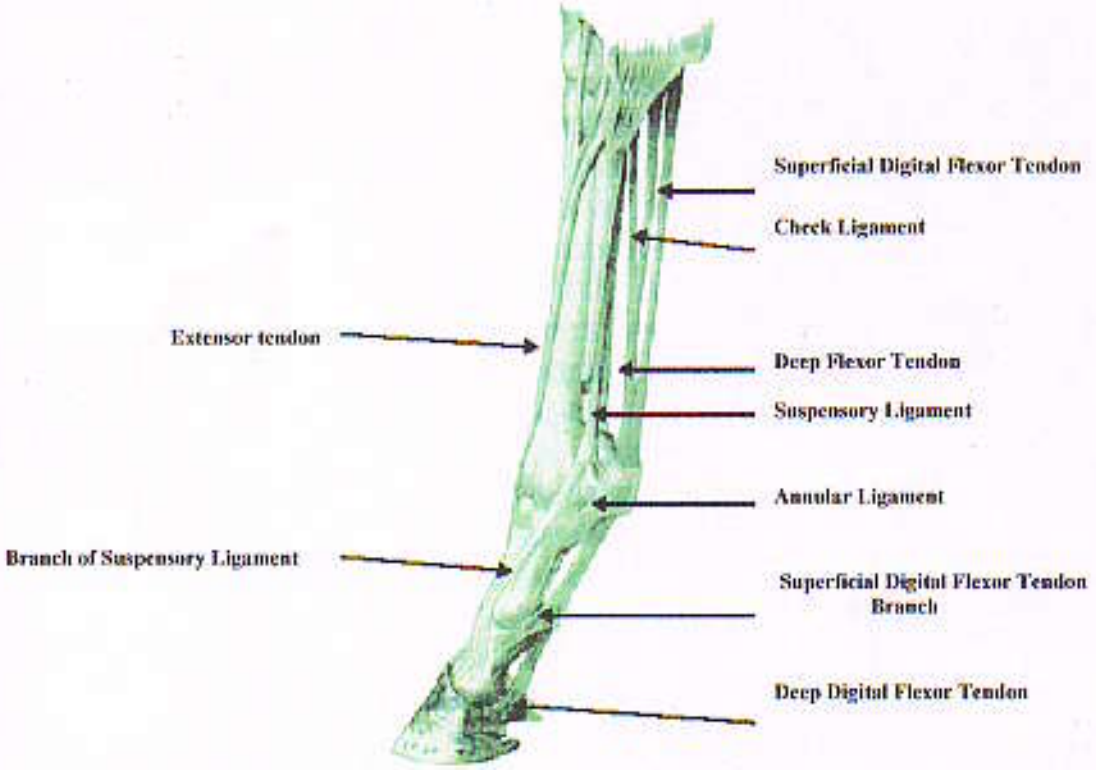
TENDON AND LIGAMENT INJURIES



(EQUINE FORELIMB TENDONS AND LIGAMENTS)
(MIDCALPO KY CLUB STUDY GUIDE)

Cindy Penno
Group 4
Functional Anatomy Course
Fall 2008

What are tendons and ligaments?

Tendons and ligaments are important components of the equine limbs. One of their functions is to transmit muscle activity to a bone or joint and cause it to move in a specific way. They are vital in stabilizing the joints of the limb and provide support to that joint while it is stationary and during movement. Their unique makeup and system of attachment to the bones allows these structures to store and release energy which results in efficiency of movement of the limb at slow and fast gaits.

Tendons are composed of collagen and non-collagenous proteins which combine to form dense connective bands of tissue. Collagen is a fibrous protein found in skin, tendon, bone, cartilage, ligaments and all connective tissues. Collagen fibers when unstressed have a wave-like pattern known as crimp. This formation when combined with cross-linking of the non-collagenous protein, allow the tendons to stretch and contract. Tendon fibers are arranged in bundles and are oriented in a lengthwise or parallel direction. This specific directional organization of fibers provides the tendon its strength since the tensile strain on the tendon during movement of the limb is in a parallel direction to the long axis of the leg. Some tendons are surrounded by a tendon sheath which is filled with synovial fluid. This tendon sheath usually occurs in areas where the tendon changes direction or where it passes under a ligamentous band. Synovial fluid lubricates the tendon to reduce friction during movement.

Ligaments are specialized structures resembling cords or bands and are made up of connective tissue like that of the tendon. Their composition consists of collagen, proteoglycans (glycoprotein) and elastin. Elastin is similar to collagen but is formed with differing amino acids. Elastin is a protein component of elastic connective tissue. Ligaments tend to have higher elastin content than tendons and the elastin content will vary depending on the specific ligament or tendon and its location and function. The directional composition of the ligament fibers is *nearly* parallel which make them able to withstand weight load in different directions as opposed to the arrangement in tendons which is *totally* parallel which gives the tendon a high unidirectional strength. Collagen adds strength to the tendon and ligament. The orientation of collagen fiber bundles and the points of attachment to the bone or joint determine where or in what direction the tensile loads affecting that structure occur. The size of the tendon or ligament indicates how much load that structure is subjected to during normal movement.

Function of tendons and ligaments in the equine limb.

"Tendons and ligaments are belts and cables that hold bones in place and allow the muscles to do their job." (Selnow)

Tendons attach muscle to bone. Tendons are actually modified extensions of the muscle group they are connected to. Where tendons and ligaments attach to the bone they connect by Sharpey's fibers which are a mineralized fibro cartilage. These fibers insert perpendicularly into the bone surface forming a very solid attachment. Tendons and ligaments transmit forces from muscle to bone and act as elastic springs capable of storing energy and giving the horse a highly energy-efficient means of locomotion. Flexor tendons flex or bend the leg when it leaves the ground and extensor tendons straighten the leg while in the air to allow the leg to prepare for the next stride. These long tendons allow the muscle that they are interconnected with to direct the motion from

a distance. The flexor tendons bend the knee, fetlock, pastern and coffin joints in the forelimb. The two major flexor tendons are the superficial digital flexor tendon (SDFT) and the deep digital flexor tendon (DDFT). These run down the palmar (back) of the leg. The SDFT is closer to the outer surface and the DDFT lies underneath the SDFT where it is protected. Both of these tendons branch and attach to the pedal bone within the hoof capsule. The DDFT is not as well protected at this point of branching. The SDFT is a major energy store and also acts as a ligament to stabilize the leg. The DDFT is an elastic energy store and is **important in absorbing the concussive forces of shock** that occur when the hoof impacts with the ground. The DDFT is also an **important store of locomotive energy**. Energy from the spring action of the tendon is stored and when released the energy accelerates movement of the limb. The extensor tendon straightens the knee, fetlock, pastern and coffin joints. There is one major extensor tendon known as the common or long digital extensor tendon which runs down the dorsal or front aspect of the leg. An important function of this tendon is to control the lifting of the toe during limb extension to reduce catching as the limb moves forward.

Ligaments connect bone to bone and usually run over at least one joint. In the foreleg stretching in one part of the forelimb is distributed throughout the entire column of bones in the leg to avoid tension at any specific point. **An important function is one of support**. The stability they provide allows the bones of the column to behave like a rigid bar and support the horse's weight and also allow for movement in the joints to permit the folding up of the limb. They allow extension and flexion of the joints and direct and limit the motion between bones. The suspensory ligament begins at the back of the knee runs down the back of the cannon bone. It then splits into two branches which attach to the sesamoid bones at back of the fetlock. The suspensory ligament supports the fetlock joint like a sling. Not all ligaments run on a parallel direction to the long axis of the leg. Some of them lie in a horizontal position and support tendons running beneath them. Annular ligaments are one example and are found in the fetlock region. These ligaments support the tendons underlying them. Check ligaments anchor tendons to the back of the leg. The superior check ligament holds the SDFT to the back of the radius where the flexor muscle and tendon fuse and the inferior check ligament begins behind the knee and attaches to the DDFT halfway down the cannon bone. Collateral ligaments found in the pastern and coffin joints connect sideways across joints and restrict sideways and rotational movements. The system of tendons and ligaments in the limbs is often called the 'stay apparatus of the front leg which is vital in the support of the horse while standing.

Impact of injury - When injury or disease strikes a tendon or ligament, the results can seriously impact the future use of the horse and it is not unusual for an equine's career to come to an end. In some situations these injuries may be life threatening to the horse. The performance horse is predisposed to tendon and ligament injuries as a result of the strenuous work asked of it however, any horse is subject to such injury. An unfortunate slip in a muddy pasture or a quick turn can seriously lame the individual. It is important for all horse owners and riders to understand that there is *a very fine line between injury and soundness of the horse*.

Tendons and ligaments have a limited capacity for stretching. *"Equine flexor tendons can extend 10 – 12% of their length and values of up to 20% have been reported before the tendon ruptures." (Equine Exercise Physiology)*
A tendon or ligament may have an average stretch and retraction of 1 – 3 inches. Over time as the tendon and ligaments are repeatedly stretched to and beyond their limit, fibers weaken and are subject to microscopic tearing. Weight carried by the horse adds to the stress load and subsequent tearing. Tendon and ligament fibers behave in what is called a 'plastic manner'. Likened to an elastic band, they safely stretch about 8% of their length and then the elastic limit of the structure is reached. As a load increases, the maximum stretch limit is exceeded and fibers begin to rupture. Not all soft tissue injuries occur at a single event. Fiber tearing can be repetitive until the day when the 'elastic' reaches its limits and ruptures with serious consequences. **Like an old rope fraying**. Because of their location on the back of the leg and lack of protection by covering muscle, tendons and ligaments are also susceptible to lacerations and blunt trauma. Severe lacerations to extensor tendon, SDFT, and DDFT seriously compromise the future of the horse. These injuries generally have a 50 – 60 % chance of return to work and it will likely be to a lesser workload than what the horse may have been accustomed to.
The most serious injuries tend to occur in the front limbs. The horse carries 60 - 65% of its body weight on the fore limbs at rest. When a horse travels at speed, there is a point in time when the entire weight is bearing on a single fore leg resulting in a tremendous strain on the tendons and ligaments. Forces on that leg may reach 2-3 times its body weight with the foot hitting the ground 150 times a minute in a galloping race horse. Many injuries occur as a result of vigorous exercise although there are a myriad of other contributing factors. Other factors include deep sand soft or slippery turf, or mud. Poor conformation can play a part as it allows for uneven stress loading on the joints and bones. Hooves with long toes and low heels will place added stress on the SDFT. Upright pasterns may place a horse at risk of tearing the distal sesamoidean ligaments.

A study by Sue Dyson and associates at the Centre for Equine Studies in Suffolk, UK reviewed records from 1069 horses. The study indicated that in general purpose horses, dressage horses, show jumpers and racers, the occurrence of tendon and ligament injuries frequently involve the suspensory ligament. Deep digital flexor tendon involvement was a common site of injury in the forelimbs of most horses. The superficial digital flexor tendon was injured most often in eventing horses, show jumpers and racers and also does occur in dressage horses. Dressage horses were also shown to be a high risk for tendon injuries in the rear legs.

Healing and Treatment Options

The severity of the injury varies depending on the number of fibers torn. **The more serious the injury is the longer the healing and recovery period**. Ruptures and total lacerations of one or more structures have a very poor prognosis for healing and potentially impact the life of the horse.

There are 4 levels of injury with the severity increasing numerically.
Type 1 – minimal disruption of fiber patterns and minimal inflammatory processes
Type 2 – Lesions show disruption of fiber pattern and local inflammation.

Type 3 – Lesions show significant fiber tearing
Type 4 – Lesions show almost total fiber tearing with hematoma formation.

After fibers tear there is bleeding at the injury site. Blood clotting, swelling and inflammatory processes come into play. As inflammation subsides the clot is reabsorbed and scar tissue forms around the injured fibers. It is important to reduce the inflammatory process as quickly as possible in order to avoid excessive swelling as this can damage and weaken the surrounding fibers at the injury site. The body's repair process results in the laying down of scar tissue which has a different collagen composition to the original makeup of the tendon. Importantly, the healing fibers **no longer** maintain the parallel structure and form a haphazard interweaving around the damaged area to form a dense scar in an attempt to 'glue' the frayed ends together. The **fiber alignment of the tendon and ligament is integral to its ability to stretch and the healing process may result in a stiffer structure at the injury site**. This inelasticity impacts ease of movement of the injured area. Adhesions to other local structures at the injury site can occur and this will impact the range of movement and the soundness of the animal. **The affected structure will never be as strong as it was originally** and will be predisposed to re injury.
Individual tendons do not all have the same healing potential and the healing depends on the structure involved and the severity of the injury. Ligament injuries are equally as serious as tendon injuries and tend to take longer to heal due in part to their avascular nature. The suspensory ligament is vital to the support of the horse's entire lower limb and essential for locomotion, if seriously damaged will leave the horse with a lifelong problem.
Research studies are looking at methods to help speed up the healing process and also improve the efficiency of the healed site. Stem cell therapy has been found effective in improving the way the tendon fibers heal structurally although so far it has not proven successful in improving the rate or quality of the body's repair job. Cyrotherapy is used in some large facilities in the belief that cooling the tendons soon after exercise will reduce microscopic lesions of the fibers and slow or stop the inflammatory process. Hypobaric oxygen therapy has been tried as well as shock wave therapy. Again, both are used in effort to try to simulate efficient healing. Tendon splitting is a surgical procedure used to clean up the injury site and encourage healing. However, for the caregiver without access to the above technology, veterinary support with use of ice, heat, anti inflammatory drugs, and bandage support is the norm along with extended time off from exercise. In a case of a total rupture the veterinarian may suture the ends back together but this injury has a poor prognosis for future use of the horse.
Ultra sound is highly recommended to diagnose early signs of damage, follow ups and to determine when to implement an exercise program for the recovering patient whom in all serious cases will be off work for several months. It may also be used as a healing therapy as it generates heat into deep tissue.
Foremost in importance for successful treatment is early recognition and diagnosis of a repetitive problem before it becomes an acute injury. Second is patient and owner compliance. The horse with an injured tendon or ligament in many cases will be on enforced stall rest for what could be a minimum of 4-6 months. It would **not be unusual** for a serious injury to take **up to or longer than a year** before ultrasound deems

the horse healed enough to go back to start a rehabilitation program. Returning to work too early can result in re injury to the unhealed tendon or ligament. The horse being such a large animal and somewhat unpredictable can still with one misstep, undo all progress in an instant.

Preventative Management

Maintaining healthy tendons and ligaments is of vital importance. Without the full function of these structures the horse's use is compromised. By understanding the anatomy and function of the tendon and ligaments of the horse's limbs and by being aware of the potential for injury the owner/rider can manage the horse so that damage can be avoided or detected early.

The physical condition of the horse is a factor in its susceptibility to injury. In referring to tendons and ligaments Dr. Nancy Lovin states,

"The more inactive these structures are, the less organized the fibrous component within the ligament or tendon." (Lovin)

Therefore the unconditioned, confined or inactive horse will have weaker tissues that are not able to withstand the stress of excessive exercise

-**Conditioning** – long slow distance training with gradual intensity. Use a program that is consistent and keeps the horse in good overall physical condition so that fatigue with its associated problems is avoided. A horse confined to a stall will need a different approach to training than a horse that is turned out and allowed to exercise at will. It takes months to condition ligaments and tendons and they must be maintained with regular activity. Inactivity will see a softening in the condition of theses structures and it will take some time to return them back to a conditioned state.

-Do not ask the horse to perform tasks he cannot do.

-Poor conformation may cause an imbalance of forces that will impact the leg structures.

-Keep feet trimmed and or shod appropriately and at timely intervals. Avoid long toes and excessively low heels.

-An obese horse will have added stress on his limbs.

-Ensure the horse has proper nutrition. This affects his overall health and ability to perform.

-Never push the horse to exhaustion.

-Proper **warm-ups**. It takes 10 to 15 minutes for the tendons to warm up and reach their ability to flex properly.

-**Cool down** is important. Remove leg boots, and bandages and cool legs with ice or cold hosing. During exercise tendons accumulate heat due to repeated stretching. Retained heat can increase tendon temperature to 46/47 0C which can damage and weaken collagen fibers and increase risk of tendon failure.

-Tight **restrictive bandaging interferes with blood flow**, lubrication and the natural rebound behavior of the tendon or ligament.

-Tendons and ligaments lose their elasticity over time. Ageing causes stiffening of the structures.

-**Palpate** tendons and ligaments regularly. Before and after each ride, check for heat or swelling. The slightest amount of either may be evidence of fiber disruption.

It is up to us, as caregivers, to look out for our horses as in their effort to please, they unselfishly give so much. Oft times at the expense of their health.

Sources

1. Adams, O.R. Lameness in Horses, Third Edition Lea & Febiger 1974

2. Catcott E.J., DVM. PhD, Smithcors J.F., DVM, PhD, Equine Medicine & Surgery A text and reference book, American Veterinary Publications, INC. 1972

3. Dyson, Sue, Murray Rachel R, Tranquille Carolyn, Adams Vicky, Centre for Equine Studies, Animal Health Trust, Lanwades Park, Kentford, Newmarket, Suffolk, CB8 7UU, UK, Association of sport and performance level with anatomical site of orthopaedic injury and injury diagnosis. BCVMA equine seminar November 2008.

4. Floyd Andrea E, DVM, Mansmaan Richard A, VMD, PhD, Equine Podiatry, Saunders Elsevier, 2007.

5. Hinchcliffe, Kenneth W, Geor Raymond J., Kaneps Andris J., Equine Exercise Physiology, Saunders Elsevier, 2008

6. King, Christine, BVSc, MACVSc, MvetClinStud, Mansmann, Richard, VMD, PhD, Lameness, recognizing and Treating the Horse's Most Common Ailment, Lyons Press 2005.

7. Lovin, Nancy S, DVM, All Horse Systems Go Chpt 7, Trafalger Square Publishing, 2006.

8. Selnow Les, Tendons & Ligaments, The Horse September 2006

---

9. Diagnostic Ultrasound & Musculoskeletal Injuries in Horses, University of California Davis, http://www.vmth.ucdavis.edu/vmth/clientinfo/laus/lausbroch.pdf

10. Ferraro Gregory L, Staver Susan M, Whitcomb, Mary Beth, Center for Equine Health, School of Veterinary Medicine, University of California Davis, http://www.vetmed.ucdavis.edu/CEH/Pubs-SuspBrochure-bkm-sec.pdf

11. Selnow Les, Tendons & Ligaments, www.thehorse.com , April 2002 Article #3426

12. Smith, R.K.W., Physiology of Tendon and Ligament, http://www.ivis.org/proceedings/geneva/2005/smith2/chapter.asp?LA=1