The effect of unloading on Achilles tendon composition

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Have you ever experienced feeling stiff and less flexible after skipping your workout sessions for a while? Then you are not alone. Many muscular- and tendon injuries occur when strenuous physical activity is resumed after a period of inactivity. However, little is known about the underlying factors *why* tendons become predisposed to injury after being used less, and this is what this study aims to investigate.

Achilles tendon

The Achilles tendon is the strongest tendon in the human body, however it is also one of the most commonly injured tendons. Both ruptures as well overuse of the tendon, resulting in activity related pain, are ailments that are becoming increasingly common. Despite the fact that these are common injuries, there has not yet been any consensus regarding how to best treat an injured Achilles tendon in order to restore the tendon function for patients. While a lot is known about the function of tendons, less effort has been made to understand how the use of the tendon affects its composition. And, understanding this connection is crucial in order to design efficient and successful strategies to treat tendon injuries. Therefore, this study aimed to investigate how the use of the tendon- both when it is healthy and intact, and when healing from a rupture- affects the composition at a molecular level. Previous studies investigating the outcome for patients with tendon injuries, treated with different rehabilitation methods, has indicated that finding the appropriate activity level is of great importance for successful recovery for the patient.

http://allcarephysiotherapy.com.au/achillies-tendon-pain/

The Achilles tendon connects to the calf muscle and the heel bone.

Mechanical function and composition

Tendons are the links between muscles and bone, and they enable us to move efficiently, control the skeleton and stabilize our joints. They also act as shock- absorbers to protect muscles from large forces. And they are indeed exposed to great forces- when a human is running, the Achilles tendon takes a load that is about 12.5 times that persons body weight! All these activities require tendons to be both very strong, but yet elastic. And as with many other functions of the human body, tendons have been designed in an intriguing way; making the tissue able to adapt to the different activities they are exposed to by altering their structure and composition.

Effects of training on tendons

Tendons have a slower metabolism than muscles, resulting in that they do not change their structure as immediate as muscles do. It is for example hard to see that your tendons grow after working out. But, exercise does increase the strength of healthy, human tendons- and also make the tendon physiologically “younger”, i.e. staying more elastic, compliant and less stiff. However, excessive loading and overuse of tendons can harm the tissue and cause activity related pain. Regarding healing tendons, previous studies on both animals and humans have concluded that early mobilization of ruptured tendons seem to stimulate the healing process and result in better tensile strength in the healed tendon. In addition, human Achilles tendons that are not treated with surgery but immobilized in a cast during the entire healing period have shown an increased risk of re-rupturing. It thus seems like there is a window of physical activity that is beneficial for the function of both intact and healing tendons, and this is likely reflected in the tendon’s tissue composition.

The study

To determine how less physical activity affect tendon composition, this study looked at the Achilles tendons from rats. To study intact, healthy tendons, one group of rats was allowed to use their leg normally, while the other group got a Botox injection in their calf muscle. This causes a paralysis in the muscle and the rat therefore uses its leg less, thus the load on the tendon is greatly reduced. To study healing tendons, the Achilles tendon was ruptured during surgery, and then left o heal. Half of the injured rats could use their leg normally, while the other half got a Botox injection in the calf so their muscle became paralyzed and the tendon thus less loaded. The tissue composition was investigated by shining infrared (IR) light on the tendons; a method that can determine which molecules are present in the tissue, and their relative amounts. Two components that are important for the tendon’s function and can be detected by IR-radiation are *collagen*, a protein, and *proteoglycans*, a protein-carbohydrate complex. Collagen is the molecule that makes the tendon strong- gram for gram it is actually stronger than steel- and proteoglycans are probably involved in making the tendon damp forces more efficiently.

So- what happens when you are inactive?

Unloading intact tendons for 5 weeks resulted in increased collagen content in the tendon, which is an indication that the tendon is likely stiffer than in its normal condition. This change may explain why the tendon is more prone to injuries when physical activity is reassumed. Converted to a human context; imagine if you are physically inactive for a couple of months- then all of a sudden you decide to play squash, or some other rather strenuous activity that includes quick, powerful moves of the legs. If your tendon then has changed its composition due to the inactivity and has become too stiff, it might be too brittle to support movements that require it to be strong enough however *elastic.* A too strong & stiff tendon might thus be more likely to rupture.

Regarding tendons undergoing rupture healing, unloading did not cause compositional differences in the amounts of collagen and proteoglycans after 4 weeks of healing. This suggests that during healing, the production of collagen and proteoglycans is mostly controlled by other physiological mechanisms in the body. However, the tissue appeared more organized in the tendon that had been exposed to normal loading. This indicates that it is not only the content of the tissue that matters and responds to different loading patterns, but also, and maybe mainly, the structure. A more structured tendon is stronger and can respond better to the different physical demands it is exposed to.

To learn more and finally design efficient and successful rehabilitation programs for tendons, future studies need to investigate the optimal frequency, intensity and duration of exercise that restores tendon composition and function.