

The ToePro Exercise Platform

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Strengthening specific small muscles of the foot and ankle can play a huge role in performance enhancement and injury prevention. Numerous studies have shown that foot/ankle strengthening exercises can improve balance (1), increase arch height (2), enhance jump performance (3), and increase gait velocity (4). Because the toe and arch muscles provide stability during the pushoff phase while walking, jumping, and running, weakness in these muscles may lead to a variety of injuries including plantar fasciitis, stress fractures, bunions, and Achilles tendinitis. Maintaining strong toes is especially important as we age, because older adults have toe strength declines of more than 35%, and the resultant toe weakness correlates strongly with an increased risk of fall (5). Falls in the elderly are common and the likelihood of a person over 70 experiencing a fall is almost 40% (6).

Despite their strong connection with performance enhancement and injury prevention, toe strengthening exercises are rarely included in conventional rehab programs. To add to the problem, the most commonly prescribed foot strengthening protocols have significant drawbacks in that they work the toe and arch muscles in a midline or downward position, which decreases their effectiveness because this is not how these muscles are used in real life (Fig. 1).

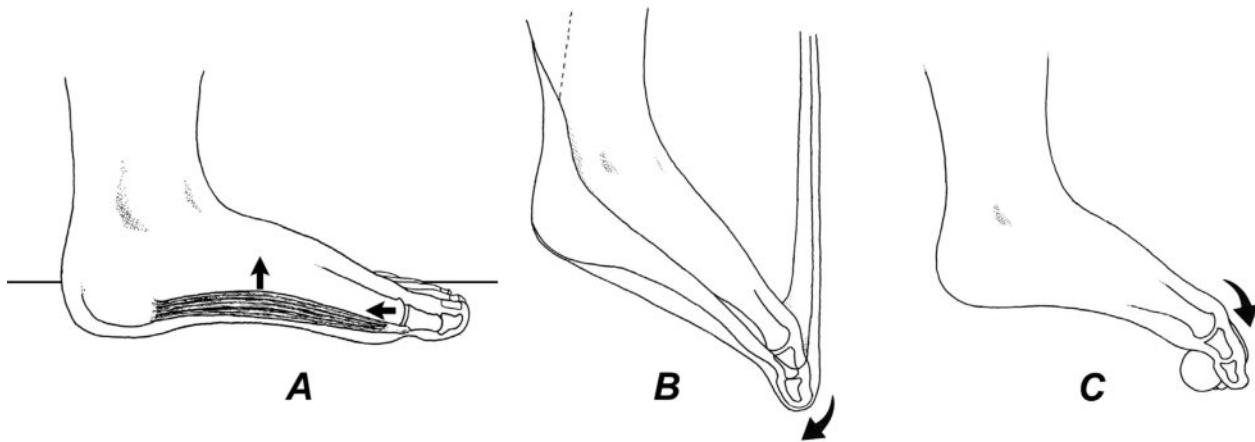


Fig. 1. The short foot exercise (A) is performed by raising your arch while simultaneously pulling the big toe towards the heel (arrows). Theraband exercises (B) are performed by forcing the toes down against resistance from an elastic band while marble pick-ups (C) require you curl your toes downward to grasp marbles or stones. Notice how the toes are in a midline or downward position in all of these exercises.

Because strength gains while exercising are angle specific (7) (i.e., strength gains are greatest when muscles are exercised in the joint angles used while exercising), to be effective, foot exercises must duplicate the positions muscles are used while walking and running. The importance of exercising the toes in their position of function was demonstrated in an evaluation of strength gains associated with short foot exercises. Houck et al. (8) had 18 adults perform short foot exercises for 4 weeks and determined that this popular foot exercise in no way improved the ability of the toes to push down while walking. This is consistent with research by Spink et al. (9),

who had 153 seniors perform foot exercises for 30 minutes, 3 times a week for 6 months (the exercises included marble pickups and various elastic band exercises). At the end of the study, there was no appreciable change in toe strength. While progressive resistance elastic band exercises can produce strength gains, the strength gains are not angle specific because the elastic band's resistance reaches a peak while the ankle and toes are pointing downward; i.e., the calf and arch muscles are shortened. This is in contrast to walking and running, where forces peak while the calf and toe muscles are in lengthened positions (Fig. 2). To produce the best functional outcomes, muscles of the foot and ankle should be exercised through ranges that match their real-life movement patterns (7).

Unlike other foot exercise devices, the ToePro foot exercise platform has been designed to improve performance by strengthening muscles of the foot and leg in their lengthened positions. The 10° sideward tilt lengthens the muscles in the outer leg; the 10° backward tilt lengthens the calf and arch muscles; while the crescent-shaped elevation in the front of the ToePro lengthens muscles of the toes (Fig. 3).

Exercising muscles in their lengthened positions results in significantly greater strength gains than exercises performed with muscles in their neutral or shortened positions. Goldmann et al. (10) show that exercising the toes while they are stretched results in a fourfold increase in toe strength compared to conventional exercises. Animal studies of gene expression and muscle thickening confirm that leg exercises performed while muscles are stretched

Fig. 2. During pushoff, the ankles and toes are in an upward position (A), stretching the calf and toe muscles (B).

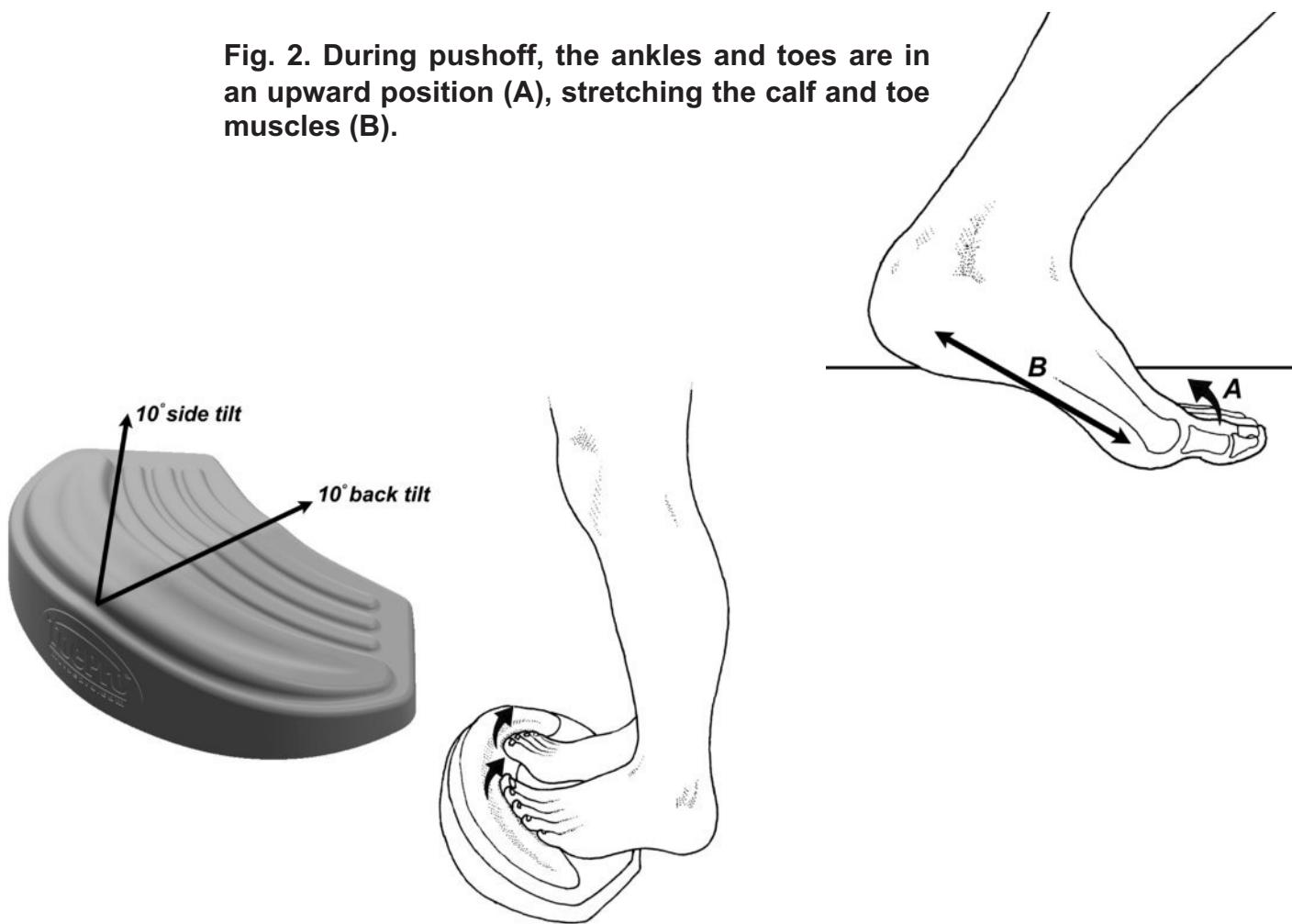


Fig. 3. The ToePro Exercise Platform. The platform is angled 10° to the side and back and the crescent-shaped elevation stretches the toes (arrows).

can increase muscle mass by 30% in less than a week (11). Such dramatic increases in strength and muscle volume have significant implications for both performance enhancement and injury prevention. Increasing toe and arch strength is important for injuries like plantar fasciitis, metatarsal stress fractures and bunions, which are strongly correlated with foot weakness.

The following sections review ToePro exercise protocols for fall prevention and performance enhancement/injury prevention. Unlike Theraband protocols, which can take up to 30 minutes to complete, start to finish, the entire ToePro exercise routine should take less than 10 minutes daily. Because of its simple shape, the ToePro strengthening platform is safe and easy to use, especially for seniors who often have trouble setting up conventional strengthening devices with moving parts and/or rubber bands. Regardless of age, ease-of-use is essential for long-term compliance with any exercise program.

Using the ToePro for the Prevention of Falls

Because of the proven connection between toe weakness and falls in the elderly, strengthening the toes should be a part of every senior's daily exercise routine. In a prospective study of 300 senior citizens by Mickle et al. (12), non-falling seniors had 20% more toe strength than the seniors who fell. Putting aside the emotional toll of dealing with falls, the financial costs are staggering. In the US alone, the cost of providing healthcare for seniors following falls is roughly \$30 billion annually (13). To begin strengthening, place the ToePro on the floor in front of a stable surface, such as a fixed table or wall. Position your toes along the back edge of the ToePro while placing your hands 1-inch from a stable surface (Fig. 4). Now, keep your entire body straight while tilting forward, pressing your toes firmly into the soft foam. Hold this position for 5 seconds and then forcibly use your toes to return to the

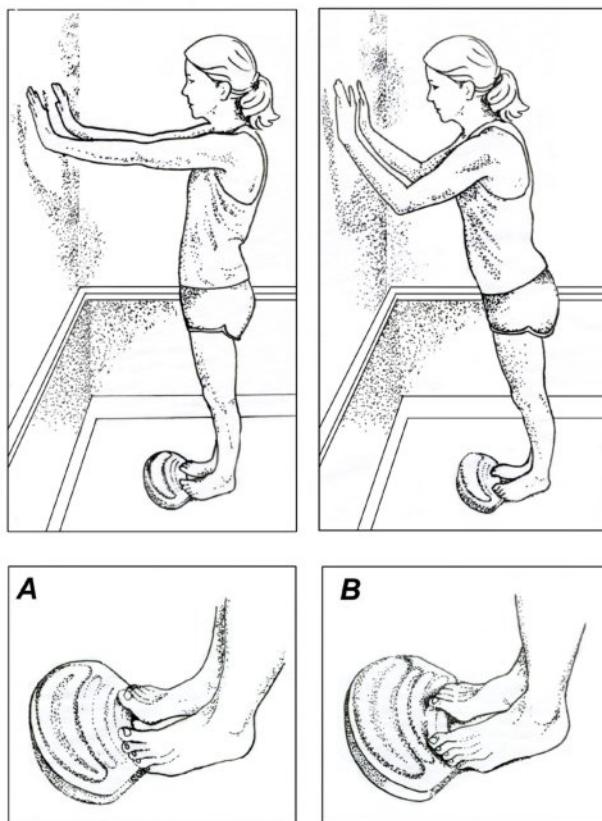


Fig. 4. Place the ToePro near a wall or any stable surface and position your toes along the base of the foam (A). Now, keep your hips and torso aligned then slowly lean forward while pushing down vigorously with your toes (B). Your fingertips should be close to but not touching the wall. Lean as far forward as you can comfortably go and hold this position for 5 seconds. Repeat this movement 25 times daily.

original position. To avoid falling while performing the exercise, less stable people should keep their hands close to a fixed surface at all times. The forward lean and 5-second toe press should be repeated until you feel fatigue. Over time, you can build up to 25 repetitions. Because the foam is thicker beneath the big toe, greater resistance is applied at this point, which is important for preventing falls because the inability to generate pressure beneath the big toe is the single best predictor of falls in the elderly (12). In fact, Mickle et al. (12) show that when you increase pressure beneath your big toe by 1 percent of your body weight, your risk of falling decreases by 70%. In other words, if a 100-pound female produces just 2 extra pounds of force beneath the big toe, her risk of falling decreases 14%.

To understand the connection between toe strength and falling, stand with your arms at your side while keeping your hips and shoulders in a straight line. Now, maintain this straight alignment while you lean forward: notice how your toes, especially your big toes, immediately push down into the floor to protect against a forward fall. The distance you can lean forward while keeping your balance is called the anterior fall envelope, and the seniors at greatest risk of falling have a small anterior envelope. Strengthening the toes reduces your risk of falling by allowing you to control that subtle forward lean that begins while reaching forward to grasp an object, and while beginning to walk forward (the two most common times for a fall to occur). This exercise can be made more challenging by holding a soft ankle weight in one hand and transferring it back and forth while leaning forward and backward to your starting position. As noted by Hill et al. (15), holding a weight equaling 5% body mass in the left hand, then right hand, then both hands, produced significant reductions in postural sway in older adults. The weight can also be placed in a reinforced grocery bag to replicate real-life external loads. Switching the weight from one hand to the other every 5 seconds while leaning forward and returning to your starting position is a great exercise. You should repeat the 5-second forward leans 25 times, twice a day. To prevent falling during this exercise, make sure you're standing in front of a wall or stable surface. If you have any doubts about your ability to perform this exercise safely or if you have had a prior fall, consult with an experienced healthcare provider for a more comprehensive fall prevention program.

ToePro Exercises for Performance Enhancement/Injury Prevention

Begin by placing your toes into the center of the front crest while shifting your weight to the outside of your feet; i.e., keep your arches raised (Fig. 5A). Now, while keeping your knees slightly bent, raise your heels while pressing down firmly with your toes, gradually shifting weight from your outer to your inner forefoot (Fig. 5B). The inward shift of body weight forces you to use the peroneus brevis muscle, which is an important muscle for improving running speeds. In an interesting analysis of muscle activity as athletes transition from slow to fast running, Reber et al. (16) show that only peroneus brevis has a linear increase in activity as running speed is increased. The authors emphasize the importance of strengthening this often overlooked muscle in order to optimize sprint performance. A more recent paper confirmed that keeping all of the calf muscles strong is important for maintaining running speed as we age. In a study comparing running efficiency in young and middle-aged runners, Paquette et al. (17) confirm that older runners slow down not because of decreased force output from the hips or knees, but because of reduced force output from the calves. In fact, force output in older runners was 10.5% lower than that of their younger peers. The authors suggest that preserving calf strength could attenuate speed declines associated with aging.

While raising your heels during the exercise, you should focus on driving your inner forefoot into the foam (Fig. 5B). Pushing down with your inner forefoot causes you to recruit the peroneus longus muscle, which is a powerful stabilizer of the big toe joint and plays an important role in preventing plantar fasciitis. In an extensive evaluation of all potential causes for heel pain, researchers from Australia (18) determined that peroneal weakness was the single best predictor of chronic heel pain. Keeping a slight bend in the knee is important when isolating peroneus longus.

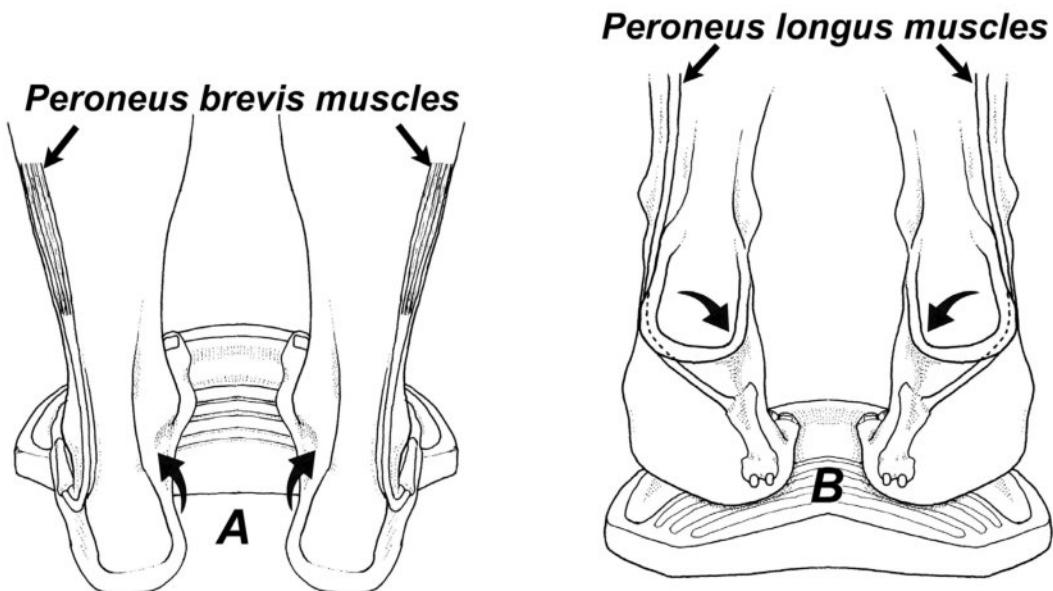


Fig. 5. Conventional ToePro Exercises. See text for full description.

Throughout the entire exercise, your toes should be forcefully grasping the crescent-shaped toe crest. Contact with this initial portion of the crest causes you to recruit the short toe flexors, while contacting the center groove forces you to contract the long toe flexors (Fig. 6). Strengthening the short toe flexors is important when treating plantar fasciitis, as FDB has the ability to offload the plantar fascia. Because patients with plantar fasciitis present with long-term strength deficits in their toes (20), strengthening FDB is essential when treating this frustrating injury; e.g., more than 10% of people suffering from plantar fasciitis have chronic pain lasting more than 2 years from the time of initial diagnosis.

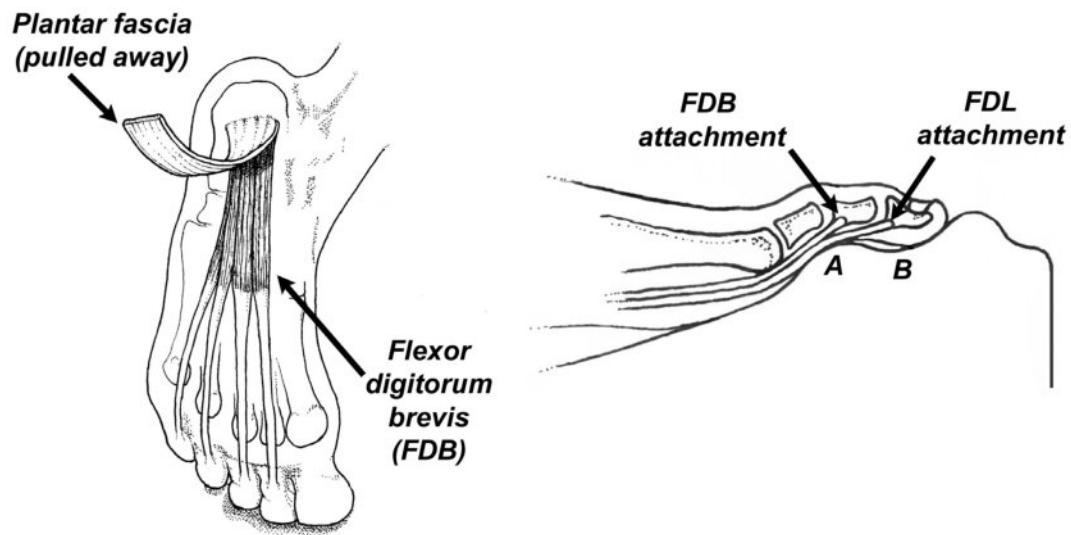


Fig. 6. The flexor digitorum brevis (FDB) and flexor digitorum longus (FDL) contact the beginning and center of the crescent-shaped crest (A and B respectively). Tension created in the FDB muscle can absorb force that would otherwise be placed on the plantar fascia. The long toe flexor muscles play an important role in distributing pressure away from the forefoot.

While the short toe flexors can protect the plantar fascia, the long toe flexors can protect the entire forefoot. A detailed cadaveric study by Ferris et al. (21), confirmed that the long toe flexors play a key role in decreasing bending strain on the metatarsals, while also reducing pressure in the central forefoot by redistributing the pressure to the tips of the toes (Fig. 7). Pressure distribution away from the central forefoot is important in the management of many common injuries, including interdigital neuritis, metatarsalgia, and metatarsal stress fractures. Vigorously pushing down with the big toe is especially important while performing the ToePro exercise, since the big toe alone can exert a downward force equaling 52% of body weight (22). Remember, as little as a 1% body weight increase in force generated beneath the big toe can reduce the risk of an elderly person falling by 7% (12). Toe strength is also important when managing Achilles injuries, since the toe muscles act synergistically with the Achilles tendon to raise your heel. If the toe flexors are weak, their share of the forces of push-off get transferred to the Achilles, increasing the risk of injuring this important tendon.

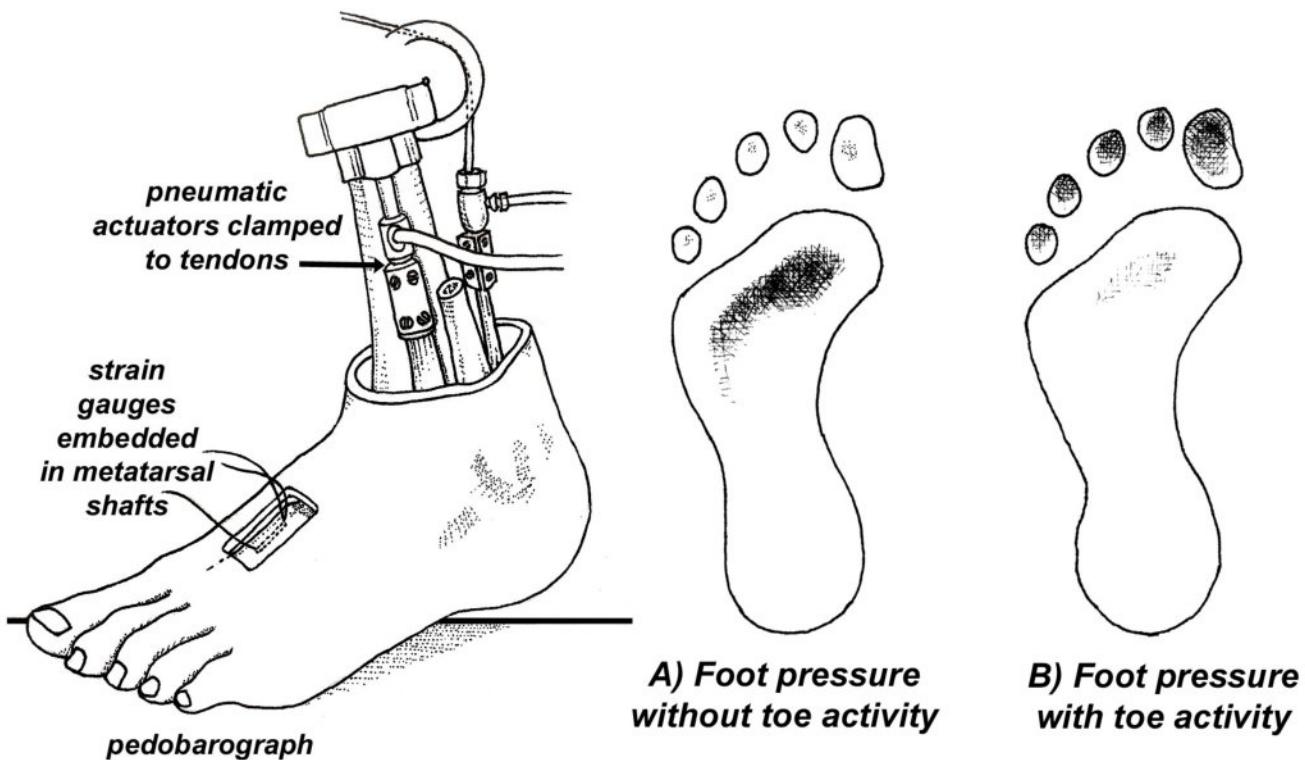


Fig. 7. In a detailed laboratory study of toe function, researchers embedded strain gauges in the metatarsal shafts while measuring pressure on the bottom of the forefoot. The authors noted that when the toe muscles were pulled with special clamps, pressure beneath the center of the forefoot was shifted to the toes (compare pressure patterns in **A** and **B**). The authors also showed there was less bending strain in the metatarsal shafts when the toe muscles were being pulled. The obvious implication of this research is that toe strength plays a huge role in stabilizing the forefoot and preventing metatarsal stress fractures.

The final part of the exercise is completed by rolling in as far as you can onto the inner portion of the big toe and holding this position for five seconds. Resistance from the foam pushes on the abductor hallucis muscle (Fig. 8), which plays an important role in preventing the formation of bunions (23). Doing everything possible to prevent pain and improve function in people with bunions is extremely important, because nearly 200,000 Americans undergo bunion operations each year, and the operation fails in one in six of these individuals (24). To increase activity in the abductor hallucis muscle, people with large bunions should wear toe separators while performing these exercises.

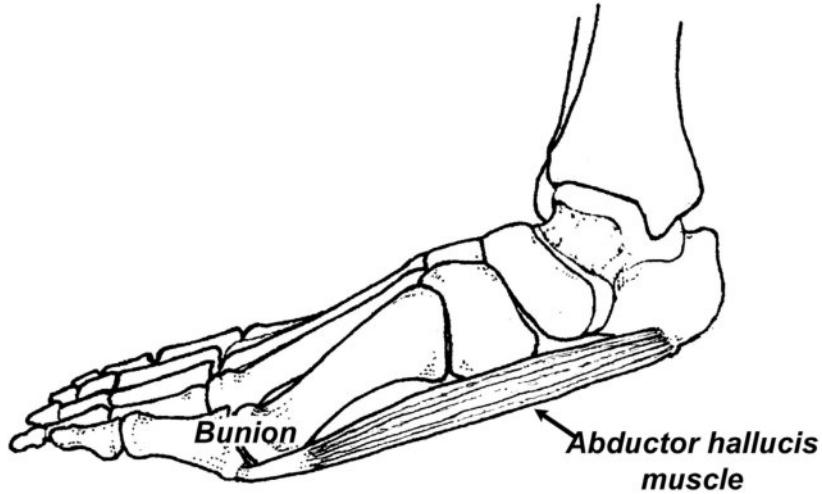


Fig. 8. Rolling onto the big toe forces you to use the abductor hallucis muscle (AH), which is weakened in people with bunions (23).

Depending on your physical fitness, you can start with 3 sets of 15 repetitions performed daily. As you progress, build to 4 sets of 25 repetitions, taking no more than 30-seconds rest between each set. It is important that you spend less than 30 seconds resting between each set. Short interset rest periods have been proven to accelerate muscle repair and remodeling. Finish the exercise by holding your heels 1-inch off the ground for up to 60 seconds. Try to balance with hands close to but not touching the wall for the final 60 seconds. If you fatigue at any time during the exercise, lean against the wall to take stress off your feet and legs. Repeat this routine 5 times per week for 12 weeks.

As you get stronger, you can increase resistance by pushing forward into a wall or by holding a weight while performing the exercises. Each strengthening session should end with a calf stretch by lowering your heels to the ground while keeping your arches raised (Fig. 9). Stretching the calf is especially important for older individuals, as even slight improvements in calf flexibility can improve balance (25). Plantar fascial patients also do well with calf stretching, as calf tightness correlates with chronic plantar fasciitis (26).

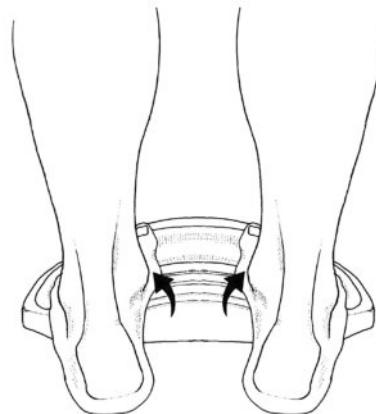


Fig. 9. After exercising, stretch the calf by shifting your weight back while keeping your arches elevated (arrows). Performing this stretch with your arches elevated allows you to stretch your calf and not overstretch your plantar fascia. Hold the stretch for at least 30 seconds.

While the ToePro exercises are most often performed with knees bent, performing them with the knees straight can be helpful with Achilles injuries. In order to better target the small muscles of the toes and arch, it is recommended that the ToePro exercises be performed with knees bent about 75% of the time. Older people trying to prevent falls should perform the beginner exercises with knees straight, as this duplicates the position that most falls occur in (refer back to Fig. 4).

Applying your Newfound Strength Gains

Although counterintuitive, after strengthening your foot and arch muscles, you actually have to teach the newly strengthened muscles how to fire while walking and running. To do this, practice pushing off with the tips of your toes while walking or running for five minutes, twice a day. The deliberate action of pushing down eventually becomes an ingrained movement pattern, and the strength gains achieved with the ToePro exercises can be used to improve performance and protect against injury while walking and running. You can tell if you're effectively using your toe muscles by looking at the insole of your running shoe: you should notice clear wear patterns under the tips of the toes with minimal imprints under the central forefoot. Most people who are injury prone have just the opposite: large wear beneath the middle of the forefoot with almost no visible appearance of toe indents. Great athletes more effectively channel force through their toes, as this gives a longer lever arm for push-off. In fact, several studies have shown the world's fastest sprinters have toes that are 1 cm longer than recreational runners (27,28) (Fig. 10). The longer toes provide a better lever arm for transferring force but individuals with average toe lengths can run faster if they strengthen their toe muscles.

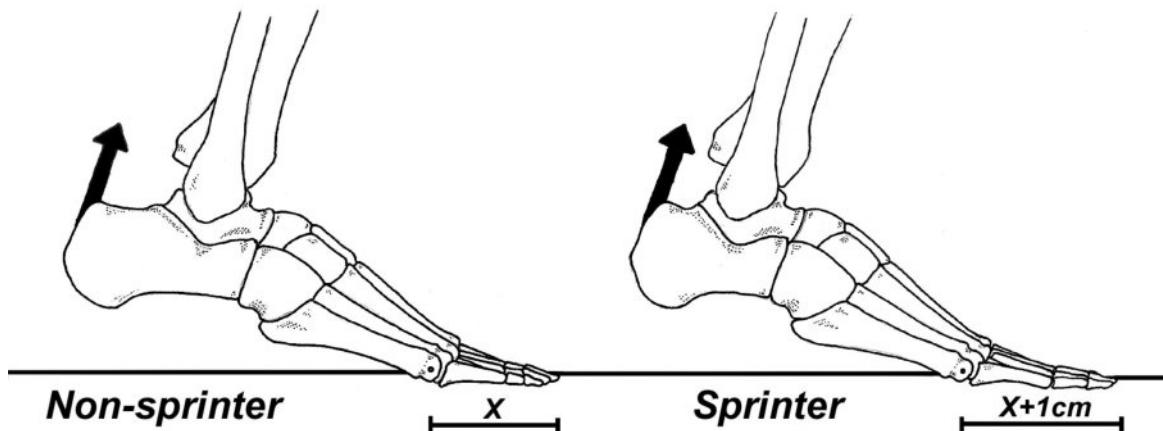


Fig. 10. The world's fastest sprinters have toes that are 1 cm longer than regular runners. The longer toes provide the runners' toe muscles with a longer lever arm for force generation.

Variations on Ways to Use the ToePro

Alternate exercises can be performed by standing sideward along the base of the device with either the inner or outer portion of the forefoot contacting the foam. By performing heel raises in this position, you can increase activity in the peroneus longus and tibialis posterior muscles, respectively (Fig. 11). Strengthening the tibialis posterior muscle can make a big difference when managing Achilles tendon injuries. In a 3-dimensional motion analysis of runners with and without Achilles injuries, Williams et al. (29) noticed injured runners failed to sufficiently rotate their lower legs during push-off, which often occurs when the tibialis posterior muscle is weak. Strengthening tibialis posterior with the ToePro forces this muscle to rotate the leg, which can help resolve even long-term Achilles tendon injuries.

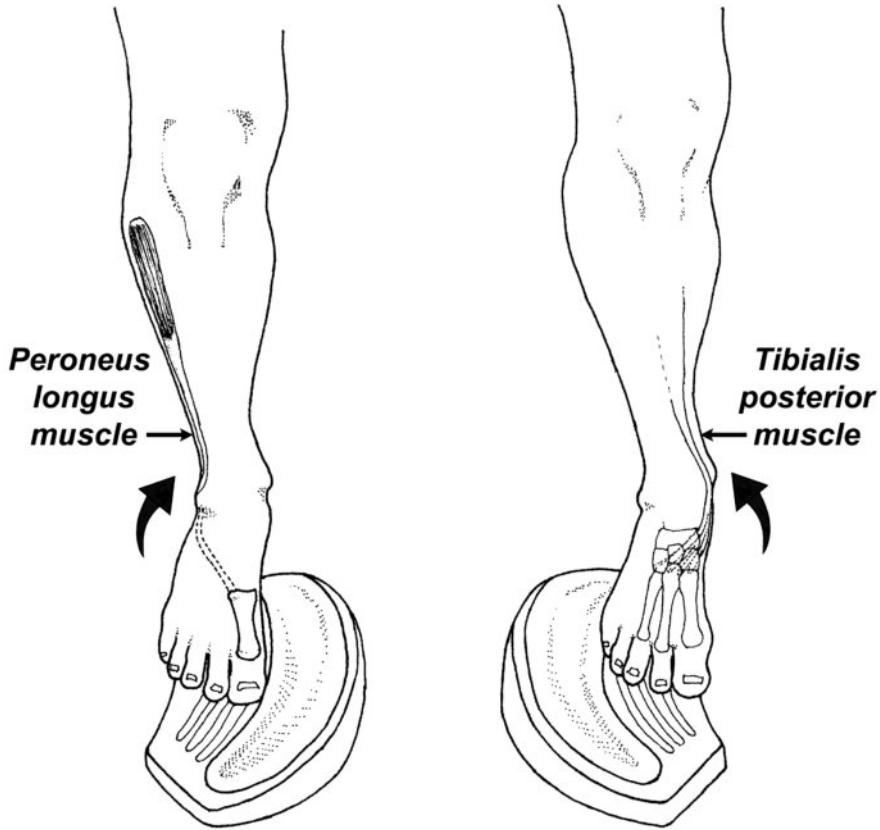


Fig. 11. Alternate ToePro exercises. Performing heel raises with your inner forefoot supported by the ToePro strengthens the peroneus longus muscle, while doing heel raises with the outer forefoot supported by the ToePro strengthens the tibialis posterior muscle.

Conversely, strengthening the peroneus longus muscle is important when treating a range of forefoot problems. Because the first metatarsal is twice as wide and 4 times as strong as the other metatarsals, strengthening peroneus longus allows the first metatarsal head to push down with more force, shifting pressure away from the central forefoot. The resultant shift of pressure towards the inner forefoot is helpful when dealing with a range of injuries, especially interdigital neuritis, hammer toes, and metatarsal stress fractures.

Because exercises produce relatively long-term strength gains, you don't have to do these exercises daily for the rest of your life. Performing the ToePro exercises 3 to 4 times a week for 3 months each year should be enough to maintain strength. A lot of people use the ToePro exercise platform as part of a warm-up for their regular exercise routine. Occasionally, especially in people with weak feet, you can get fluttering or cramping in the calf or arch muscles after doing these exercises. These are harmless symptoms that become less of a problem as you become stronger. Because of the risk of developing mild muscle strains, begin these exercises slowly and only increase sets and repetitions as you feel stronger. Again, it usually takes around 12 weeks to fully strengthen these very important and often overlooked muscles.

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