Managing tendinopathy in dancers and dance students

By the International Association for Dance Medicine & Science
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Introduction

Tendinopathy is a clinical diagnosis of pain and dysfunction in a tendon, associated with a specific movement or activity. It is a common dance injury[1] yet the mechanism of injury and management strategies may not be well understood. Tendon injuries used to be referred to as "tendinitis" and primarily were thought of as an inflammatory injury. Over the past two decades the literature has been supporting the notion that tendon injuries are driven by cellular changes and not primarily by an inflammatory process, which has significant implications for treatment.[2] Tendon injuries are now commonly referred to as "tendinopathies" to avoid confusion with what causes themand how best to manage them. Previous treatment approaches have been predominantly passive and aimed at reducing inflammation.They include restand unloading the tendon, typically by wearing a brace. It is now better understood that a load management and modification approach is best practice.[2]This resource paper will discuss the current understanding of tendinopathy, ways to manage it according to evidence-based practice,and present some typical dance-specific tendinopathies.

What is a tendon?

A tendon is a tissue that generally connects a muscle to bone. It serves several purposes including attenuating or absorbing tensile forces - forces acting parallel to the orientation of the tendon including pulling, lengthening, and contracting. Tendons act as springs that store energy (stretch-shortencycle) and they allow a muscle belly to either be close to or far from its site of action, depending on tendon length. Tendons also change the direction of pull of a muscle by encasing a bone pulley, such as the patella, or "kneecap."[3] Because of these roles of tendons, they are subjected to tensilepulling
(parallel to the muscle), shearing (sliding), and compressive forces (perpendicular to the tendon).

Tendons are made up of flat cells called tenocytes that lie in rows between parallel collagen fibers and extracellular matrix (ECM) as illustrated in figure 1. There is minimal blood and nerve supply in the normal tendon. Within the matrix,there are proteins called proteoglycans, which are hydrophilic and can draw water into the tendon. Tendon composition is more fibrous/fibrocartilagenous where itinserts onto bones, called the enthesis(figure 1).[3, 4]

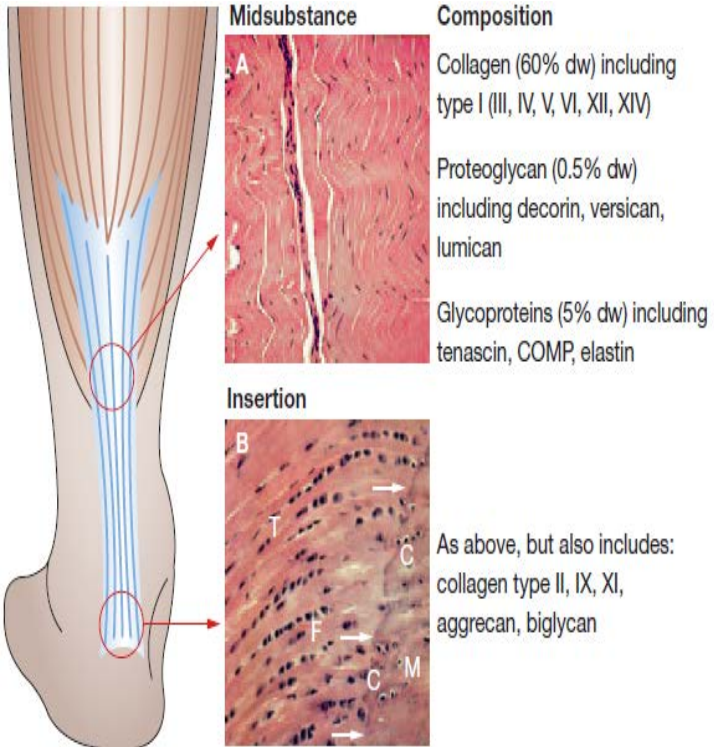

Figure 1: Tendon structure and composition-AchillesTendon.*(Reproduced with permission:Riley G. Tendinopathy--from basic science to treatment. Nat Clin Pract Rheumatol. 2008; 4(2):82-9.)*

Tendon response to load

Tendons adapt to load that is placed on them and that adaptive response varies from normal to pathological.[2]Imagine a rubber band quickly being stretched and snapped across a room. That stretch-shorten cycle will store and release more energy than if one just stretches and releases a band between one's fingers. Plyometricactivity (jumping and explosive movements) maximally loads a tendon because of the energy storage and release in the tendon during a stretch-shorten cycle. Jumping, running, and quick direction changes are examples of high load activities for the lower limb tendons, whereaslow weight bearing activities like bicycling or swimming load tendons very minimally.In a ballet class,*petite* and *grand allegro*(phases with jumps and bigger traveling movements)would be consideredhigh-load, whereas*barre*and *adagio* would be low-load.

Tendons have a specific capacity to withstand load. A normal tendon response to load is to become stiffer. If that tendon is given an appropriate amount of load and sufficient recovery time, the tendon will adapt to the demand placed on it and will be able to cope. If too much load and/or insufficient recovery time is placed on a tendon, it will go through stages of cellular and tissue changes that are considered pathological. The Continuum of Tendinopathy frames our current understanding of these changes (figure 2).[2]

The continuum model has three stages within it.At one end is a normal healthy tendon and at the other end is a tendon in complete disrepair. Many factors contribute to a tendon progressing along the continuum.Overload,however, is the most common factor.

The first stage of tendinopathy is known as *reactive tendinopathy*. This usually occurs with a sudden change in activity, such as increasing rehearsal and class time to prepare for a show or returning to a normal dance volume after an injury or holiday. The reactive cellular response is to allow the flat tenocytes to become round and the number of proteoglycans (types of proteins that draw water into the tissue)to increase in order to thicken and swell the tendon. This increasesthe surface area of the tendon so it can accommodate the forces being placed on it. While the tendon may be thick and swollen, there is no evidence of inflammatory cells. The collagen fibers,which are typically parallel, may have some gapping between their rows due to the rounder tenocytes. However, they are still parallel and well organized. [2]

If sufficient time is given for the tendon to adapt (approximately 3 days) or the load is reduced to appropriate levels for that tendon, it will return to normal within a few days. If the excessive load continues, the tendon will progress towards *disrepair* (*failed healing*). Proteoglycans and other proteins continue to increase in the tendon causing greater separation and disorganization of the collagen. New blood vessels and nerves also begin to grow in the tendon in this phase. Depending on load management and modification, it is still possible to reverse the progress of tendinopathy in this stage. [2]

A tendon that is continuously overloaded and unable to repair itself will progress into *degenerative tendinopathy*. In this stage a focal lesionwill develop where the cells and surrounding matrix tissue have been profoundly broken down. In a lesion, collagen is highly disorganized, and there is apparent cell death. It is unlikely that this lesion will ever repair. However, if there is healthy tendon tissue around the lesion, that tissue can be strengthened and a dancer can still become painfree and return to full activity. If a tendon in this degenerative state is still overloaded, it can rupture and surgery will be indicated. One of the complicating factors with tendinopathy is that typically dancers are pain free prior to a rupture and have asymptomatic tissue degeneration. Tendons will not spontaneously rupture if they are healthy[5]and if they were previously symptomatic, the dancer would likely seek treatment, modify their dancing, or report their symptoms.

Interestingly, unloading a tendon can have similarly deleterious effects as overloading it. [2]When dancers unload their tendons in a cast or brace, they are unable to weight-bear or do any strengthening. Cells and collagen undergo similar changes when unloaded as they do when overloaded. The tendon's capacity to tolerate load, even its baseline load, becomes diminished and it becomes overloaded much more easily. These changes are also generally reversible if the tendon is appropriately and gradually strengthening and loaded in order to improve its capacity. [2]

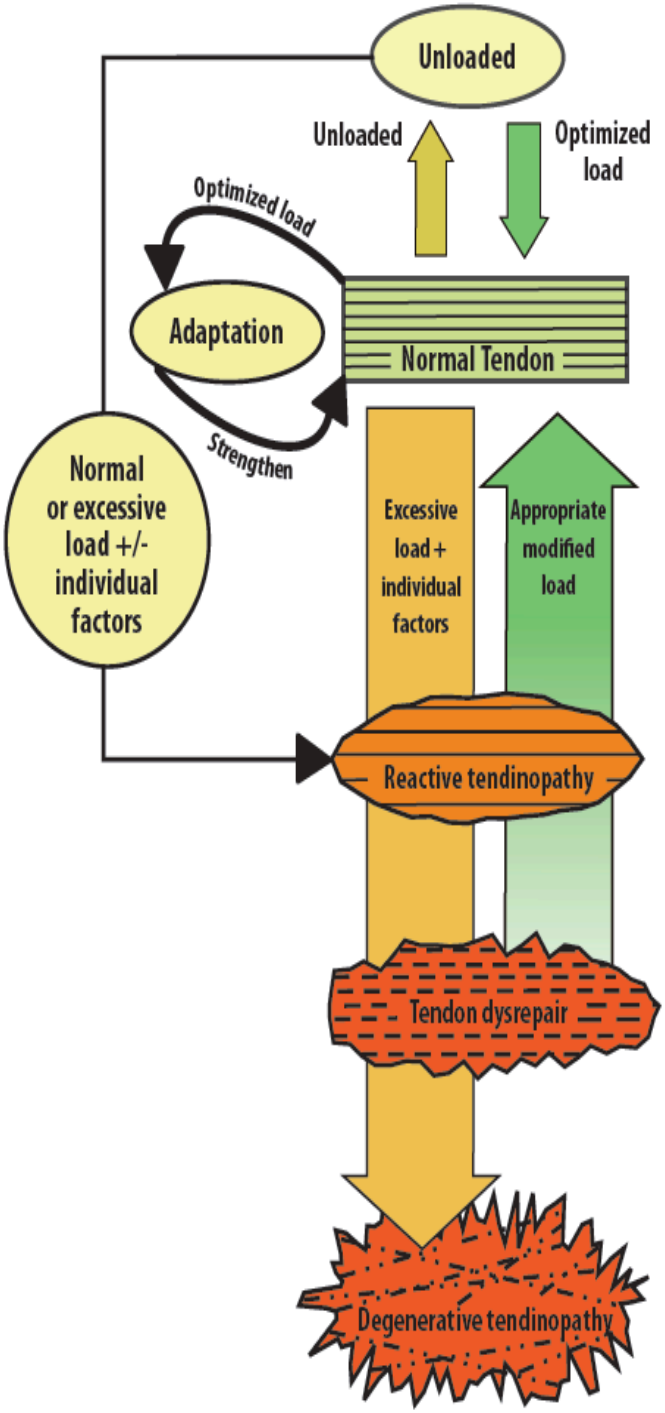

Figure 2: Continuum Model of Tendinopathy *(Reproduced with permission: The Cook-Purdam model to help clinicians understand the relationship between load/unloading and the several stages of tendon pathology. Clinical Sports Medicine, by Brukner and Kahn, McGraw-Hill Education, 2012)*

How to manage and modify load appropriately

For dancers, teachers and choreographers:

Generally speaking, tendons like consistent load and dislike change, especially drastic change. Tendons respond very well to strength training, even quite heavy loads and particularly heavy, slow resistance training. They donot tolerate a sudden increase in jumping, running,and changes of direction (i.e., choreography with any of these elements). If a dance company, school, or club will be rehearsing choreography that has a heavy volume of jumping, running, or cutting, they should slowly ramp up the volume of these activities and allow several days of recovery between rehearsals. This strategy applies to learning new skills in class, particularly for younger students who are progressing through levels and participating in short intensives or workshops. Gradually increasing and decreasing activity should also be integrated at the beginning and end of a program, respectively, or before and after holidays. A strengthening program should always be maintained to keep baseline tendon capacity high.

For healthcare professionals (e.g.,medical professionals, physio/physical therapists, and athletic trainers):

If an individual dancer has acute tendinopathy pain (focal pain on a tendon associated with activity), the following questions should be considered.

- Did the dancer's typical load change in volume/intensity/frequency?
- Did the dancer start learning high load choreography?
- Are there faults in the kinematic chain (e.g., injuries in the trunk, lower extremities, or upper extremities) that are allowing them to overload a tendon due to a compensatory technique?

If there are technique or movement pattern faults, these must be identified and corrected by working with a teacher, choreographer, or physio/physical therapist. If the tendinopathy is predominantly due to overloading activity, the dancer should reduce how much they are doing that particular activity to tolerable amounts, and adapt a HIGH-LOW-MEDIUMroutine once pain has reduced to allow for recovery.[6]For example:on the first day, the dancer participates in dance class/rehearsal and does 50% of all jumping (high load); the next day the dancer only does a low load activity such as ballet *barre*, bicycle, or cross-trainer.

The third day, the dancer may do a medium load activity, such as: strength training,ballet class withonly double leg jumping, or ballet class with 25% volume of jumping, for example. Modifications must be made according to the dancer's presentation and tolerance for loading and consultation with a physiotherapist is advised.

Complete rest is never advised, but relative rest is. Relative rest means avoiding the provocative activities that causeoverload to the tendon, such as running or jumping. The dancer should still participate in class as much as possible, or engage in other strength training and exercise as the injury will allow. If a dancer has to perform and cannot reduce the volume of provocative loading, some temporary relief from unloading may be sought with taping and strapping techniques, consulting a physio/physical therapist for assistance is advised.

Compression: another source of tendon aggravation

While tensile loading has been demonstrated in the literature as a key contributor to the onset of tendinopathy, compressive loading (when forces are perpendicular to the tendon tissue, i.e.,the Achilles tendon over the calcaneus or the hamstring over the ischial tuberosity) seems to also be another important factor in certain tendinopathies. Compressing a tendon over a bony prominence stimulates increased fibrocartilage production. This is a normal adaptive response;[7] however, excessive loading can trigger a pathological response with similar cellular changes seen in tensile overload. When tendons are compressed, tenocytes develop as large, round proteins that slow the diffusion of fluid and protect the tendon from shearing or sliding forces. This is a normal adaptive process,however, higher concentrations of these larger proteins are associated with pathology.[7] In addition to reducing the tensile overload when managing tendinopathy, as discussed above, it is also important to assess if there is a compressive component. If there is, make appropriate biomechanical or accessory modifications to reduce the compression.

Common sites for compression include: just proximal to the Achilles tendon insertion over the calcaneus, tibialis posterior inferior to the medial malleolus, hamstring tendonson the ischial tuberosity, gluteus medius/minimus on the greater trochanter of the femur, and adductor longus/rectus abdominus on the pubic ramus.[8] In the dance population, these compression sites can occur from repeating excessive ranges of motion, technical faults, and anatomical variation or predisposition. Heel lifts, taping, and addressing technique with a teacher and physiotherapist can be helpful to modify compression. Movements may need to be modified as well;for hamstring tendinopathy dancers may limit the height of the leg kicking to the front or side to below 45°**.** For Achilles insertional tendinopathy (pain over the heel bone),dancers shouldlimit *grand plié*to avoid symptoms from compressing the tendon over the heel bone. Dancers can also compress the patellar tendon when weight-bearing on the knees and may need to limit kneeling or wear knee-pads if it is painful.

Common dance-specific tendinopathies

Tendinopathic injuries are overuse in nature and tend to be under-reported in injury surveillance due to the ability of dancers to continue training while injured. There is norobust literature to define the prevalence of various tendinopathies in dancers; however, the most commonly seen tendinopathies clinically include: patellar tendon, proximal hamstring tendon, Achilles tendon, proximal adductor longus tendon, and less commonly, gluteus medius and minimus tendons. In those who do partner work or repetitive weight bearing on the hands (e.g. gymnasts or acrobats), medial and lateral elbow (epicondylopathy) and rotator cuff/supraspinatus tendinopathies can be common.

While flexor hallucis longus tendon and tibialis posterior tendon injuries are common in dancers,the injury is typically a tenosynovitis orinflammation of the sheath surrounding the tendon versus a true tendinopathy, which is not inflammatory, but rather cellular changes within the tendon itself.[9] Achilles tendinopathies are common; however, they are also often coupled with primary posterior ankle impingement with secondary tendon pain versus a true Achilles tendinopathy.These should be diagnosedby a medical professional and must be clarified in order to treat properly.[9]

Managing these tendinopathies requires proper load modifications as described above. If there is a compressive component, other adjustments can be made. For Achilles tendon, peroneal tendon, and tibialis posterior tendon compression, a heel lift can be helpful in shoes, although for dancers this may not be practical. Addressing foot and ankle posture with intrinsic strengthening may be crucial. Taping techniques can be applied to the hip and pelvis for gluteal tendon compression as well as those of the upper extremities.

Summary

Tendinopathy occurs on a spectrum with the preliminary changes occurring in the cells. While some swelling may be present, it is not a true inflammatory cascade (inflammatory cell-response cycle).Diagnosis is crucial as some tendinopathies may be secondary to a primary injury that has not been identified. Treatment must address kinetic chain and movement pattern faults. Load modification, relative rest as needed (total unloading is contraindicated), removal of tendon compression, and a strengthening regimen should be implemented for return to full dance and sports participation.

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