Adopted 7/99
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Knee Rehabilitation Tubing Exercises*

These exercises can be applied to a wide variety of patients, ranging from those with complete anterior cruciate ligament reconstruction to those with nonsurgical injuries.

The objective of this protocol is to increase strength in the supporting knee muscles throughout a functional range of motion. However, range of motion exercises must not compromise or re-injure the involved knee. Ultimately, by progressively increasing the number of repetitions to improve muscular endurance, a return to full functional activities is anticipated.

A comprehensive knee rehabilitation program should include

1. Hamstrings and quadriceps strengthening exercises.
2. Open-chain, isotonic exercises performed through a pain-free range.
3. Closed-chain strengthening exercises (the involved extremity is loaded while the distal portion is fixed). These exercises will promote synergistic contraction of the thigh muscles while limiting anterior tibial glide. This can be particularly useful for post-surgical ACL reconstruction patients.

Elastic tubing can be used to perform these exercises effectively. It offers the dual advantages of providing inexpensive variable resistance while also being suitable for in-home rehabilitation. The following five exercises have great adaptability in a variety of clinical situations.

Please Note: Read the entire protocol before recommending any of these exercises to your patients. Remember that these protocols are general guidelines and patients will progress at different paces for a variety of reasons.

***Five Knee Rehabilitation Exercises*[1]**

1. ***Double knee dip***
2. ***Single knee dip***
3. ***Leg press***
4. ***Hamstring pull***
5. ***Side-to-side jump***

*See accompanying video, Conway, O. "Knee Rehabilitation Tubing Exercises."

1. Double Knee Dip

Technique: Stand on tubing with both feet. Hold one end of the tubing in your right hand, the other end in your left hand. The tubing should be taut. Perform the dip with both legs simultaneously, with the tubing held at waist level during each dip. Hold a neutral pelvis throughout the exercise.

Prescription: Perform one dip every 2 seconds, or 30 dips per minute, allowing 1 second per flexion phase and 1 second per extension phase. Perform one set of 30 dips in a pain-free range, gradually working up to 3 sets of one minute each.

Rationale: The double knee dip will cause notable quadriceps activity and significant tibialis anterior recruitment. The vastus medialis will be the most active, followed by the tibialis anterior. EMG studies by Ciccotti et al. demonstrated that quadriceps activity during the double knee dip was equal to or greater than during running.[2] This is an example of a closed chain exercise.

Caution: For patients with patella tracking problems, do not perform this exercise at knee angles greater than 60 degrees

2. Single Knee Dip

Technique: Stand on tubing with the involved extremity. Anchor one end of the tubing in a door jamb or around a chair. Hold the other end of the tubing in the same-side hand. Tubing should be taut. Hold on to a chair or a stationary object with your other hand for balance. Perform single leg dips with the tubing hand held at your waist level during each dip. Maintain a neutral pelvis throughout the exercise.

Prescription: Perform one dip every 2 seconds, or 30 dips per minute, allowing 1 second per flexion phase and 1 second per extension phase. Perform one set of 30 dips per minute in a pain-free range, gradually working up to 3 sets of one minute each.

Rationale: The single knee dip will cause pronounced activity in all quadriceps muscles, with the vastus medialis working slightly harder. EMG studies by Ciccotti et al. demonstrated that quadriceps activity during the single knee dip was equal to or greater than that during running.[2] This is an example of a closed chain exercise.

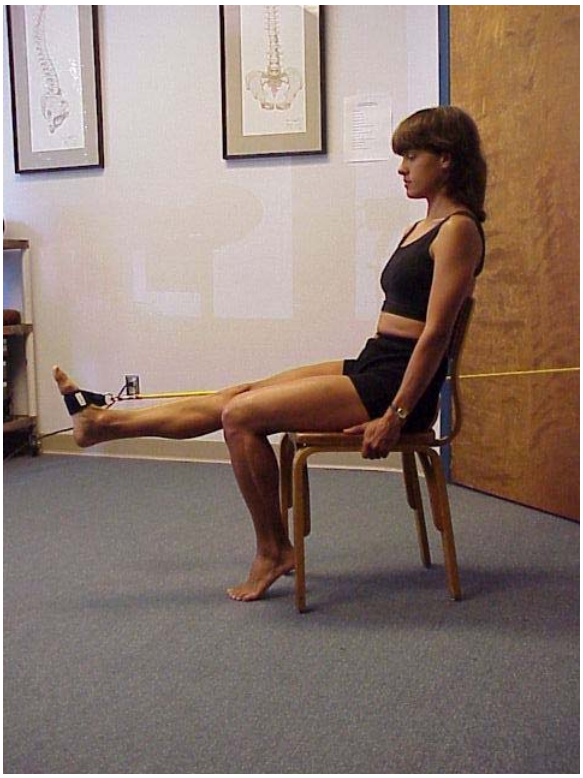
Caution: For patients with patella tracking problems, do not perform this exercise at knee angles greater than 60 degrees. **Note:** A straight leg has a knee angle of 0 degrees. As the knee bends from this position, knee angles numerically increase.

3. Leg Press

Rationale: Sit in a chair and place the tubing collar over the ball of the foot of the involved extremity. Anchor the other end of the tubing to a door jamb behind you at your seated hip height. The tubing is slightly taut with your knee and hip in maximal flexion.

Prescription: Perform a leg press by extending your knee and hip simultaneously. Allow your knee to return to your chest during the knee and hip flexion phase, at a rate of 20 presses per minute. Perform one set per minute (20 presses) in a pain-free range, gradually working up to 3 sets of one minute each.

Rationale: The leg press will result in substantial rectus femoris and tibialis anterior activity, though less than in the double dip. This is an example of an open chain exercise.

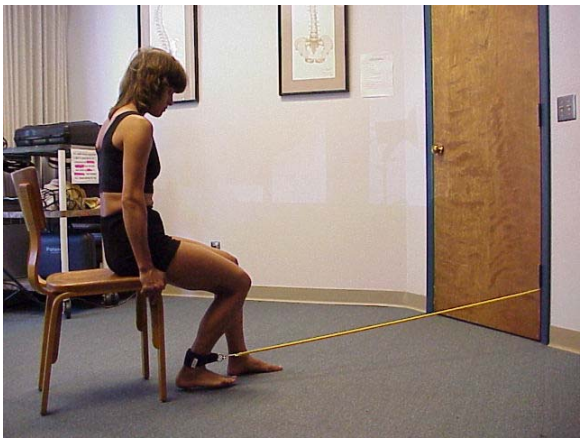


4. Hamstring Pull

Technique: Sit at the edge of a chair and place the tubing collar around your ankle, just above the heel on the involved extremity. Anchor tubing to the facing wall, 12 inches above the ground. Knee is flexed 10 to 20 degrees with the tubing taut.

Prescription: Flexing your knee as far as possible, drag your foot along the floor. Then lifting your ankle slightly, straighten out your knee, returning to the starting position. Perform one set of 20 pulls in a pain-free range in one minute, gradually increasing to 3 sets of one minute each.

Rationale: The hamstring pull will promote pronounced hamstring and adductor firing, with the medial hamstring being the most active. EMG studies by Ciccotti et al. shows that this exercise produces greater medial hamstring activity than running.[2] This is an example of an open chain exercise.



5. Side-to-Side Jump

Technique: Tubing is anchored to a wall or in a door jamb at waist level. The other end is attached to the right side of a belt around your waist. The tubing should be slightly taut. Mark an initial position on the floor for reference. The exercise involves a lateral jump of about 3 feet, with only one foot in contact with the floor at a time. Begin by pushing off with your right leg, and land on your left foot. Immediately push off with your left leg, and land on your right foot. Continue hopping back and forth, from one foot to the other.

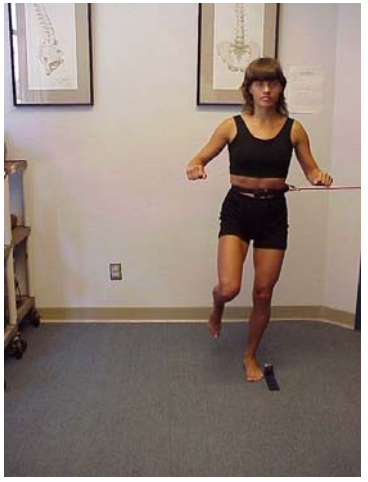
Prescription: Repeat in a slow, controlled manner at a rate of 25 side-to-side jumps per minute. Then switch the tubing to your left waist and repeat 25 side-to-side jumps per minute, beginning with a right to left jump. Repeat 2 sets of 25 jumps per minute on each side.

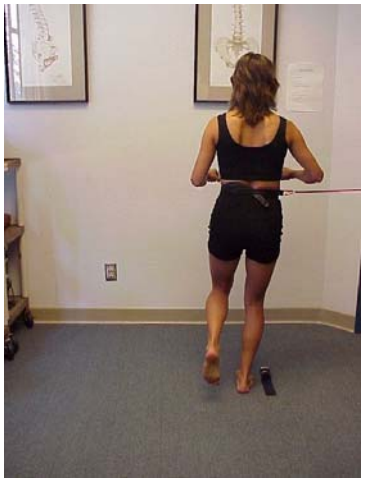
Rationale: The side-to-side jump will feature the greatest overall muscle activity of the five exercises, with the quadriceps and gastrocnemius being the most active at push-off. EMG studies by Ciccotti et al. demonstrated that quadriceps activity during the side-to-side jump was equal to or greater than that during running, and gastrocnemius activity was equal to running.[2] This can be an intense exercise and is usually added in the later phases of knee rehabilitation.

Securely attach or tie tubing to belt.

Side-to-Side Jump. Place a marker on the floor as a starting point. Jump approximately three feet from the marker and then back again, hopping from foot to foot.





Recommended Rehabilitation Sequence

These five exercises can be applied to a wide variety of patients, from nonsurgical sprain/strains to complete anterior cruciate ligament reconstructions.[3]

This program can be accomplished either through a continuum of exercise progression that increases muscle activity, or through a single exercise that gradually increases the resistance.

Note: Make sure all exercises are performed in a pain-free range.

Program 1 (Hintermeister et al.)[1]

For nonsurgical injuries

Begin double knee dips, hamstring pull, and leg press as soon as possible. Add single knee dips in 4-6 weeks, then add side-to-side jumps in 6-8 weeks.

For debridement and/or menisectomies

Begin double knee dips, hamstring pull, and leg press as soon as possible. Add single knee dips in 6 weeks, then add side-to-side jumps in 6-8 weeks.

For anterior cruciate ligament reconstructions

Begin double knee dips, hamstring pull and leg press as soon as possible. Add single knee dips in 6 weeks, then add side-to-side jumps in 12 weeks.

Program 2 (Steadman and Sterett)[3]

Day 1-3

Immediate post-operative phase. Perform double knee dips limited to between 0 and 90 degrees of flexion.

Day 3-Week 8

Early rehabilitative phase. Same as above, plus hamstring pull, plus leg press between 20 and 110 degrees of flexion, plus weight bearing as tolerated.

Week 8-12

Intermediate rehabilitative phase. Same as above, plus single knee dips to fatigue.

Week 12-20

Late rehabilitative phase. Same as above, plus side-to-side jumps.

After completion of the previous program, starting at week 21, the patient continues to work until the following exercises can be done pain-free.

- 3 minutes double knee dips
- 3 minutes single knee dips each leg
- 50 side-to-side jumps each side

Then, functional activities such as biking, jogging, or skating can be added.

ACL Considerations

Kennedy et al. recommend avoiding early exercises that promote full flexion.[4] As the knee moves into greater flexion, the tibia translates forward, placing greater stress on the ACL.

They demonstrated that anterior cruciate ligament loading can be minimized if flexion is limited to angles *less than 30 degrees*. The five exercises presented in this protocol create minimal ACL stress if kept within ranges less than 30 degrees.

Shelbourne and Nitz go further, advocating avoiding open chain exercises altogether, at least after cruciate reconstructive surgery.[5] They do recommend closed chain exercises, encouraging full extension, as early as 2-3 weeks following reconstruction.

Flexion is limited to no more than 30 degrees initially, with a gradual increase in flexion to patient tolerance as rehabilitation progresses. They report a faster return to functional activity with less muscle atrophy and without compromising knee stability when closed chain exercises are introduced early.

They think that open chain exercises place too much sheer stress on the joint and ligament. Closed chain exercises, on the other hand, tend to close-pack the knee, giving the joint more stability while minimizing ACL loading.

Patellofemoral Considerations

Hungerford and Barry demonstrated that performing quadriceps strengthening exercises at angles greater than 30 degrees of knee flexion could aggravate patellofemoral symptoms.[6] Presumably, stress at the patella progressively increases during greater degrees of flexion and in weight bearing exercises such as the single and double dip.

Patients with known patellar tracking problems should exercise within a limited range of flexion during the initial rehabilitation phase. Likewise, while trying to increase a patient's functional range in flexion, be aware that symptom aggravation may signal a previously unrecognized patellar problem.

Patients with patellofemoral symptoms may benefit from vastus medialis exercises. Although no exercise isolates the vastus or the VMO specifically, electromyograph studies by Laprade et al. demonstrated that vastus medialis activity was slightly higher when medial tibial rotation and knee extension were combined simultaneously.[7]

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