

PLANTAR FASCIITIS

DEFINITION

The plantar fascia is a thick connective tissue that extends from the heel to the ball of the foot (see image #1). The fascia functions to support the arch of the foot, and also acts as a shock-absorber during all weight-bearing activity. If the toe flexor or ankle inverter muscles are weak, and/or if any of the causative factors below are present, additional stress can be placed on the fascia, which can lead to small tears in the tissue fibers, similar to a rope fraying when it is under tension. Due to the mechanics of the foot during gait, the portion of the fascia that attaches to the heel bone is placed under the greatest stress; this area is therefore the most common site of injury. Each small tear weakens the fascia and increases the risk of further injury. The term “fasciitis” is defined as “inflammation of the fascia”; however, this definition is now thought to be incorrect due to the absence of inflammatory cells within the plantar fascia (Rothbart, 2010). To provide support for this theory, histological findings (Lemont et al, 2003) revealed that there was no tissue inflammation in 50 subjects reported to have plantar fasciitis, but instead an accumulation of damaged collagen fibers. It has been reported that plantar fasciitis occurs in approximately two million Americans each year and in 10% of the U.S. population over a lifetime (Riddle et al, 2003).



#1. Source: Rothbart (2010)

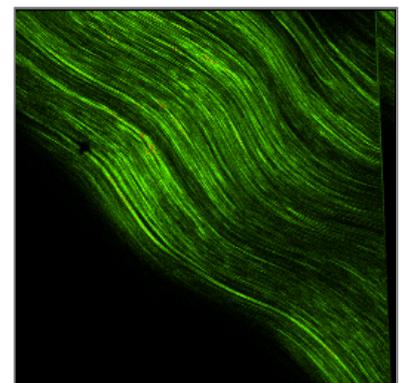
CAUSATIVE FACTORS

Plantar fasciitis can be caused by things such as:

- excessive walking, running, jumping, or climbing;
- a sudden increase in body weight;
- wearing shoes without proper cushioning;
- weak toe flexor or ankle inverter muscles;
- tight calf muscles;
- tight plantar fascia;
- poor foot posture (e.g. over-pronation);
- episodic injury (e.g. planting a shovel in the ground using your foot, landing on a sharp point, etc.), which can lead to plantar fasciitis, if not treated properly.

PHYSIOLOGICAL STRUCTURE

Structurally, fascia is very similar to tendon tissue, in that both are composed of collagen fibers, which provide high tensile strength, and elastin, which provides elasticity. The collagen fibers in a healthy tendon or fascia contain closely packed bundles of fibers oriented in a wavy pattern parallel to the direction of pull (Schierling, 2011) (see image #2). The wavy pattern acts as a buffer or a shock absorber within the tissue, permitting small longitudinal elongation of individual fibrils without damage to the tissue. It has been estimated that these wavy patterns allow 1 to 3% stretching of the tissue, and thus, provide a very efficient safety measure to resist sudden, possibly hazardous tensile strains subjected to them (Järvinen et al, 2004.). The elastic nature of the collagen provides a further means to prevent tissue damage. For example, if one or both feet were in the air prior to landing from a jump, upon foot impact there would be minimal stress on the plantar fascia due to the wavy patterns of the collagen fibers

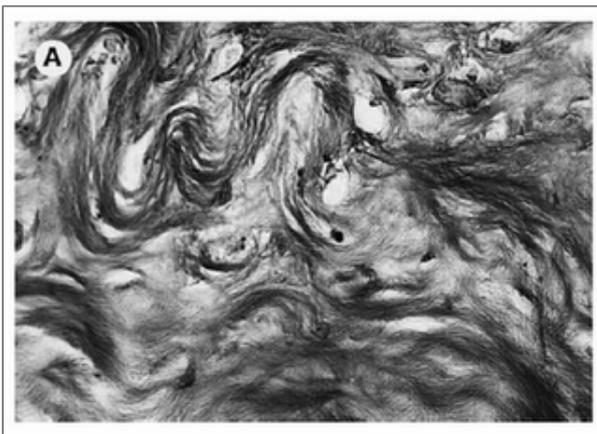


#2 Source: Davies (2011)

straightening out, followed by stretching of the fibers due to their elastic nature. As long as the fibers do not reach their elastic limit, there would be no damage to the tissue.

MECHANISM OF INJURY

When the collagen fibers have been stretched to their elastic limit, and the tensile load exceeds their failure force threshold, tearing of the fibers can result. Micro-tears within the fascia or tendon can weaken the structural integrity of the tissue and increase the chance of further injury. As part of the healing process, new collagen fibers are laid down to repair the damaged fibers. If the tissue is stressed during this repair process (e.g. a person resumes activity before full recovery), the new collagen fibers become damaged, causing the new collagen to grow in a disorganized, random fashion (see image #3), effectively forming scar tissue (Davies, 2011).



#3. Source: Järvinen et al (2004)

The problem with scar tissue is that it is very inflexible. As a result, whenever tension is placed on the scar tissue, such as during walking or running, there is very little stretching of the tissue that can take place, resulting in restricted range of motion and pain. There is also a greater risk of tearing, due to the increased stress that is placed on the tendon or fascial injury sites, as well as the bony insertion points. Uncontrolled eccentric exercise (e.g. running, climbing) can do more damage (i.e. tearing), which causes more disordered collagen (i.e. scar tissue) to build up, magnifying the problem.

ECCENTRIC LOADING AND REHABILITATION

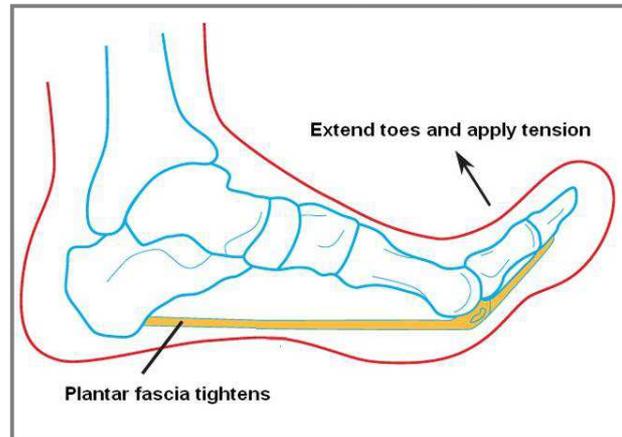
Fortunately, controlled and targeted eccentric exercise has been shown to reverse the problem (Davies, 2011). The physiological repair process is as follows:

- A moderate amount of eccentric exercise (into moderate pain zone) breaks down the disordered collagen at the injury site;
- The body responds by increasing collagen synthesis and producing new fibers;
- If the new collagen fibers are laid down in the proper direction (i.e. in line with the original, healthy fibers), they will not break down when exposed to additional controlled eccentric exercise;
- Over time, as the controlled and targeted eccentric load increases, more and more disordered fibers are broken down and replaced with properly-ordered fibers, which regain their original wavy pattern;
- Eventually, the tissue has been repaired enough to handle a return to high-level training;
- The failure force threshold of the tissue increases due to structural changes in the collagen fibers (i.e. increased density and thickness) (LaStayo, 2003), which can help to reduce the recurrence of injury.

A number of research studies have shown very positive effects of eccentric loading on rehabilitation of tendonitis injuries at the ankle, knee, and elbow (Jensen (1989); Alfredson (1998); Cannell (2001); Croisier (2001)). In most cases, subjects who underwent eccentric loading recovered completely from their injuries, with little or no recurrence of injury. These results highlight the beneficial effects of eccentric loading on tissue healing, as well as prevention of further injury.

To apply eccentric loading to the plantar fascia, the fascia must be placed under progressively increasing resistance while lengthening, in a controlled fashion. Taking into account the origin and insertion points of the plantar fascia on the calcaneus and proximal phalanges, increased tension and lengthening of the plantar fascia can be accomplished by extending the toes (i.e. moving them up towards your shin) (see image #4). Further increases in tension can be accomplished by:

- 1) applying a tensile force to the proximal phalanges in the direction of toe extension (see image #4),
- 2) dorsiflexing the foot at the ankle joint (i.e. moving your foot toward your shin), and
- 3) contracting the gastrocnemius (calf) muscle at the end of ankle dorsiflexion to increase tension on the Achilles tendon insertion point that is located on the posterior surface of the calcaneus – this causes a forward rotation of the calcaneus, which in turn increases the tensile load on the plantar fascia.

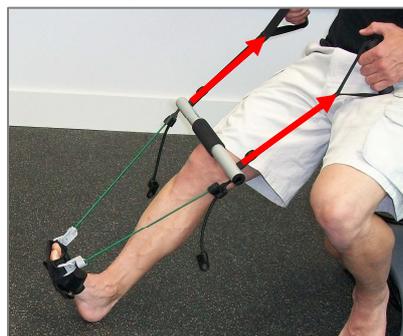


#4. Source: Image modified from <https://docpods.com/Windlass-Mechanism-in-the-foot>

TREATMENT PROTOCOL FOR PLANTAR FASCIITIS

PRECAUTION: *It is recommended that this treatment protocol only be followed under the advice of a physician.*

1. Choose a resistance level that will allow you to perform the following exercise for at least 10 repetitions;
2. Detach the resistance bands attached to the rear attachment points on the foot support, leaving only the resistance bands attached to the toe section;
3. Stretch plantar fascia for 15 to 30 seconds by pulling back on the handles and relaxing the muscles of the foot and lower leg (see image #5):



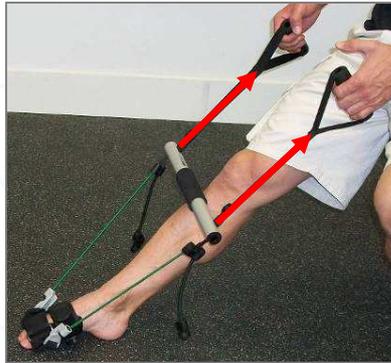
#5. Stretch plantar fascia

4. Flex toes (curl forward) as much as possible while plantar flexing at the ankle joint (i.e. pointing your foot toward the floor) (see image #6);

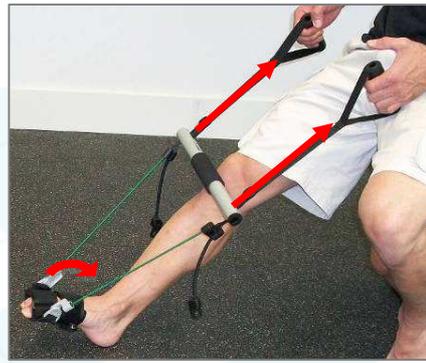


#6. Flex toes and plantar flex ankle

5. Eccentrically load the plantar fascia - pull back more on the handles of the AFX as you extend your toes and dorsiflex at the ankle joint (i.e. move your foot back toward your shin), attempting to resist the movement with your foot (see images #7 and #8);

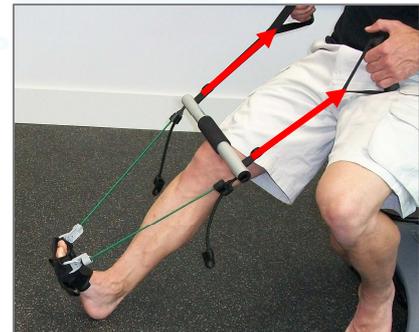


#7. Pull back on handles



#8. Extend toes and dorsiflex ankle

6. When you reach the end of the range of motion for dorsiflexion and toe extension, contract your calf muscle as much as you comfortably can and maintain the contraction for approximately 3 seconds (ensure that you dorsiflex your foot and extend your toes as much possible) (see image #9):



#9. Contract calf muscle

7. Return to step 3 and continue with this cycle (steps 4 to 6) until you have completed the prescribed number of repetitions (see Training Schedule below);
8. At the end of each set, stretch the plantar fascia for 15 to 30 seconds by pulling back on the handles and relaxing the muscles of the foot and lower leg (see image #5).

Guidelines and Precautions

- Perform eccentric loading slowly (4 to 6 seconds for each repetition);
- Initial increases in eccentric tension should be approximately 10 to 20% greater than concentric tension, followed by a gradual increase over time;
- Each workout, attempt to increase eccentric resistance level as tolerance to pain will allow;
- If excessive pain is experienced the day following exercise, reduce the intensity of eccentric resistance;
- Beginning in Week 2, increase the resistance band level when 3 complete sets of 15 reps can be performed without pain;
- Avoid any repetitive or excessive loading of the plantar fascia such as running, jumping, or climbing during this recovery program.

Training Schedule

Week 1	Week 2 and Onward
Day 1: one set of 10 reps for each foot that is affected	Day 1: 3 sets of 12 to 15 reps
Day 2: rest	Day 2: rest
Day 3: two sets of 10 reps	Day 3: 3 sets of 12 to 15 reps
Day 4: rest	Day 4: rest
Day 5: three sets of 10 reps	Day 5: 3 sets of 12 to 15 reps
Day 6: rest	Day 6: rest
Day 7: rest	Day 7: rest

Continue the program following the regimen listed for “week 2 and onward” until full rehabilitation has occurred (Note: research has shown that full rehabilitation of tendonitis injuries typically occurs within 12 weeks).

PREVENTION OF RECURRENT PLANTAR FASCIITIS

To reduce your risk of recurrent plantar fasciitis, the following strategies should be undertaken:

- strengthen the toe flexors (see image #6) and foot/ankle inverters (see images #10 & #11);
- stretch the plantar fascia and calf muscles prior to any weight-bearing activity;
- allow for sufficient recovery periods after strenuous or prolonged weight-bearing activity;
- reduce your body weight if you are overweight;
- ensure that the soles of your shoes have proper cushioning.



#10. Foot/Ankle inversion



#11. Foot/Ankle Eversion

HOW AFX HELPS

- Unlike rubber bands, AFX will not slip off the foot or roll-down the arch during exercises, so you can focus on proper movement and not worry about slippage;
- The AFX is designed to apply targeted resistance to the phalanges (toes), which is ideal for strengthening the toe flexors and treating plantar fasciitis;
- All the resistance can be applied to the toe flexors and plantar fascia in a controlled fashion using eccentric loading;
- AFX uses military-grade bungee that does not over-stretch and is safer than rubber bands, due to a built-in safety feature that prevents rupture of the elastic resistance;
- The AFX has been designed with 2 sets of resistance bands that approximate an optimal strength ratio between toe flexors and plantar flexors, and between toe extensors and dorsiflexors, to allow for balanced strengthening, which is important for injury prevention and proximal-to-distal force generation during weight-bearing activities;
- The AFX incorporates an attachment bar, which allows for resistance forces that are more inline with the direction of movement during inversion and eversion movements, so that the inverter and evertor muscles can be activated to a greater extent.

~ By Rick Hall

Rick is the Principal Scientist for Progressive Health Innovations, and co-inventor of the AFX. Rick has a M.Sc. in Biomechanics, and has conducted research in athletic performance enhancement, exercise physiology, and injury prevention for over 20 years. He is a member of the International Foot and Ankle Biomechanics Community, and is also a reviewer for the Journal of Biomechanics.

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