# Tendon Function and DYSfunction

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## Basics of Tendon Function

**Tendons attach muscles to bones. Simple enough, right? Well... kind of... not really!**

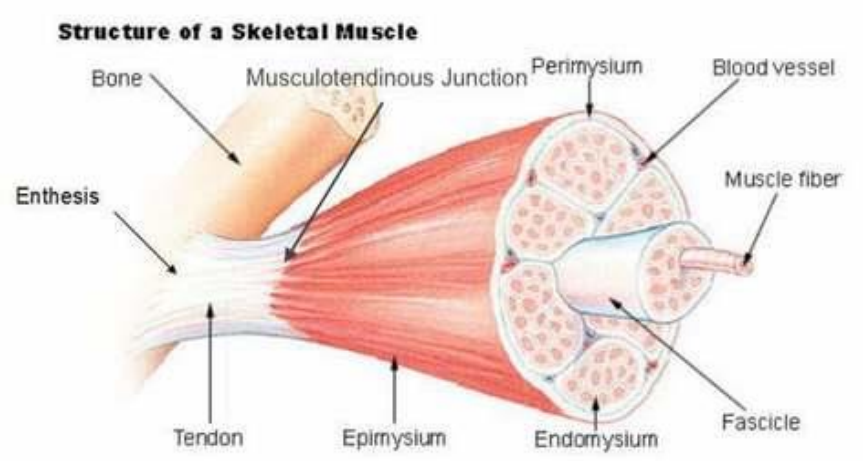

Our two largest calf muscles, the gastrocnemius and soleus are both connected to the calcaneus (heel bone) via the achilles tendon.

Tendons are a specific type of force-transmitting architecture between a muscle and a bone. They are made of a strong fibrous collagen tissue and transmit the force of muscular contraction to a bone in an effort to create joint motion.

Good quality tendons are like stiff springs; A stiff spring will stretch a little, and then recoil with most of the force that was required to stretch it initially. In our tendons, we call this stretch 'creep', and the recoil of the tissues 'recovery'. To prevent wasting energy and causing damage to a spring (or a tendon in this case), we need to have a certain degree of stiffness, resilience and efficiency. An example of this would be if I create tension in my calf by hopping on a single leg. The calf muscles transfer this fairly high load to my calcaneous bone via the achilles tendon. When I do this action repeatedly, a strong tendon will be able to handle the load that is asked of it... whereas a tendon with poor load tolerance may start to creep and not recover quickly... which means that some of the energy that was loaded into the tendon will be lost. This can lead to fatigue of the tissue, and eventually inflammation and micro or macrotearing of the tendon (small tears or a complete rupture).

**Peritendinous Dysfunction**

There are three common anatomical areas that lead to peritendinous dysfunction and pain: The weakest zones of a tendon are where it transitions from tendon to bone (enthesis), followed by the transition zone from muscle to tendon (musculotendinous junction) (1).




Transition from muscle to tendon to bone, with the musculotendinous junction and the enthesis noted in the photo

Additionally, since tendons are mostly found near joints, they are protected from the hard bony surface by a bursa (a fluid-filled sac). If there is excessive compression of a tendon on a bursa, it will often become inflamed and irritable. This is more common than you'd expect, and often a diagnosed tendinopathy includes a bursitis.


This photo illustrates a few of the bursae located around the patella. Our body is designed such that any location where there is higher friction between two surfaces, a bursa will typically be present to provide padding and lubrication.

**Creating Tendon Irritability**

Tendons become irritable when they are stressed beyond their load tolerance. Overuse may develop for one of many reasons:

**1) Excessive volume**: Tendons may not be able to adapt to an increased volume of a specific activity (over a period of days/weeks/months)

**2) Poor biomechanics**: Doing a motion differently than you may have done it previously (over a period of days/weeks/months) may cause irritability, even if the volume hasn't changed. If you've been doing a specific motion with poor biomechanics for a while, but then increase the volume, re-read principle #1.

**3) Impaired mobility or strength elsewhere**: Often, a proximal or distal impairment may cause you to (a) move poorly, which may ultimately cause you to over use some parts of your body and under-use others (b) compress on nerve tissues

**4) Excessive stretching:** Prolonged and frequent stretching of muscles/tendons may result in excessive creep and poor recovery of the tendon. Subsequent loading of the tendon may result in increased potential of tendon irritation.

**5) Nerve compression:** Decreased space at the intervertebral foramen (where the nerves exit your

spine), or compression of a nerve by tight muscles may affect the strength of the muscles supplied by that nerve. This may cause poor movement patterns, referred pain, and /or dysfunctional muscle tone that may cause irritation of the tendon.

**6) Maintenance required:** Even with reasonable volume and good biomechanics, if you ask your body to perform an activity enough and don't ensure that the muscles maintain good mobility and tissue quality, the muscles may develop trigger points which in turn will pull on its tendon with increased tension.

**7) Intrinsic factors:** An individual's risk for developing tendinopathy is also affected by older age, sex, and systemic diseases such as Marfan's Syndrome, Ehlers–Danlos Syndrome, thyroid disorders, diabetes, rheumatoid arthritis, and having a predisposition to developing kidney stones, gallstones or gout(2).

Changes on a Cellular Level

Microtearing of tendon fibers will evoke a cascade of events, mainly in areas with poor blood supply:

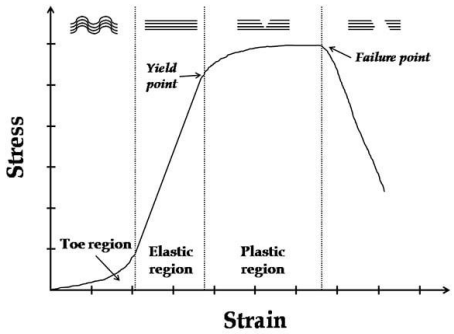
1) Cytokines (small proteins that have an effect on the behavior of cells around them) activate tendon fibroblasts (cells that help to lay down type 3 collagen to help with the initial healing the cellular matrix that was disrupted).

2) At the same time, pain stimulating mechanisms are activated due to the inflammation that was created during the activity that damaged the tendon.

3) Other proteins in the area stimulate enzymes that degrade the extracellular matrix (the support network for tendon cells), and promotes the formation of new blood vasculature and new nerves (3).

Yup, this thickened tendon is actually at greater risk of tearing or rupture. It is thicker because of excess inflammation and water, excessive production type 3 collagen fibers and misalignment of the type 3 collagen fibers.

**The result is a thicker, yet weaker tendon. It has a greater density of nerve endings which increases the sensitivity to all stimuli including the chronic inflammation. Together, these factors create a positive feedback system in which the inflammation irritates the nerve endings, causing increased inflammation... AND the chronic inflammation degrades the quality of the tendon itself. This means that when the tendon is loaded during sports or daily activities, further injury will occur to the tendon, thus creating additional inflammation and pain (3).**




When a tendon is loaded or stretched beyond the elastic range, it experiences irreversible creep (plastic changes) to the tissue. This is known as microtearing, and will eventually lead to collagen / scar tissue

formation, resulting in tendon thickening. If it continues beyond the plastic phase, macrofailure (a complete tear) of the tendon may occur (4,5).

**Tendon Take-Homes**

Statistically significant increases in tendon strength can be seen in the research after approximately 2-3 months of consistent strength training. Conversely, in a prolonged period of deloading, it only takes between 2-4 weeks to see statistically significant decreases in tendon strength (6-8).

Therefore, a few general principles can be gleaned from all of the above information:

1) **Train regularly**, and **do not take more than 2 weeks off from strength training**, or else you may face the consequences.

2) **Gradually increase your training volume in anything you do that is physically active**.

3) **Correct the mobility restrictions, strength impairments, and poor movement patterns that are within your control.** Have a good personal trainer, coach, or physiotherapist assess your movement patterns.

4) If you are using your body regularly, **use a foam roller regularly** (poor man's massage therapist), **and see a body worker** (e.g. massage therapist or physiotherapist) for maintenance visits (once a month minimum).

5) **Control your modifiable risk factors** for developing comorbid conditions: Eat (mostly) healthy, sleep (mostly) well, and live a happy and stress-reduced life.

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