The Science of Stretching

To stretch or not to stretch? Impact on performance and injury rates in runners.

By Thomas Michaud, DC

In 1986, Rob DeCastella set a course record by running the Boston Marathon in 2:07:51, just 39 seconds off the world record. A few days before the race, I saw Rob in my office; when I checked his hamstring flexibility, I was shocked to see he could barely raise each leg 30 degrees off the table (even tight runners can raise their legs 60 degrees). Having never seen hamstrings that tight, I asked Rob if he ever stretched. He responded: "When I run, that's as far as my legs go forward, so that's as far as I want them to go forward."

At the time, it was just assumed that runners had to stretch to run fast

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and remain injury-free, but here was one of the world's fastest runners who not only didn't stretch regularly, but avoided stretching altogether!

According to conventional wisdom, I should have encouraged Rob to stretch, but I didn't. Besides being one of the world's fastest runners, Rob DeCastella knew a lot about exercise physiology and I trusted his judgment.

Years later, research appeared suggesting tight runners were metabolically more efficient than flexible runners. This is what DeCastella intuitively knew: *Tight muscles can store and return energy in the form of elastic recoil,* just like a rubber band can stretch and snap back with no effort. Because tight muscles provide free energy (i.e., the muscle fibers are not shortening to produce force, so there is no metabolic expense), stiff muscles can significantly improve efficiency when running long distances.

To understand why muscles are able to store and return energy, just take a

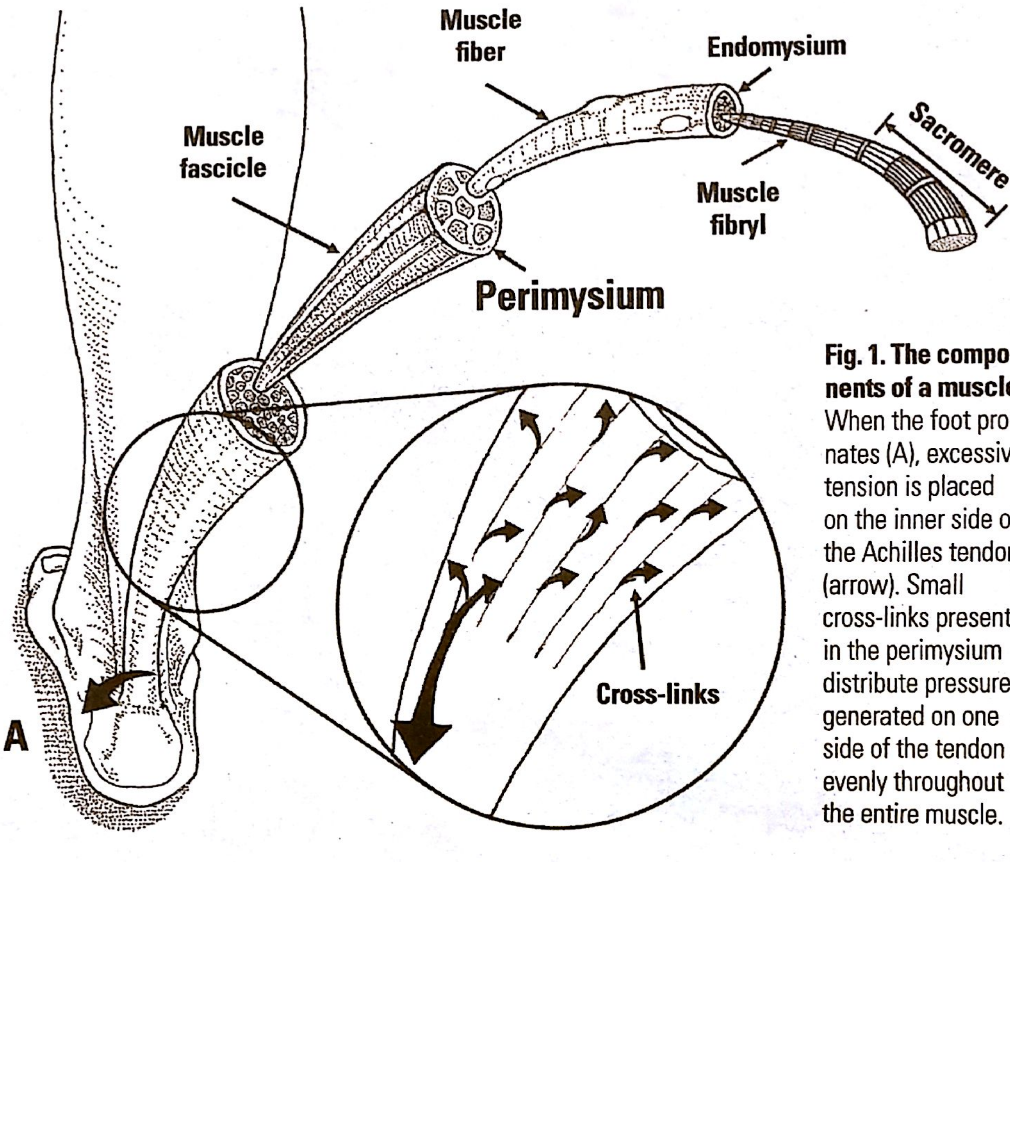

Fig. 1. The components of a muscle. When the foot pronates (A), excessive tension is placed on the inner side of the Achilles tendon (arrow). Small cross-links present in the perimysium distribute pressure generated on one side of the tendon evenly throughout the entire muscle.

look at how muscles are made. To protect individual muscle fibers from developing too much tension, and to assist in the storage and return of energy, muscle fibers and fibrils are surrounded with perimysium and endomysium. These envelopes contain thousands of strong cross-links that traverse the entire muscle. (**Fig. 1**) These cross-links are essential for injury prevention because they distribute tension generated on one side of the tendon evenly throughout the entire muscle.

If these cross-links were not present or were excessively flexible, the asymmetric tendon force would be transferred through the muscle fibers only on the side of the tendon being pulled. Because fewer muscle fibers would be tractioned, the involved fibers would be more prone to being injured because the pulling force would be distributed over a smaller area.

The muscle itself would also be less able to store and return energy simply because fewer fibers would be stretched (the more fibers being pulled, the greater the return of energy). The tight cross-links present in the soft-tissue envelopes act as powerful reinforcements that distribute force over a broader area.

Given the improved efficiency associated with tightness, you would think that the world's fastest runners would all be extremely stiff. This isn't the case. Compared to the mid-to-late '80s, today's elite runners are significantly more flexible. The reason is that even though tight muscles can make you more efficient, they are easily strained and are more likely to produce delayed-onset muscle soreness after a hard workout.[1]

Because the best runners often run a significant number of miles per week with grueling track workouts, increased delayed-onset muscle soreness would interfere with their ability to tolerate their rigorous training schedules and more than likely increase their potential for injury.

To prove that tight muscles are more prone to injury, researchers from Lenox Hill Hospital in New York classified subjects as either stiff or flexible before having them perform repeated hamstring curls to fatigue.[1] Following the workout, the stiffer subjects complained of greater muscle pain and weakness. The enzyme marker for muscle damage (CK) was also significantly higher in the stiff group after working out.

The study authors state that because flexible people are less susceptible to exercise-induced muscle damage, they are able to exercise at a higher intensity for a greater duration on the days following heavy workouts. The catch-22 to muscle tightness is that while a certain degree of tightness increases the storage and return of energy, excessive tightness can increase the potential for injury, especially with hard workouts.

While excessively tight runners are injury prone, excessively loose runners are also prone to injury because their muscles have to work harder to stabilize joints that are moving through larger ranges of motion. Flexible muscles are also less able to store energy in their epimysium and perimysium, so their muscles have to work harder to generate the same force.

The end result is that overly flexible runners are just as likely to be injured as are stiff runners. It turns out that if you make a graph of the injuries associated with different degrees of flexibility, it forms a U-shaped curve with both the tightest and the loosest runners being injured.[2] (Fig. 2, page 28)

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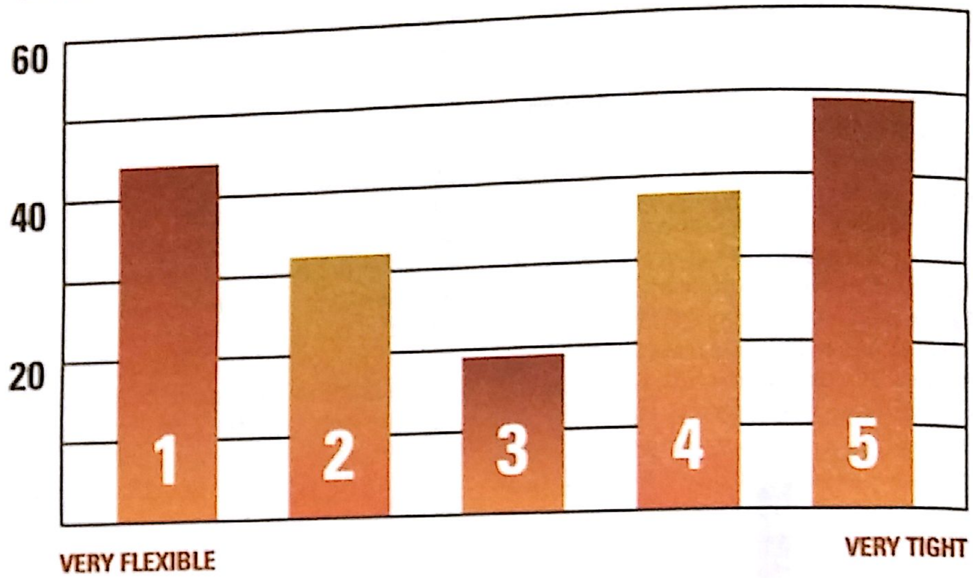

Fig. 2. U-shaped curve of injuries versus flexibility. The vertical axis of the graph represents cumulative injury incidence as a percentage. There were the same number of people in each of the five groups.

Too Tight or Too Loose? Avoiding Flexibility-Related Injuries

Because runners in the middle of the graph above are typically not prone to flexibility-related injuries, the goal of a rehab program should be to get your runners away from the extreme ends of the curve. A simple test to quickly evaluate flexibility is to have the athlete bend their thumb back toward the wrist and measure the distance. (**Fig. 3, page 32**) Checking range of motion in the thumb is one of the easiest ways to evaluate overall flexibility because thumb flexibility is a marker for whole-body flexibility (just as grip strength is a marker for whole-body strength). If the thumb is overly flexible, consider adding resistance training and incorporating agility drills to improve strength and coordination.

In contrast, if your runner happens to fall on the tight side of the flexibility spectrum, consider incorporating specific stretches into a daily routine. Keep in mind that improving flexibility is not that simple. Some great research has shown that when done for just a few weeks, stretching does not alter the ability of a muscle to absorb force because the improved stretch tolerance results from changes in the nervous system that allow the muscle to temporarily lengthen, with no corresponding changes in muscle stiffness and/or work absorption.[3]

Stretching and Injury Rates

The inability of short-term stretches to improve muscle flexibility explains why there are so many studies showing that stretching does not change injury rates. Because of compliance issues and time constraints, almost every study on stretching and injuries has evaluated stretches over a short duration (probably because so few people would stick with a long-term stretching regimen).

That being the case, it's not surprising that while some great research shows tight muscles are more likely to be injured,[1] relatively few studies have ever shown that stretching alters your potential for injury.

In order to produce real length gains, some experts suggest it is necessary to stretch regularly for four to six months. In theory, when a muscle is repeatedly stretched for several months, cellular changes take place within the muscle, allowing for a permanent increase in flexibility. Animal studies have shown that the increased flexibility associated with repeated stretching results from a lengthening of the connective-tissue envelope surrounding the muscle fibers (especially the perimysium) and/or an increased number of sarcomeres being added to the ends of the muscle fibers.[4]

Although I typically suggest that stiff runners should stretch and flexible runners should strengthen, recent research suggests runners may intuitively know whether or not they should stretch. In the largest randomized control study of stretching to date, Daniel Pereles and colleagues[5] randomly assigned 2,729 recreational runners to either a stretching or a non-stretching pre-run routine. Not surprisingly, there was no significant difference in injury rates between the runners who stretched versus the runners who didn't stretch.

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However, if a runner who routinely stretched was assigned to the non-stretch protocol, they were nearly twice as likely to sustain a running injury. This research confirms that regardless of their overall flexibility, the individual runner should always be the final judge of deciding whether or not a pre-exercise stretching routine is right for them. ■

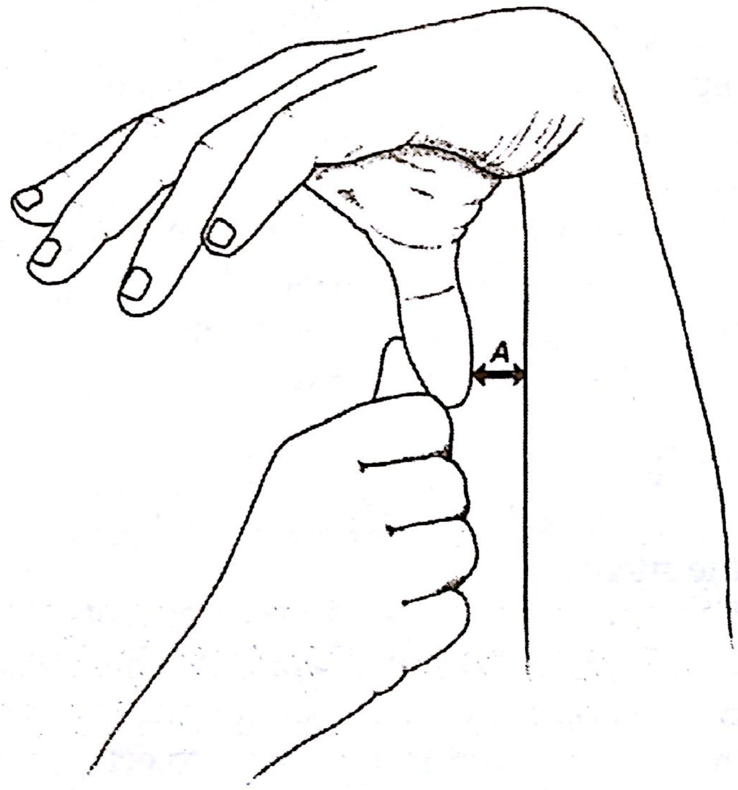

Fig. 3. The thumb-to-radius index. The index (A) is measured with the wrist flexed and radially deviated. Hypermobility is present when the thumb can be positioned within 2 cm of the radius.[6]

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