ball in front of patient to allow patient to push up and decrease the eccentric load
 - Progress by decreasing assistance, and increasing range until fall.
 - Once patient can withstand whole range of motion, increase load by adding speed to the starting phase. The partner can also push on the patient's shoulder to increase difficulty. For variation person can hold down legs with different forces to load one side more than another



Plyometric progression

In this case, plyometric exercise is used to strengthen the hamstrings while regaining the neuromuscular properties needed to effectively perform sport specific activities.

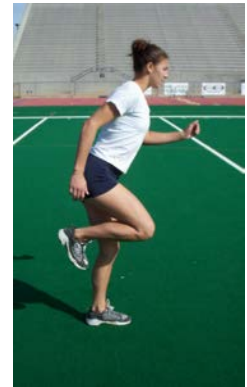
Plyometric exercise is based on the principle of utilizing the muscle's stretch reflex with stores energy through its eccentric phase of contraction. If utilized quickly, the energy stored can produce more force output during the concentric event. This brief moment between the two phases is the amortization phase. When performing plyometric exercise it is essential to perform a rapid eccentric phase to decrease the amortization time. They should be progressed systematically for proper overload; typically low intensity with high volume up to high intensity with low volume. It is also important to warm up properly in a plyometric fashion, which can be incorporated in the dynamic warm up. An appropriate plyometric warm up for these particular exercises include:

- Marching
- Jogging
- Toe jogging to warm up a quick reaction time
- Straight leg jogging to prepare for impact exercises
- Butt kicks for stretching
- Exaggerated skipping
- These motions should also be progressed from 50% effort up to 100% effort to decrease the risk of re-injury.

This list is in order from easiest to hardest and should be progressed from one to another when completed with 100% effort while abiding by previously stated criteria for progression.

1. Cycle split jump

- Athlete stands in half lunge
- Perform jump, switching feet in the air with emphasis on pulling backwards landing with feet opposite the starting position.
- Land and repeat jump with effort emphasized on decreasing the ground-contact time.



2. Running Butt Kicks

- Begin running by flexing your knee and bringing your heel back and around to your buttocks. Maintain a slight forward lean throughout the drill, and stay on the balls of your feet. Complete 20 kicks within 10 yards.
- Maintain a quick, yet shallow arm swing, keep your elbows at 90° and drive your hands from chest to front hip pocket.



3. Running High Knees

- Execute proper running form; keep your elbows at 90° and drive your hands up to chin level and back to your rear pocket. Stay on the balls of your feet, and drive your knees up as high as possible, and then down as quickly as possible.

4. Pogo jumps with knees to butt

- Athlete stands erect, feet comfortably hips width apart
- Perform straight jump and pulls heels towards the buttocks
- Land and repeat jump with effort

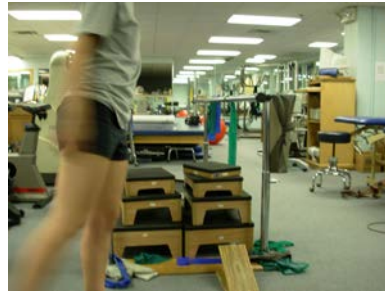
emphasized on decreasing the ground-contact time.

5. Rollerboard Hamstring pulls

- Athlete lays supine with back on rollerboard.
- The athlete's legs are fixed either with a partner holding them or fixed to a stationary object.
- The athlete then flexes and pushes away from his/her feet with emphasis on decreasing the turn around time between flexion and extension



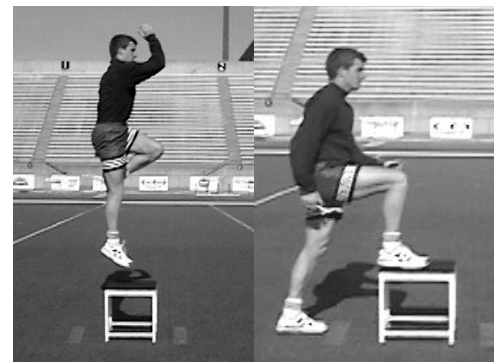
6. Leg Swings (bent knee and straight knee)
 - a. The athlete stands erect with one hand supported for balance.
 - b. The athlete swings his/her leg forwards until he/she feels a slight stretch
 - c. Quickly and powerfully push the leg down into full hip extension and let the leg gently swing back into hip flexion with emphasis on decreasing the time between flexion and extension.
 - d. This can also be done with the knee flexed to isolate the hamstrings. Start by flexing the knee up, then extending it forward, forcefully bend the knee downwards until almost straight, and then continue to forcefully drive the leg up towards the butt with the knee bent. Then flex the hip to the starting position and repeat (Claw)



7. Heel toss with med ball
 - a. Athlete is hanging from pull up bar with medball squeezed between his/her heels
 - b. From a stand still position, the athlete throws the ball backwards with forceful hip extension and knee flexion.
 - c. A partner must retrieve the ball and replace it between the athlete's feet.
 - d. This exercise can be progress by using a heavier medball.

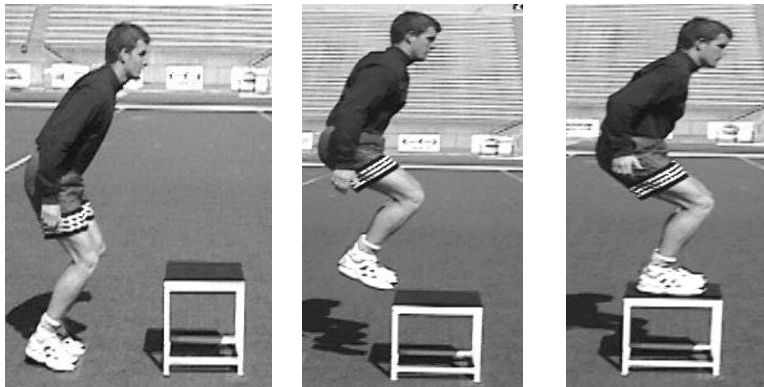


8. Box step up and jump
 - a. Place an 18" box in front of you. Place your right foot on top of the box. Push off with your right foot and jump into the air. Land in the same position as you started. Perform the set then alternate legs.
 - b. Emphasize the quick contraction and minimal ground contact time to get as high as possible. Use your arms to help you explode up.
 - c. Variations: Perform with dumbbells or Turn 180-degrees in the air and land on opposite side of box



9. Box Jumps

- a. Stand facing a 12"-18" box. Keeping your feet together, jump up onto the box. Immediately hop back down and then explode back up in one movement emphasizing minimal ground contact time. Use your arms explosively to help propel you up and push off your toes.
- b. Variations: Move on to higher boxes of 24" – 48". On the higher boxes always step down do not jump.

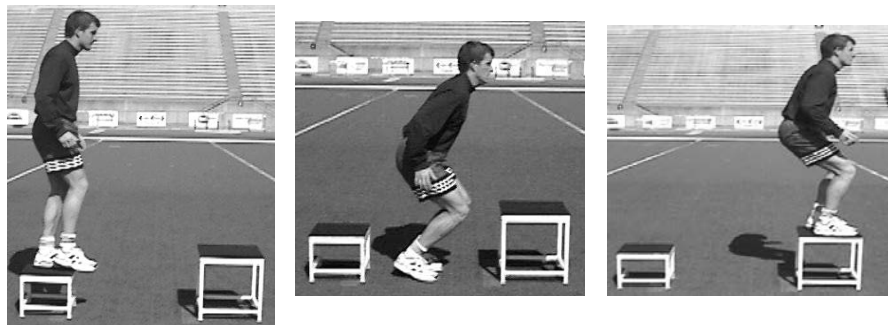


10. Depth Jumps

- a. Stand on top of a 12" box. Place a 12"-18" box about two YDS in front. Drop down off the 12" box landing with your feet close together. Explode up onto the 12"-18" box and stick your landing. Step down and repeat the jump emphasizing rapid change in direction.
- b. Keep your feet close together when landing on the ground or on the box. Bend your knees when landing on the ground and use your arms to help you explode up. Variations: Progress to higher boxes. 18" box on to 24" – 48" boxes.

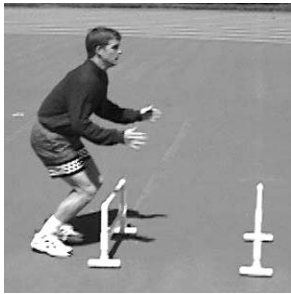
11. Forward Depth Jumps in Series

- a. Set up a series of 6-8 boxes 12" - 48" high and ~1 YD apart. Begin by standing atop the first box. Drop down to the ground and then explode up onto the second box. Continue through the series using your arms explosively decreasing ground contact time.
- b. Variations: Perform the depth jump series laterally. Perform the depth jump series on single leg



12. Forward Hurdle Hops – over and back

- a. Stand facing a series of 6-8 hurdles at 12"-18" high and one YD apart. Hop over the first hurdle then over the second. As you land over the second hurdle, immediately hop backwards over the second hurdle, then forwards again decreasing the ground contact time. Use your arms explosively and tuck your knees into your chest. Maintain your balance by keeping your torso upright and your body's center of gravity over the hurdle.
- b. Hop over the third hurdle, then the fourth, now repeat over and back hop on the fourth hurdle. Carry on through the series performing over and back hops every other hurdle. (Hop forwards over "odd" number hurdles; hop over and back over "even" numbered ones.)
- c. Variations: Explode into a 15-YD sprint, Go up for a header over the last hurdle and explode into a 15-YD sprint.



- Jogging/running progression
 - See attached for Field and Road Running Progression

Criteria for progression within this phase: Complete the activity with estimation of 3 or less on a numeric rating scale where 0 = no pain and 10 = maximal pain.

Criteria for progression to next phase: Complete running progression. Able to perform 10 Nordic Hamstring exercises with minimum assist and no pain

Return to activity: 2 weeks to 6 months

- Running activities are increase from jogging at low intensity to running and finally sprinting (please see attached running progression)
- High intensity plyometrics
- Agility and sport/position specific drills (please see attached agility reference)

MAINTAIN FLEXIBILITY AND CONTINUE PROTECTIVE ECCENTRIC PROGRAM

Field Sports Running Progression (Distances based on 100 x 50 yard field)

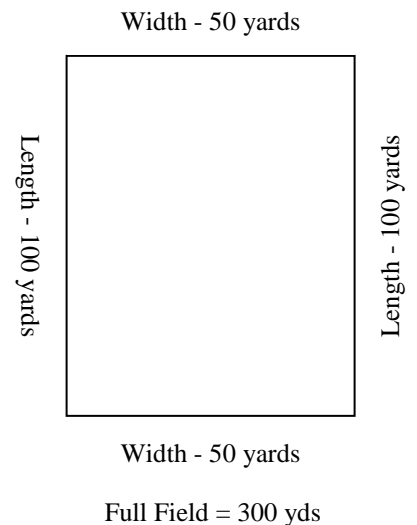
Level 1	Walk ½ field then jog ½ field – repeat for 5 laps total
Level 2	Walk ½ field then jog full field – repeat for 6 laps total (~1 mile)
Level 3	Walk ½ field then jog 2 full fields – repeat for 9 laps total (~1.5 miles)
Level 4	Walk ½ field then jog 3 full fields – repeat for 9 laps total (~1.5 miles)
Level 5	Jog full 12 laps (~2 miles)
Level 6	Jog full 15 laps (~2 ½ miles)
Level 7	Jog full 18 laps (~3 miles)

**** Levels 8 through 17 should be progressed to tolerance. Once at maximum level of time suggested continue to next level abiding by criteria for progression ****

Level 8	Alternate between running and jogging every field and a half
Level 9	Alternate between running and jogging every 2 fields
Level 10	Run full 18 laps (3 miles)
Level 11	Jog ½ field, then run ½ field, then sprint for width of field, then run ½ field and repeat. – 12 laps (2 miles)
Level 12	Run ½ field then sprint a width of a field and repeat – 10 times
Level 13	Run ½ field then sprint a length of a field and repeat – 10 times
Level 14	Jog ½ field then sprint a width of a field and repeat – 10 times
Level 15	Jog ½ field then sprint a length of a field and repeat – 10 times
Level 16	Sprint width of a field then rest 2 minutes and repeat – 10 times
Level 17	Sprint length of a field then rest 2 minutes and repeat – 10 times

Soreness rules: (your pain)

- If sore during warm-up, take 2 days off and drop down 1 level
- If sore during workout, take one day off and drop down 1 level
- If sore after workout, stay at same level



Road Running Progression

Based 12 minute jogging mile/8 minute running mile

Level 1	Walk 2 minutes then jog 2 minutes – repeat for total 35 minutes
Level 2	Walk 2 minutes then jog 3 minutes – repeat for 32 minutes
Level 3	Walk 2 minutes then jog 4 minutes – repeat for 30 minutes
Level 4	Walk 2 minutes then jog 5 minutes – repeat for 28 minutes
Level 5	Jog full 2 miles – 24 minutes
Level 6	Jog full 2 ½ miles – 30 minutes
Level 7	Jog full 3 miles – 36 minutes

**** Levels 8 through 17 should be progressed to tolerance. Once at maximum level of time suggested continue to next level abiding by criteria for progression ****

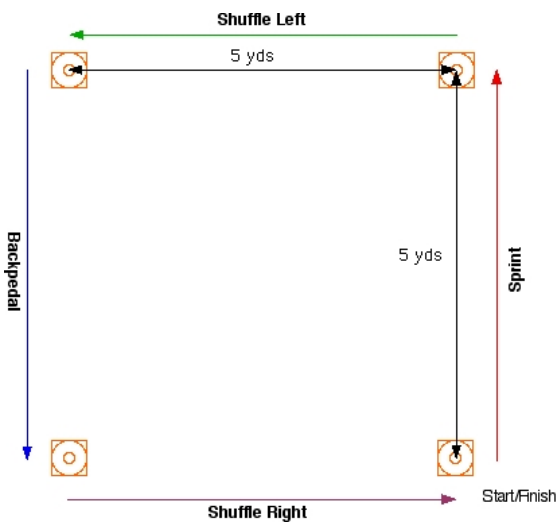
Level 8	Alternate running for 2 minutes and jogging for 3 minutes – 30 minutes
Level 9	Alternate running for 5 minutes and jogging for 2 minutes – 28 minutes
Level 10	Run full 3 miles – 24 minutes
Level 11	Jog 2 minutes then run for 2 minutes then sprint for 30 seconds, then run 2 minutes and repeat – 30 minutes
Level 12	Run 2 minutes sprint 15 seconds and repeat – 24 minutes
Level 13	Run 2 minutes sprint 30 seconds and repeat – 24 minutes
Level 14	Jog 2 minutes sprint 15 seconds and repeat – 24 minutes
Level 15	Jog 2 minutes sprint 30 seconds and repeat – 24 minutes
Level 16	Sprint 15 seconds then rest 2 minutes – 24 minutes
Level 17	Sprint 30 seconds then rest 3 minutes – 24 minutes

Soreness rules: (your pain)

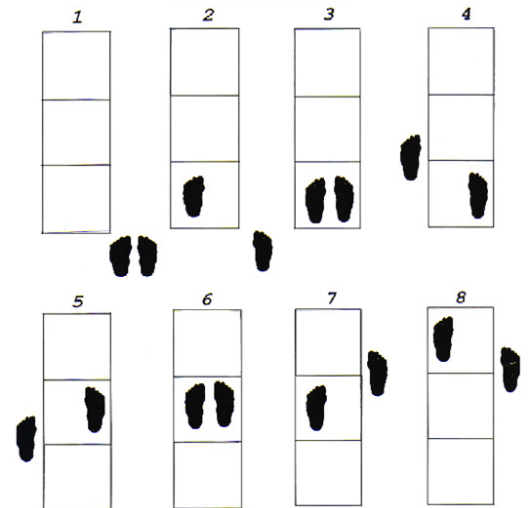
- If sore during warm-up, take 2 days off and drop down 1 level
- If sore during workout, take one day off and drop down 1 level
- If sore after workout, stay at same level

Agility Drills Progression

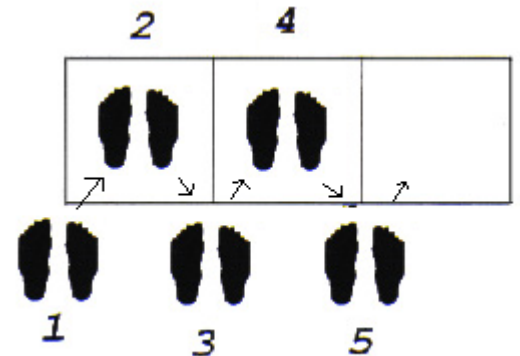
- Backward Running
 - Run backwards, progressing distance, speed, and % effort
- Ladder High Knees
 - Run through ladder with maximal hip and knee flexion increasing speed and % effort
- Back Ladder
 - Run through ladder backwards increasing speed and % effort
- Cross Ladder
 - Start on L side of ladder, place R foot in ladder, followed by L, place R foot out of ladder followed by L. Place L foot back into ladder, followed by R, place L foot out of ladder followed by R. Repeat until end of ladder. Progress by increasing speed and % effort.



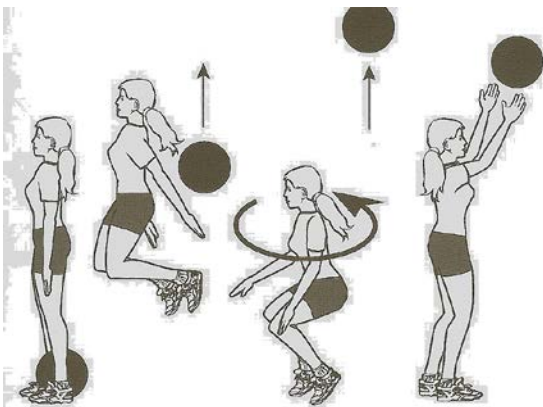
- 20 Yard Square
 - Start in 2 pt stance, sprint five yards to first cone make sharp R cut. Shuffle R five yards, make sharp cut back. Backpedal 5 yds to next cone, make sharp cut L. L shuffle through finish.



- In and Out Shuffle
 - Start in 2 pt stance; stand on side of the ladder facing the first box. Jump with both feet into first box, then back to starting position, then jump to second box, and jump straight backwards, repeat pattern through ladder



box, then back to starting position, then jump to second box, and jump straight backwards, repeat pattern through ladder



- Flip and Catch
 - Start in standing position, placing medicine ball tightly between both feet. Proceed to jump into the air, kicking the ball into the air behind you. After landing quickly turn and catch the ball before it hits the ground.

These exercises can be modified to meet sport and positions specific demands.

References

- Askling C, Karlsson J, Thorstensson A. Hamstring injury occurrence in elite soccer players after preseason strength training with eccentric overload. *Scand J Med Sci Sports*. 2003 Aug;13(4):244-50.
- Askling C, Saartok T, Thorstensson A. Type of acute hamstring strain affects flexibility, strength, and time to return to pre-injury level. *Br J Sports Med*. 2006 Jan;40(1):40-4.
- Baechle T, Earle R. Essentials of Strength and Conditioning, 2nd Edition. Hong Kong: Human Kinetics. 2000
- Brown L, Ferrigno V, Santana J. Training for speed, agility, and quickness. United States: Human Kinetics. 2000.
- Chu D. Jumping into plyometrics. United States: Leisure Press. 1992
- Kaminski T, Wabbersen C, Murphy R. Concentric Versus Enhanced Eccentric Hamstring Strength Training: Clinical Implications. *J Athl Train*. 1998 Jul;33(3):216-221
- LaStayo P, Woolf J, Lewek M, Snyder-Mackler L, Reich T, Lindstedt S. Eccentric muscle contractions: their contribution to injury, prevention, rehabilitation, and sport. *J Orthop Sports Phys Ther*. 2003 Oct;33(10):557-71.
- Mjolsnes R, Arnason A, Osthagen T, Raastad T, Bahr R. A 10-week randomized trial comparing eccentric vs. concentric hamstring strength training in well-trained soccer players. *Scand J Med Sci Sports*. 2004;14:311-317.
- Peterson J, Holmich P. Evidence based prevention of hamstring injuries in sport. *Br J Sports Med*. 2005 Jun;39(6):319-23.
- Radcliff J, Farentinos R. High-powered Plyometrics. Champaign, IL: Human Kinetics. 1999.
- Werner, Gregory A., "JMU Strength and Conditioning – Plyometric Training." 2004
http://orgs.jmu.edu/strength/JMU_Summer_2000_WebPage/JMU_Summer_2000_Sections/10P_Summer_Plyometric_Training_Info.htm
- Worrell T. Factors associated with hamstring injuries. An approach to treatment and preventative measures. *Sports Med*. 1994 May;17(5):338-45.

**This Clinical Guideline may need to be modified to meet the needs of a specific patient.
The model should not replace clinical judgment.**