

the **CrossFit** JOURNAL ARTICLES

Hamstrung

Kelly Starrett

Stretching sucks. It does. There, it's been said. You can't brag about your best stretching time, you don't get to write your stretch PR on the wall, and there is no immediate "Fran"-like gratification that you are really tough. And despite the fact that flexibility is one of the ten CrossFit pillars of complete, well-balanced fitness, increasing flexibility potential remains the ungreased squeaky wheel of most athletes' training programming. According to the ten general physical skills list, flexibility is allegedly as important as power or strength. So why don't we take it more seriously? Because, typically, we simply fail to frame flexibility in terms that are important to us: increasing performance.

Stop kidding yourself. Lacking flexibility in crucial areas has a crushing impact on your athletic abilities; to say nothing of the host of pains and problems that inflexibility predisposes you to. If you know you have tight hips, calves, hamstrings, quads, thoracic spine, or shoulders and aren't actively, aggressively striving to fix them, then you must be afraid of having a bigger squat, faster rowing splits, or a more explosive second pull. Or, you must be very lazy. Because if you are tight and a CrossFitter, you are missing a huge opportunity to get better, stronger and faster. Simply put, not stretching is like not flossing, and the results are not pretty. There are many areas of restriction in the typical athlete, but it makes sense to begin a discussion about flexibility and performance at

perhaps the most commonly neglected and profoundly underaddressed area of the body, the hamstrings.

The goals of this article are to help you understand how hamstring restriction impedes performance and function, learn to identify tight hamstrings with a few simple assessment tools, and above all, know how to address the problem.

Physiology and function

Before examining a few movements that are greatly affected by short hamstrings, we should touch on a few salient points about anatomy and function. Every athlete should know that the hamstrings are both a hip extensor (they help extend the thigh, or open the hip) and a lower leg flexor (they bend the knee). The important piece of information here is that the hamstrings cross both the knee and the hip. Hamstrings are two-joint muscles. This means that tight hamstrings will affect the knee and also the hip and back. This is important because most

of the typical musculoskeletal complaints involving the knee, hip, or back typically have short hamstrings as a confounding variable. That is, explosive hip-based movements will often have consequences at the knee because taking up a lot of slack at one end of the muscle (the hip) will steal length from the other side (the knee). And this is true the other way around as well. In fact, muscles that are too

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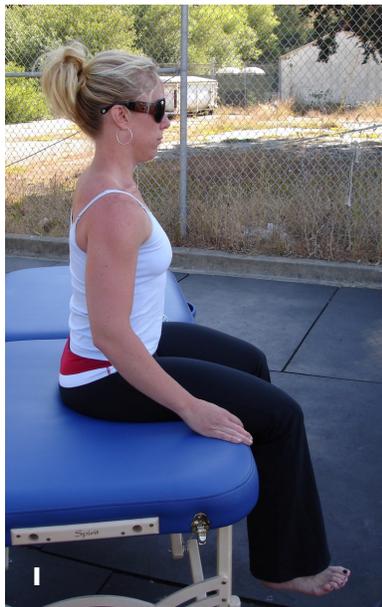
short to stretch to meet the functional demands of a desired movement are said to be passively insufficient.

For example, it is well known that the quadriceps (also a two-joint muscle) help stabilize the pelvis and control the eccentric loading that occurs in the knee in, say, squatting. The quads also play a role in straightening the lower leg, of course, but that task is and should be the chief domain of the hamstrings and glutes through hip extension. Now if an athlete's hamstrings are too tight or aren't of sufficient length to allow full extension of the lower leg (knee) when the hip is loaded in a flexed position (i.e., rowing, deadlifting, running), then the quads have to overcome the passive insufficiency of the hamstrings and also bear their load to boot. Not only does this typically predispose the athlete to possible knee pain and future pathology, but it is the equivalent of driving your quadriceps around with a gigantic hamstring brake on.

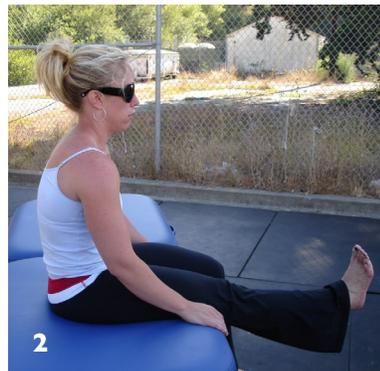
Want your quads to work more efficiently? Well then quit giving away your hard-earned strength, speed, and power potential because of your tight posterior legs. And when Olympic gold medals are determined by margins of 1 percent or less, you had better believe that passive drags on the athlete's function, like tight hamstrings,

matter. They need to be systematically addressed.

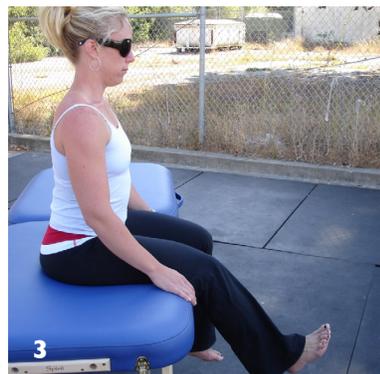
To test and illustrate the passive insufficiency concept (the quadriceps brake metaphor), sit up with a straight back on a table with knees bent over the edge, the backs of your legs touching the side or hanging perpendicular to the ground, and your feet off the floor. Now sit up tall and position your low back to mimic the same lumbar curve you would have while squatting. Next, without reversing or losing the good position of your low back (have a partner watch so that you don't cheat, because almost all of you will try to cheat), extend one of your legs. If your hamstrings are tight, you won't be able to completely straighten your leg unless you give your hamstrings some slack by letting your lumbar curve collapse so your pelvis can tilt posteriorly. Now try it with both legs at the same time. Unless you've got great hammie flexibility, chances are you weren't able to extend all the way. Of course, despite that fact that most of you couldn't straighten your legs on the table, you will straighten your legs when performing real movements. Your quads have little functional option but to drag your hamstrings (and subsequently your pelvis and low back) along if a fully extended knee is going to be achieved. Diagnosis: hamstrung.



1. Sitting tall at the edge of a table with a good natural lumbar curve.



2. Extending a leg leads to loss of the lumbar curve.



3. This is as far as she can extend the leg without losing the lumbar curve.

Now, lower your legs and repeat, but this time pay attention as you straighten them through the movement arc. At what point of the swing arc do you start to notice resistance? It is likely that you didn't encounter the full and immediate resistance of your hamstrings at the end of leg extension all at once. It is likely that your hamstrings started to gradually tighten. In most athletes with significant hamstring restriction, resistance to lengthening starts early and builds throughout the available range of motion. Remember, your quads have to overcome this hamstring inertia to do their job. This means that you're giving away force potential in even low-power activities like walking. This brutal phenomenon is particularly visible in rowing where an athlete with short hams will always achieve full leg extension before the end of the pull.

Let's have a reality check for a moment. Does failing this quick test mean that

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you can't squat 400 pounds, or rip off a sub-three minute Fran? No. In fact, most of you probably failed that sitting test and still have impressive performance numbers. And you probably use these high performance measures as rationalization that you don't need to do anything about your tight legs. But just imagine for a moment how much more you might still have in the tank if you simply eliminated any potential hamstring "drag". You would certainly get better gas mileage in your car if you didn't drive around with the emergency brake on. Again, we aren't interested in stretching our hamstrings (just) to avoid back pain when we're ninety (or thirty) years old; we're after being fitter, faster, and stronger now.

So tight hams make your quads work harder than they should have to. But there's more bad news. Tight hamstrings also have limited ability to generate force when they are put under load at the very end of their available range. Muscle force production is greatly affected by where in the range of motion the muscle is asked to generate that force. This is known as the length-tension relationship. More specifically, the length-tension relationship means that force (tension) generation in skeletal muscles is a function of the magnitude of the overlap between the functional contractile units of that muscle. Or, in plain English: overly stretched working muscles are weak muscles. You have actually experienced this for yourself many times. For example, most athletes will have noticed that they are much stronger at the mid-range of a movement like a pull-up or squat than they are when the relevant muscles are under peak stretch. As human beings, our muscles are set up so that their internal structures allow for optimal overlapping of the base contractile units. This is why force is typically optimized in a muscle that is working in mid range. The inherent design flaw with this is that the further you move the muscle away from the optimized working length (like the hamstrings at the bottom of the squat), the less force the muscle is capable of generating. This is why heavy quarter squats are very popular and heavy full squats are not. If you are in hamstring length denial, you are not only making the muscles opposite the hamstrings work harder, but you are limiting the potential force production of the hamstrings themselves because you are placing the muscles into an early position of diminishing "end range" force.



1. Muscle fibers overlap significantly, like this, in their optimal working range
2. Overly stretched muscle fibers, at the end of their working range, look more like this and cannot generate force as well

But wait, it gets worse. Because we are trying to shift stretching rationale away from injury prevention and toward performance improvement, this article would be remiss if it did not point out that your lack of hamstring length also affects your functional application of force in movements like the squat and ultimately reduces the effectiveness of your body's natural leverage and range of motion in these very fundamental movements. In squatting, for example, everyone knows that tight hamstrings bring about a whole host of gross mechanical errors, from knees way out past the feet to lifting the heels to horrifically unsafe rounded backs.

But what about you, with your big, safe, CrossFit Total-tested squat? Well, there is a point in everyone's squat where the athlete's lumbar curve will begin to reverse itself. It is at this point where biomechanical positioning starts to be less than optimal. In world class weightlifters this reversal point tends to be in the squatting range where the butt starts to meet the ankle. For folks with less than ideal flexibility, it's likely that the lumbar curve starts to reverse well above the point where your hip crease is level with your knee. Remember, losing your lumbar curve early means that your hamstrings are working at end range and are their weakest earlier than is desirable. But now, your end-range weakened hamstrings are starting to affect your body's inherent ability to optimize movement leverages.

Try it for yourself: Get into a good squat position and have someone watch you descend. Your partner will say "stop" the second you start to lose your tight, perfect, slightly arched spine positioning. Note this depth because from here you are becoming less efficient the farther down you go. Know that very strong athletes might reverse relatively early, have safe squats, and still

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Just hitting the point of lumbar reversal (left), and deep in the hole, with excess reversal (right).



Lumbar reversal just beginning (left). Note that reversal begins earlier (above parallel) for this athlete than for the one pictured above, but in his full squat (right) the reversal remains minimal (nearly neutral) and he keeps a tight position, with active hips and hamstrings.

generate huge amounts of force, but this discussion is about optimizing work capacity, and the earlier you start to lose your lumbar curve, the earlier you are beginning to mute your hip function (and violate optimal length-tension relationships, etc.).

Improving hamstring flexibility

To start, get a baseline measurement of your hamstring length. You need to assess flexibility in two ways because, remember, the muscle crosses two joints. First, lie on your back and have a partner pin down your left leg at the hip. Now have your partner lift your right leg, keeping the knee straight. The partner should be aware of when they first start to notice significant resistance and when your pelvis starts to move at the end of the leg lift. This point is the end of hamstring range with the leg straight. The partner will likely be able to push

farther, but they are really just starting to drag the hips along with the leg.

The angle the raised leg makes with the ground is the measured position. Normal range is considered to be between 80 to 85 degrees of motion. And this amount works fine for the average non-performance-obsessed person. But you want to be greedy; more is better in this case. Now have your partner repeat the test, and see if they can feel where in your range of motion they begin to notice the hamstrings getting tight. On this, later is better. Your goal is to have a sudden onset of resistance that builds quickly to the end of the range of motion. It is not cool to have hamstrings that are “stiff” during the entire time your leg is being straightened.

Now repeat the test but this time bend the knee to ninety degrees to start. This method of looking at hamstring length usually does a better job of telling the truth because the straight-leg method is fraught with ways to compensate. Again have your partner straighten your leg. When they reach that position of obvious resistance, note the position. Your partner will be able to straighten your leg with enough force, much like your quads can, but they are simple stretching collateral connective tissue at this point. In the fully stretched position, you leg should be no farther than 20 degrees from straight up and down. Were you able to hit 80 degrees? This length would earn you a “C” grade in hamstring flexibility. While this is adequate for most people, it is not for us. Now apply a little bit of “CrossFit” motivation and record everyone’s hamstring ranges on the wall. Create awards for “hams of shame” and “hams of fame.”



(left) Hamstring assessment with knee bent 90 degrees (right) Hamstring assessment with straight leg

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Hopefully the case has been made by now that: 1) increasing the flexibility of your hamstrings will improve your performance, and 2) your hamstrings are tight. So here are some quick and dirty ways to slay these performance-sucking vampires. The rules of best practice stretching are simple.

1. Keep performing full-range functional movements, the way you already do. In reality, your body is actually going to have to add functional contractile units to your muscles over time to actually make your muscles longer. This is why most people become more flexible when they start CrossFitting.
2. Stretching before a workout is less than ideal as it alone will not prepare you very well to perform actual work. Stretching immediately afterward is always desirable. Don't just jump in your car and head to work right after finishing "Diane"; give your hamstrings five minutes of loving. However, if you are severely limited by your flexibility, to the extent that it interferes with your training, get really warmed up, stretch, then do your workout. Yes, pre-workout stretching can blunt one's potential for generating maximal force production, but if your workout is compromised by your inflexibility, the benefits way outstrip the potential drawbacks here. If you are that tight, get to workout a little early and do the responsible thing.
3. It is OK to stretch anytime, especially in the way outlined below. Is it better to be warmed up first? Yes, of course. But in the morning, for example, you can take a hot shower and have your cup of coffee and then stretch, as you should be warm enough.

4. Stretch often. Muscles are like obedient dogs. They need constant, repetitive training. One session of stretching lasting one minute isn't going to change anything. Stretching big muscles like hamstrings and quads takes time. Ninety seconds per leg should be a baseline, five or six times a day.
5. Make stretching something you do while doing something else. Stretch your hamstrings while seated at your desk at work. Stretch in front of the television. Stretch every time you check the CrossFit website (well, OK, maybe not that many times). The point is, don't make a big deal of it. Grease the groove. Develop a reputation as that "stretching guy."
6. Don't bend over and touch your toes in an attempt to stretch your hamstrings. This is a rookie mistake and primarily a low back stretch. You can't very well stretch a muscle that is working hard to keep you from falling over.
7. Stretch the hamstrings over both joints. This means that you should stretch with the leg straight and stretch with the knee bent. (See photos.)
8. Attack stretching your hamstrings with the same fervor you gave to getting your first pull-up or muscle-up or handstand. Become obsessed.

How to stretch your hamstrings

A proven, effective method to stretch hamstrings is called contract-relax. It comes from a fancy method of physical rehabilitation called PNF (proprioceptive neuromuscular facilitation). Using contract-relax stretching, you are basically trying to reset the resting length of the muscle itself. The same is true of stretching techniques like isometric shutdowns, or reciprocal inhibition. But we're



Use something like a jump rope, stretch band, or towel to gently pull the leg up and back when stretching by yourself.

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not arguing about which technique works best; we just want to stretch. For most muscles, the contract-relax method described below is like a miracle.

To use contract-release to stretch your hamstrings, lie on your back, extend one leg, and lift it up and toward your chest as you did in the testing positions described at the beginning of this section, so that the hamstrings being stretched are at their end range in either the straight-leg or bent-knee position. You can perform the straight-leg variation while sitting in a chair at work. Now, without actually moving the body, and maintaining tension at the hamstrings' end range, try to generate a force in the muscle that is about 25 percent of what you think you could maximally produce. It is likely your quads will kick on too as you do this; this is OK. It should feel like you are trying to rip the hamstrings while they are under load. Hold that contraction for about five seconds, and then relax the muscle suddenly, like you are turning off a light switch. Next, take up the newly created slack in the muscle by extending a little farther and hold for about ten seconds. Start again with the contraction-and-release cycle. Repeat this process about five or six times. After stretching the hamstrings in both knee positions (bent and straight), stand up and enjoy the changes.

To sum up: you are not as efficient as you could be if you have tight muscles that are getting in the way of your athletic potential (and you probably do). You can change this even if you have been telling people for years that you just aren't flexible. No excuses.



Kelly Starrett will be receiving his Doctorate of Physical Therapy at the end of July 2007. He and his wife, Juliet, are the owners and operators of [San Francisco CrossFit](#). Kelly is a former member of the U.S. Canoe and Kayak Team, a former National Champion whitewater paddler, a nice guy, and a good, flexible dancer.