



AN INTEGRATED APPROACH TO REHABILITATION OF LEG INJURIES

Part II

with Art Riggs

After introducing the importance of a holistic view of knee rehabilitation in order to restore proper gait, the previous article ended with our fingers deep in the IT band. The techniques that were demonstrated began with more superficial work that is appropriate soon after injury or surgery, and progressed to tools for returning flexion mobility. We now turn our attention to treatment strategies to improve full extension to the knee and to a more detailed explanation of the complexities of gait, including techniques to deal with the compensatory reactions in the feet and hips that occur after injury.

Treatment #5 Returning Normal Extension

Because of the impossibility of normal gait without full knee extension, I feel that this is the major goal for proper rehabilitation after injury or surgery. Of course tight fascia and muscles, particularly the hamstrings, will prevent full extension, but the therapist should also be skilled in working with the deeper restrictions in the joint itself by using mobilization techniques (shown later) to work with the knee joint. Let's begin with some of the major muscles that contract after trauma and prevent the knee from straightening.

Working with Popliteus and Plantaris

One area of caution: You may feel a fairly strong pulse from the popliteal artery, but don't let this

deter you; just use the usual precautionary techniques to distinguish the muscle tissue from the artery and be precise in your work.

Since these are relatively weak flexors of the knee compared to the hamstrings, popliteus and plantaris are often neglected in conventional therapy. Their role in preventing full knee extension is less one of strong muscular resistance than of being "agitators" delegating responsibility to stronger muscles that do the dirty work of preventing knee extension. The body always reacts to pain as a strong dictate of movement, and both these muscles can be sensitive or painful when stretched if they shorten after injury. At the first sign of pain in popliteus and plantaris, they send inhibi-

tory reflexes to the quadriceps inhibiting them from contracting to straighten the knee. They also recruit their allies (agonists?), the hamstrings, to strongly contract and prevent the knee from straightening. Reducing irritation to and lengthening these small muscles is a first step in proper functioning of the larger muscle groups.



Photo # 10-- Popliteus and Plantaris

Note: This article will use the more common usage of the term "leg" to refer to the entire lower extremity as opposed to strict medical terminology where "leg" specifically refers to the portion of the lower extremity between the knee and ankle.

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Although most of the examples in this article will recommend working with muscles in a stretched position to effect a release, working in a very sensitive area like the posterior knee is best done with enough flexion to allow easy entry through superficial layers and have popliteus and plantaris relaxed so they are not irritable. As they relax and lengthen with your work, then slowly extend the knee by using a smaller bolster to retrain their stretch receptors to feel safe with more extension. Once these muscles relax, the primary flexors and extensors of the knee can begin to work properly without neurological interference from popliteus and plantaris.

Usually popliteus and plantaris are shortened as a protective mechanism rather than from adhesions. Therefore, strokes in a distal direction are most effective to train them to relax and lengthen. Use very soft fingers to sink through superficial tissue to find the tight muscles and very slowly stroke distally, with an intention of simply relaxing and stretching an irritable muscle. The texture and depth of popliteus and plantaris is very similar to what it feels like to work on the scalenes in the anterior neck, so use the same principles. While working on these muscles, it is also a perfect time to begin stretching the more superficial fascia in the posterior knee.

Working with the Hamstrings

These are the most important muscles to relax and stretch to allow extension. The hamstrings will have learned to contract anytime the knee approaches the painful angle of straightening. You must not only release any fibrous restrictions, but must also train these muscles (and to a much lesser extent, the gastrocnemius which also crosses the joint and is a minor flexor) to relax into a lengthened position. In the prone position refrain from using a bolster under the ankle so the leg can straighten.

Hamstring work is almost always beneficial for injured knees, but remember that if the knee is still inflamed and extension is painful in the joint, then it is a natural reflex for these muscles to be short and tight. If the joint is painful in movement or structural barriers such as adhesions are present, then the hamstrings will naturally contract to protect the knee. Extensive work with the hamstrings will always be helpful, but permanent lengthening will only take place after the joint heals. This will sometimes take several weeks or even months, so follow-up visits over an extended period of time are helpful to incrementally lengthen the muscles. Joint mobilization will be very helpful in freeing the joint so the hamstrings will not contract for protection.



Photos #11 & 12 --Facilitated Lengthening Strokes for the Hamstrings

Although this may be the most important muscular work you do to return normal function to the knee, luckily, it is relatively simple work without fancy tricks. Notice that if you have your client slide down so that both feet are hanging off the table; comparing the injured knee with the healthy knee is an easy measurement to determine normal extension. In this case, the right knee doesn't allow full extension, so the right heel is about an inch higher than the left. Use your fingers, knuckles or forearms to slowly stroke distally while visualizing grabbing and stretching the hamstrings. You should continue your intention of lengthening below the knee to the gastrocnemius and soleus. Note the dorsiflexion of the ankle to provide stretch.

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Photo #13 --Anchor and Stretch Techniques for the Hamstrings

Not all your work with the hamstrings will be to educate them to lengthen. There may be significant thickening and adhesions in different depths of the muscles or surrounding fascia that need detailed release. Anchor and stretch strokes using precise pressure at fibrosed areas are effective. Visualize that you are placing all of your intention on a knot in a rubber band. Anchor with proximal oblique pressure at adhesions when the knee is flexed and then slowly lower the ankle to extend the knee and focus the stretch at your anchor.

Cautionary note: If your client is recovering from anterior cruciate repair, the surgeon may prefer that the knee does not reach full extension. It is advisable to check with the doctor for guidelines about the limits of extension to work for. This caution should also apply to the use of joint mobilization techniques shown in the next section.

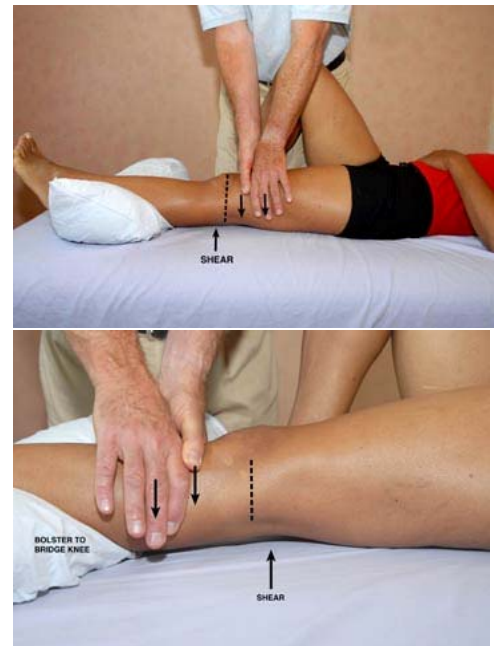
Treatment #5--Joint Mobilization Techniques for the Knee

The largest paradigm shift in my bodywork occurred after I had been practicing for almost 10 years when I took a spinal mechanics class and began working with joints, not only in the spine, but virtually anywhere on the body. I hope that new therapists won't wait as long as I did.

With the knee, we are primarily working to improve extension, flexion, and a bit of rotation between the femur and the tibia. Anatomists agree that the knee joint is the most complicated in the body, but some relatively simple joint mobilization techniques can be practiced safely and effectively even if you are new to this concept. Although it is tempting to look at the joint as a simple hinge, in reality, when moving from extension to flexion and back, the tibia must slide anterior and posterior and rotate relative to the femur. After knee injury or surgery, tightening muscles that surround the knee can contract and compress the joint from all sides impeding the articulation of the bones. If normal movement between the tibia and femur is not returned within a reasonable period of time, then adhesions form deep in the joint and can permanently restrict joint mobility. Since most therapists are apprised of ways to stretch the knee into flexion, we will concentrate on extension and rotation.

Anterior and Posterior Shear of the Tibia and Femur

Straightening the knee to full extension requires that there is freedom for the tibia to glide back and forth on the femur (shear) rather than just straightening like a simple hinge. Soon after injury, adhesions begin to form, and even the slightest limitation can impact gait. Most therapists are trained to work on the knee supported by a bolster, but this practice prevents extending the joint into its structural barriers to release them. Early in the recovery process, you may work in supine position with the leg just resting extended on the table as you gain your client's confidence, but as you begin making progress, place a bolster under the ankle or calf so the knee is suspended in space ("bridging") as demonstrated in the photo.



Photos # 14 & 15--Anterior/Posterior Shear

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Remember to place your intention deep in the joint, and that unlike simply stretching the knee into extension as you would if the client is prone, you are applying posterior pressure directly down towards the table and visualizing sliding the tibia and femur in opposite directions. Mobilization can be applied in two ways. First, you can use relatively quick pulsations of pressure with about two pounds of force, repeating the pulsations for a minute or more. It is crucial to move the joint all the way until end range resistance is felt. This is helpful in over-riding conscious soft tissue holding patterns and begins to free up the joint as the bones slide back and forth. Secondly, you can apply a steady pressure downwards with a bit more pressure, but being careful that your client is not too uncomfortable. Sustain the pressure for a minute or two, waiting for a feeling of softening in the joint and a sense that the bones are sliding past each other.

In the first photo I am putting pressure on the femur so that it is sliding posterior relative to the tibia. Conversely, by placing your hands below the knee on the tibia, you are now sliding the tibia posterior relative to the femur. As you become adept at these procedures you can expand your effectiveness by experimenting to either compress or traction the joint as you apply anterior/posterior shearing pressure. The key to the success with this and most joint

mobilization techniques is to apply enough force to mobilize the joint, but not so much force that your client has pain or is fighting against you.

Mobilizing Rotation of the Tibia and the Femur

When the knee moves, the tibia actually rotates upon the femur, rotating externally as the knee extends and internally as the knee flexes. If rotation is impaired, then flexion and extension are impaired. The rotation is subtle, but important to work with.

Cautionary note: Rotational joint mobilizations should not be performed if there is any question of a torn meniscus or ligaments after injury, but are very helpful after surgical repair of such injuries.



Photos # 16 & 17 —Supine Rotational Mobilization.

Reverse the process as you pull the leg back into full extension by rotating the tibia externally through the range of motion. Of course it can even be more helpful to perform this technique while also stretching tight fascia or muscles, but your primary intention is to be rotating the tibia around the femur.

As you flex the knee by helping your client bring her knee to her chest, place steady pressure to rotate the tibia internally. When you reach the end range of comfortable flexion, stay in this position and continue to exert gentle internal rotational force while waiting for softening of resistance



Photos # 18 & 19 —Seated Rotational Mobilization

This technique works well if your client has large or heavy legs or you feel unstable on the table. It

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has the added advantage of stabilizing the femur during movement and of the natural gravity of the lower leg placing traction the joint while you work. As you have your client flex her knee, rotate the tibia medially and then reverse the rotational direction to external as the knee is extended. Remember that the most release will happen at the end range of movement so hold a sustained pressure at this range of motion for up to a minute.

UNDERSTANDING MOVEMENT PATTERNS

The treatment suggestions that we have covered so far should provide considerable benefit for your clients who have knee problems and anyone looking for better movement and freedom of the entire leg. As mentioned earlier, a great many people have sustained injuries that persist in compensatory patterns of movement that have been ingrained for decades. A holistic treatment plan that deals with the complicated relationship between the feet, ankles, knees, and hips will be a great boon to your practice and will provide better movement for all your clients, not just with injuries.

Now, let's revisit the chart in Box 1, more detail to discuss the basic kinesiology of walking gait at toe off and heel strike with more attention to the feet, ankle, and hips.

Toe off: This is the important stage of walking that propels the body forward. With limited knee extension, the stride is shortened, approximating the "mincing"

steps of very elderly people (I find that working for better knee extension is greatly appreciated by my older clients). If the foot is not far enough behind the body,

GAIT ANALYSIS

TOE OFF

Normal Gait: Shows a full stride with propulsion from the foot. Labels include: LIMITED HIP EXTENSION, INHIBITED PROXIMAL HAMSTRINGS & GLUTEALS, SHORT DISTAL HAMSTRINGS, SHORT PLANTARIS AND POPLITEUS, INHIBITED GASTROC AND SOLEUS, LIMITED PLATARFLEXION, and PROPULSION.

Limping Gait: Shows a shortened stride with various muscle inhibitions and limitations. Labels include: LIMITED HIP EXTENSION, INHIBITED PROXIMAL HAMSTRINGS & GLUTEALS, SHORT DISTAL HAMSTRINGS, SHORT PLANTARIS AND POPLITEUS, INHIBITED GASTROC AND SOLEUS, LIMITED PLATARFLEXION, PROPULSION, SHORT PSOAS, and SHORT RECTUS FEMORIS.

HEEL STRIKE

Normal Gait: Shows a full stride with impact on the heel. Labels include: IMPACT.

Limping Gait: Shows a shortened stride with various muscle inhibitions and limitations. Labels include: INHIBITED HIP FLEXORS, SHORT HAMSTRINGS, SHORT PLANTARIS AND POPLITEUS, INHIBITED GASTROC & SOLEUS, IMPACT, LIMITED DORSIFLEXION, and INHIBITED QUADRICEPS.

Box 1: In varying degrees, limited knee extension will have the following results in gait, including a short stride. If you can return normal extension to the knee (the primary restriction), then most of the secondary compensations in the foot and hip will improve with minimal intervention. Muscles that are inhibited will need to be strengthened, and any good sports medicine book will have suggestions. These images confine themselves to the pelvis and below, but notice how pelvic tilt is also affected and will have effects up the spine and beyond. If you consider how a tight psoas on the affected side will present side-bending and rotational strain on the lower back, it becomes clear how the effects of injury radiate globally.

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it loses its power to propel the body forward and energy is expended in lifting the body up instead of forward. The foot ceases to flex at the toe joints (transverse arch) and become immobile causing the plantar fascia to shorten. The ankle remains in a neutral position rather than plantarflexing to push off, so tibialis anterior becomes short and gastrocnemius and soleus become weakened.

As previously covered, since the knee won't extend, the hamstrings, upper gastrocnemius, plantaris, and popliteus become shortened and will all need lengthening work, but don't forget to work with the superficial fascia, especially behind the knee to stretch this tissue. Perform joint mobilization to return normal flexion, extension and rotation of the joint itself.

Many therapists neglect the hip in rehabilitation of the leg. If the leg cannot extend freely to the rear, then rectus femoris and psoas will become short because they don't need to release to allow the hip to extend for a long stride. They also will become fibrous from overwork, since the leg is not propelled by the foot and ankle to swing forward, rectus femoris and psoas will have to use more energy to lift the leg to overcome inertia. Instead of swinging freely forward, the knee will be lifted at a more vertical angle by the pull of these muscles.

Heel Strike: If the knee cannot

straighten, then the leg is unable to swing forward in front of the body with ease. Instead of landing on the rear of the heel with the ankle slightly dorsiflexed, the foot lands flat at a more vertical angle, preventing the normal rolling motion from heel to toe that dissipates shock. Gastrocnemius and soleus remain short and will need lengthening so the foot can dorsiflex. The ankle will need to be mobilized in both plantar and dorsiflexion to begin working like a smooth hinge.

In addition to being short in the distal portion to prevent knee extension, the hamstrings will also remain tight near the ischial tuberosity as they prevent a full leg swing forward. It is easy to see how working with the hamstrings is the key to rehabilitation.

All of these complex feedback loops occur from the simple restriction to knee extension. Remember the chicken/egg relationship with the joint and the muscles. The lack of proper joint movement will cause the muscles to shorten, but these shortened muscles will solidify improper joint movement if the walking pattern becomes ingrained. Be sure to become skilled in joint mobilization techniques on the joint itself to help restore proper mechanics. The best news is that these techniques work equally well for restoring proper movement patterns after injury to the feet, ankles, and hips.

Although one can understand these kinesiological principles at a cerebral level, by far the best way to understand what is happening in your client's body is to feel the sensations in your own deep experience by mimicking the limping pattern. What joints aren't moving? What muscles are contracting improperly? If you simply concentrate to prevent your knee from straightening, you will experience the profound compensations from the toes up through the hips as you walk. In classes, I actually have students tape their knees to prevent full knee extension, and also have them experiment with placing a pebble in the forefoot or heel of their shoes. This is an excellent way to feel both the joint and muscular adaptations to pain or discomfort, and will enable a strategy for treatment.

Treatment #6 Balancing Secondary Compensations

Now we can move to some techniques to return proper function to secondary areas that respond to knee dysfunction. Work to satellite areas is extremely important because of their tendency to reinforce limping patterns, but until proper function is returned to the primary site of injury, the secondary compensatory patterns will persist. It is perfectly appropriate to work on secondary compensations throughout your treatments because they often cause discomfort as they adapt. However, your primary goal should be to

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return the primary injury site to health as soon as possible, and then focus on the feet and hips.

Freeing the Toes, Transverse Arch, and Plantar Fascia

With a limping gait, the feet become stiff and inflexible as they land similar to wearing a very stiff-soled shoe that prevents the toes from flexing and providing power on toe off.



Photo # 20 Restoring Toe Extension

Working in the end range of motion is the key to this technique. With soft fingers, bend the toes as far as possible into an upward dorsiflexed extension. With knuckles or fingers patiently work the area of the metatarsal heads, with both cross-fiber strokes and in the direction of lengthening of tissue. This is also an excellent way to work on the plantar fascia for the length of the foot.

The biomechanics of stretching the foot into dorsiflexion in either the prone or supine position



Photo #21 Softening the Plantar Fascia and Freeing Dorsiflexion.

can be difficult when the leg is straight. This technique offers the advantage of using your body weight, being able to exert strong pressure to dorsiflex the ankle, and the use of the broad and comfortable tool of your forearm. This technique is also useful to treat plantar fasciitis.

Improving Ankle Movement



Photo #22 ---Freeing the Ankle Retinaculum

The front of the ankle is surrounded by a fibrous retinaculum that can stiffen the ankle joint like an Ace Bandage, limiting both plantarflexion and dorsiflexion and causing torsion on

the ankle. Use your knuckles or the ulnar surface of your forearm to soften and free this tissue. Anchor in one direction and then mobilize the ankle in any opposing direction to improve freedom. This is an excellent technique after ankle sprains or on virtually anyone who wishes easier ankle movement.

Improving Hip Mobility



Photo #23 Freeing the Proximal Hamstring for Easier Leg Swing

By flexing the leg with the knee relatively straight, you can place the hamstrings on a nice stretch while releasing any areas with anchor and stretch strokes against the stretch. Don't strain yourself by holding the leg with your arm if your client is large. You can be inventive and use your shoulder and body to apply stretch to the leg or even have your client apply the stretch by using a strap over the bottom of her foot.

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Photo #24 Releasing the Rectus Femoris

The rectus femoris and front of the pelvis will become short and tight if your client has been walking with a limp that prevents the leg from freely swinging back into extension. Working in the neutral supine position will soften tissue but not stretch enough to open the area. This position allows you to work easily using your own body weight as you stretch the leg into extension. Support your client's head and neck, and possibly low back with pillows, and have your client pull her opposite leg to her chest to keep the pelvis in a neutral position.

Apply pressure with your other hand to extend the hip and work in the direction of stretch working with your fingers for superficial tissue and with your forearm for deep muscular work on the quadriceps.

This technique is also useful for working with the psoas in a stretch, but do not over-extend the hip. If the hip is too extended, it becomes difficult to sink through the superficial tissue in the anterior pelvis to contact the psoas.

Conclusion

I hope that this article has given you insight into the interesting interrelationship of the joints of the legs as well as some specific tools to successfully treat problems, not only to the knees, but to the other joints of the lower extremity. All joints of the leg are inextricably linked together in a complex feedback loop that must be treated in a holistic manner for the best results. Remember that each client

will present his or her own unique adaptive mechanisms to injury and that the solutions to solving limping problems rarely are simple or lie in only one area. These considerations are what make our work so interesting and rewarding.

Remember that a holistic treatment not only includes a broad view of distant joints and compensations, but should consider the whole person you are working with, including the causative factors of their injury (especially with overuse injuries), their approach to self-help through home programs of stretching and strengthening, and their emotional feelings. Fear, anger, depression, and self-judgment are often associated with injuries. We always treat more than muscle, tendon, and bone. The best therapists' skills are more of an art than a craft as they provide a hopeful healing environment for their clients with their humanity and contact with the person behind the injury.

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