The Advanced ToePro Workout to Improve Strength, Speed, and Agility

By Tom Michaud, DC

Whether you play soccer, tennis, basketball, or run cross-country, the best athletes can be separated from ordinary athletes by their ability to take forces generated in their hips and thighs and transfer them quickly and efficiently through their feet and toes into the surface beneath them (Fig. 1). The sequential and rapid transfer of force through their toes allows great athletes to run faster, jump higher, and change direction more quickly. The powerful connection between strong toes and athletic performance was initially demonstrated by Yasuhiro et al. (1). In their simple study, the authors measured toe strength in 25 athletes and then evaluated agility by timing them as they ran around a series of cones on an obstacle course. The authors decisively proved the most agile athletes had the strongest toes. An earlier study from Japan showed that performing 200 repetitions of toe flexion exercises 3 times a week for 8 weeks significantly improved vertical jump height, 1-legged long jump distance, and 50 m sprint times (2). More recent research consistently shows that simple foot strengthening exercises can rapidly improve a range of parameters associated with athleticism, including vertical and horizontal jump distance, maximum force generation, and the rate of force development (3-7).

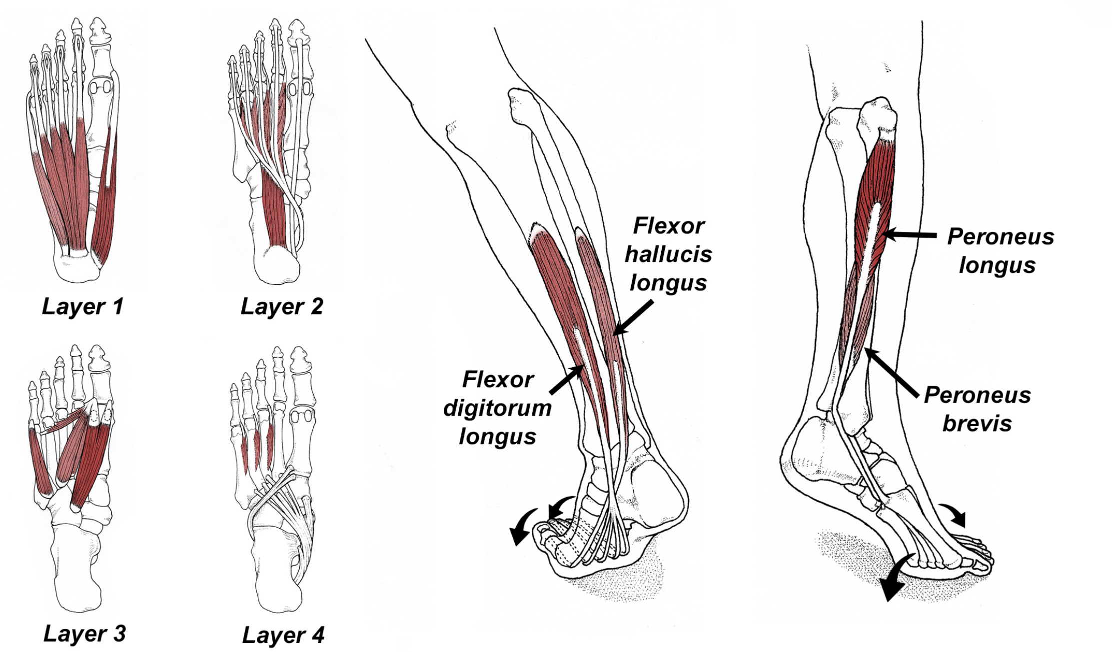


Fig. 1. The foot contains 4 layers of muscles that work with muscles of the leg to transfer energy into the ground during propulsion. While flexor digitorum and flexor hallucis longus work with the Achilles tendon when running and jumping forward, the peroneal muscles play a key role in transferring force to the inner forefoot when cutting and changing direction.

An extremely important point is that in order for foot strengthening programs to improve athletic performance, they need to do more than just strengthen muscles: they need to improve resiliency of the long tendons below the knee. Though rarely discussed, the tendons above and below the knee are very different. While tendons in the proximal muscles, such as the glutes and quads, are short and relatively inelastic (they lengthen less than 2% when fully stretched), tendons below the knee are long and flexible, lengthening as much as 11% when fully loaded. Due to their functional differences, tendons above the knee are referred to as positional tendons, while tendons below the knee are referred to as energy storing tendons (Fig. 2). The anatomic variation between proximal and distal tendons is explained by their functional roles: the positional tendons are the force transmitters, taking large amounts of energy created by the muscles of the hips and thighs and transmitting that force into neighboring joints to produce movement. In contrast, the energy storing tendons of the feet and ankles are specifically designed to absorb force associated with ground contact, and then return that force in the form of elastic recoil, comparable to a bouncing ball or a pogo stick. The free explosive energy supplied by the long tendons of the foot and ankle is what makes great athletes great and explains why exercises targeting these muscles so often produces significant improvements in athletic performance.

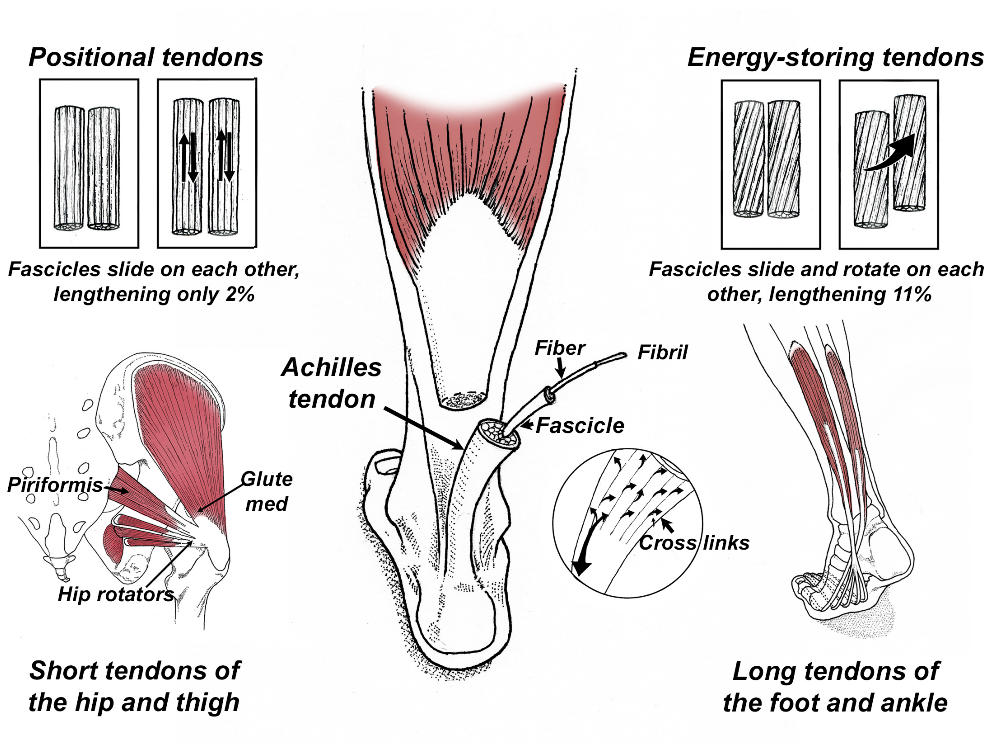


Fig. 2. Positional and energy storing tendons. Note that tendons in the proximal muscles, such as the glutes and quads, are short and relatively inelastic (they lengthen less than 2% when fully stretched), tendons below the knee are extremely long and flexible, lengthening as much as 11% when fully loaded. The energy-storing tendons function like springs to store and return more than 90% of the energy it takes to stretch them. The returned energy provided by these tendons significantly improves metabolic efficiency during locomotion (unlike muscles, tendons do not consume calories) and enhances athletic performance by increasing vertical and horizontal jump distances and overall agility.

In one particularly interesting study, researchers from Germany had runners perform 5 sets of 4, 6-second isometric contractions, which are known to improve tendon resiliency, and then measured running economy at the start and end of a 14-week exercise program (8). A control group was included, and these athletes did not change their training. At the end of the study, runners performing the tendon strengthening program showed a 4% reduction in the rate of oxygen consumption and overall energy cost, "indicating a significant increase in running economy." The energy returned by tendons is especially important at faster running speeds, as the contribution of energy supplied by tendon elastic strain energy increases by more than 40% when transitioning to higher speeds (9). Additionally, because they absorb force more efficiently, compliant muscles and tendons can also reduce injury rates. In fact, researchers from Brazil recently demonstrated that compared to a control group, runners randomized to an 8-week foot strengthening program had a 2.42-fold lower rate of injury (10). This number is significant as nearly 80% of runners are injured annually (11), and very few interventions have been shown to alter injury rates.

Given the connection between foot strength, tendon resiliency, and performance, the big question is which exercise prescriptions most effectively improve muscle strength and tendon resiliency. Over the past few years, there is growing evidence that isometrically contracting muscles while they are in their lengthened positions increases both muscle volume and tendon resiliency. Researchers from Finland demonstrate that prolonged isometric contractions of lengthened muscles increases the interfascicular sliding between tendon fibers, which mechanically stimulates tenocytes to accelerate remodeling (Fig. 3) (12). Prolonged isometric contractions act as a natural pain block (13) and promote the release of important enzymes, such as lysal oxidase and ERK 1/2 (14), which improves tendon resiliency by increasing collagen synthesis. Lastly, prolonged isometric contractions have also been shown to alter fluid flow dynamics within the tendon, which stimulates tendon remodeling (Fig. 4) (15).

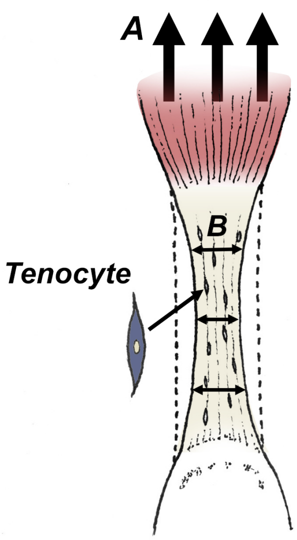


Fig. 3. Because tendons are made of nearly 70% water, muscle contraction (A) creates an internal force that squeezes fluid from the tendon (B), comparable to twisting a wet towel. Movement of the fluid stimulates specialized cells called tenocytes to accelerate tendon remodeling.

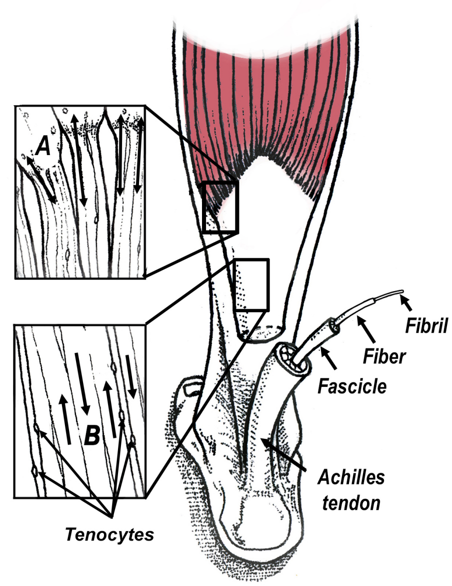
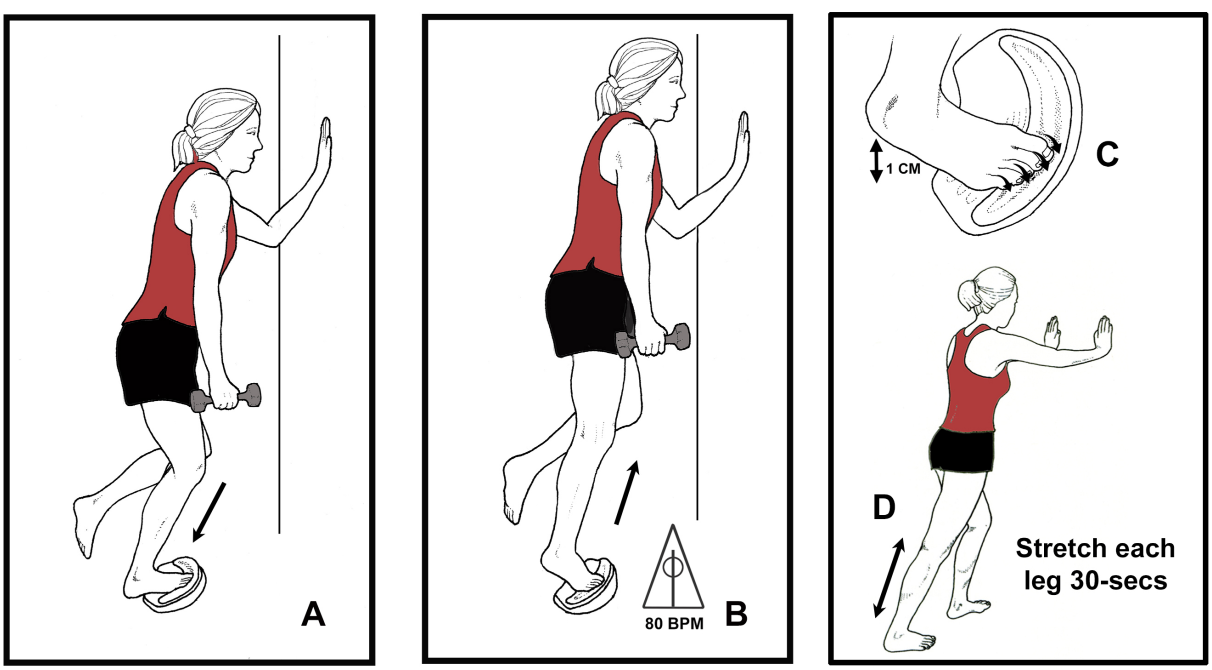


Fig. 4. Because muscle fibers (A) attach to corresponding tendon fibers (B), when individual muscle fibers contract, their respective tendon fibers slide over one another, generating a mechanical shear force that stimulates tenocytes to remodel.

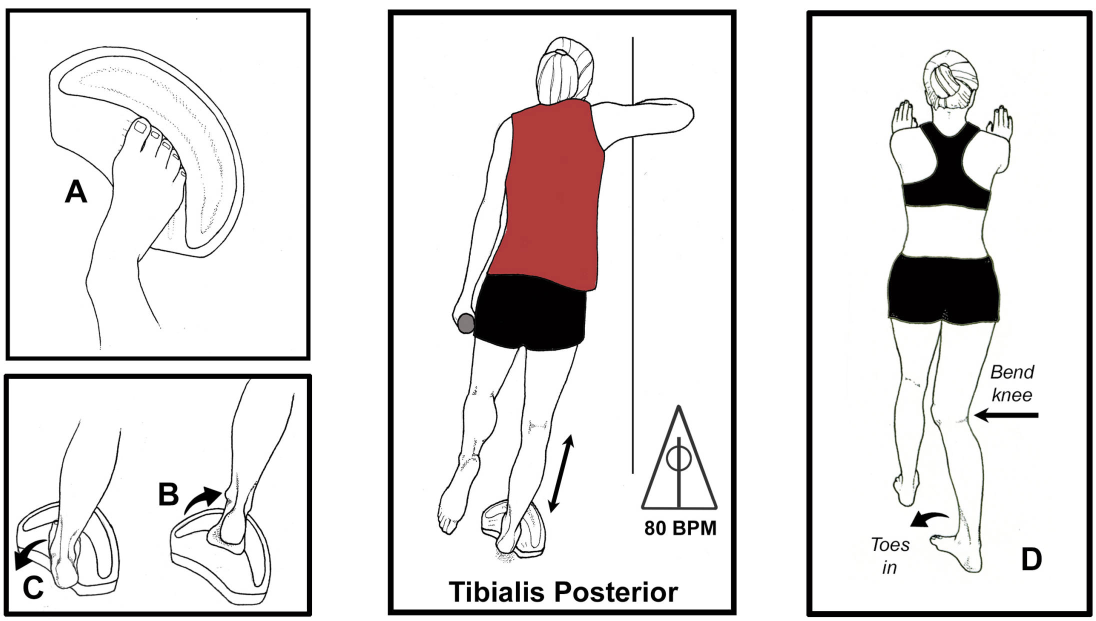
In some of the most fascinating work on ways to improve muscle performance, Gordon et al. (16) demonstrate that exercising to the beat of a metronome improves corticomotor excitement and can boost the rate of force development. Accelerating the rate of force development is essential for agility, as it allows for more explosive changes in direction along with greater vertical and horizontal jump distances. Although the exact mechanism is unclear, Gordon et al. (16) suggest that forcing an individual to exercise at a high cadence increases the precision necessary to maintain the specific timing of the movement, "thus strengthening existing neural connections and potentially the formation of new connections."

The exercises illustrated in figure 5 include both metronome and isometric training to maximize foot/ankle strength and enhance tendon resiliency. Because this is a relatively advanced program, consider performing 4 to 6 weeks of conventional ToePro strengthening exercises prior to beginning this routine. At different times during your training, you can monitor progress by measuring performance during the triple hop test, single-leg jump height, and/or using the heel raise metronome test to evaluate calf endurance. You can also just time yourself on a 50 m sprint or measure your horizontal jump distance. Over the past 6 months, I've given this routine to athletes of all levels and most people notice significant improvements in agility in just 4-6 weeks. Given the entire program takes less than 20 minutes to complete, this small investment in time can pay dividends down the road, not just for improving athletic performance, but also for preventing future injuries.

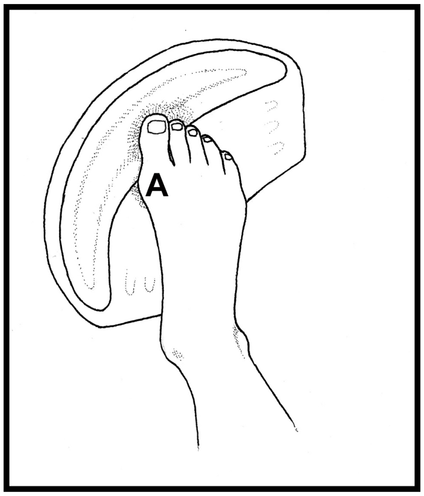
Fig. 5. The Advanced ToePro routine. To start, place the ToePro near a wall while holding a weight in one hand and contacting the wall with the opposite hand for balance **(A).** You decide how much weight to hold based on your level of fitness. Ideally, you should be able to perform between 20 to 25 repetitions before you fatigue. If you are unable to do 20 repetitions, use less weight. If you can do more than 25 repetitions, increase the weight so you are fatigued after performing the 25th repetition. Multiple sets of 20-25 repetitions performed to fatigue was chosen because this routine has been shown to accelerate muscle repair and remodeling better than conventional heavy load/low repetition routines (17). Extremely fit athletes can often do this exercise while holding 40 to 50 pounds, while beginners often need to lean against a supportive surface, like a table, so they are able to do a minimum of 20 repetitions.

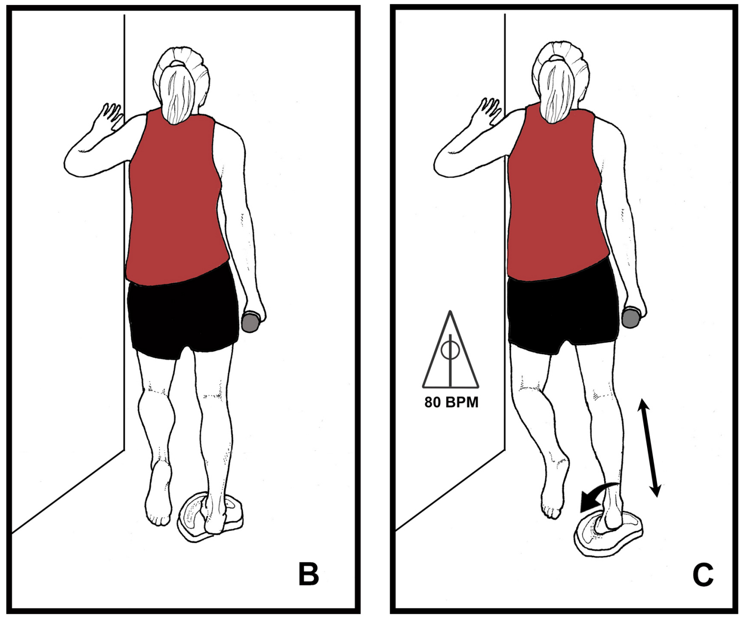


You begin the exercise by positioning your foot so the tips of your toes are in the top groove of the ToePro. Next, set a metronome to 80 bpm and do 25 single-leg heel raises in time with the metronome (**B**). Once finished with your 25th single-leg heel raise, lower your heel so that it is 1 cm from the floor and hold a 30-second isometric contraction. Importantly, while holding this isometric contraction, you should be lightly tapping the tips of your toes into the ToePro in time with the beat of the metronome (arrows in **C**). Note that people with cortical inhibition are often unable to tap their toes in time with the metronome, and if this is the case, reduce the beat frequency of the metronome until you find a tempo you can keep up with. Over time, gradually increase to 80 bpm as you improve. After completing the isometric contraction with toe pulses, perform 25 single-leg repetitions on the opposite leg, and finish with another 30-second isometric contraction with toe taps. When finished with your first set, take a 60-second rest. During this rest, hold a straight-leg calf stretch for 30-seconds on each leg (**D**). Repeat the same routine two more times, making sure to take 60-second stretch breaks between sets.



The next 2 exercises target the tibialis posterior and peroneus longus muscles. To exercise tibialis posterior, rotate the ToePro slightly so your 2nd through 5th toes line up with the top crest (**A**), and then lean sidewards into a wall holding a weight in the hand opposite the wall. Next, repeatedly raise and lower your heel in this position, making sure you actively raise your arch as much as possible while going up (**B**), and lower your arch as you get towards the low point of the exercise (**C**). Keep your knee slightly bent the entire time while doing this exercise and time your heel-raises to the beat of the metronome. After your 25th repetition, hold a 30-second isometric contraction with your heel close to the floor (as in **C**). You should perform subtle pulses where you slightly raise your arch in time with the metronome during the isometric hold. Note that these movements are subtle and should not cause discomfort. This routine is repeated on the opposite leg and when finished, perform a 30-second stretch on each tibialis posterior (**D**).





Peroneus Longus and Brevis

To exercise peroneus longus, rotate the ToePro so your big toe fits into the upper crest and your inner forefoot is near the center base of the crest (**A**). Next, lean sidewards into the wall with a weight held in the opposite hand (**B**). Once stable in this position, repeat single-leg heel raises driving your inner forefoot and great toe into the ToePro (**C**). This is an excellent exercise, and you will feel your peroneal muscles fire vigorously while performing 25 repetitions. As with the other exercises, finish by lowering your heel near the floor and maintain a 30-second isometric contraction, attempting to pulse your big toe and inner forefoot into the foam in time with the metronome. The exercise routine is complete when you perform the same routine on the opposite side and finish with a 60-second rest. While resting, you should perform 30-second bent-knee calf stretches on each leg (as in the tibialis posterior routine). Note the 30-second stretching durations used in this protocol were chosen because stretching a muscle for this length of time temporarily lengthens the muscle without impairing performance (18).

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