

# Suspensory Ligament Injuries in Horses

*What is the suspensory ligament? Where is it located?  
What does it do? How is it injured?*



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## **Contributing Authors:**

Gregory L. Ferraro  
Director  
Center for Equine Health

Susan M. Stover  
Department of Anatomy, Physiology and Cell Biology  
School of Veterinary Medicine

Mary Beth Whitcomb  
Department of Surgery and Radiological Sciences  
School of Veterinary Medicine

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**Center for Equine Health**  
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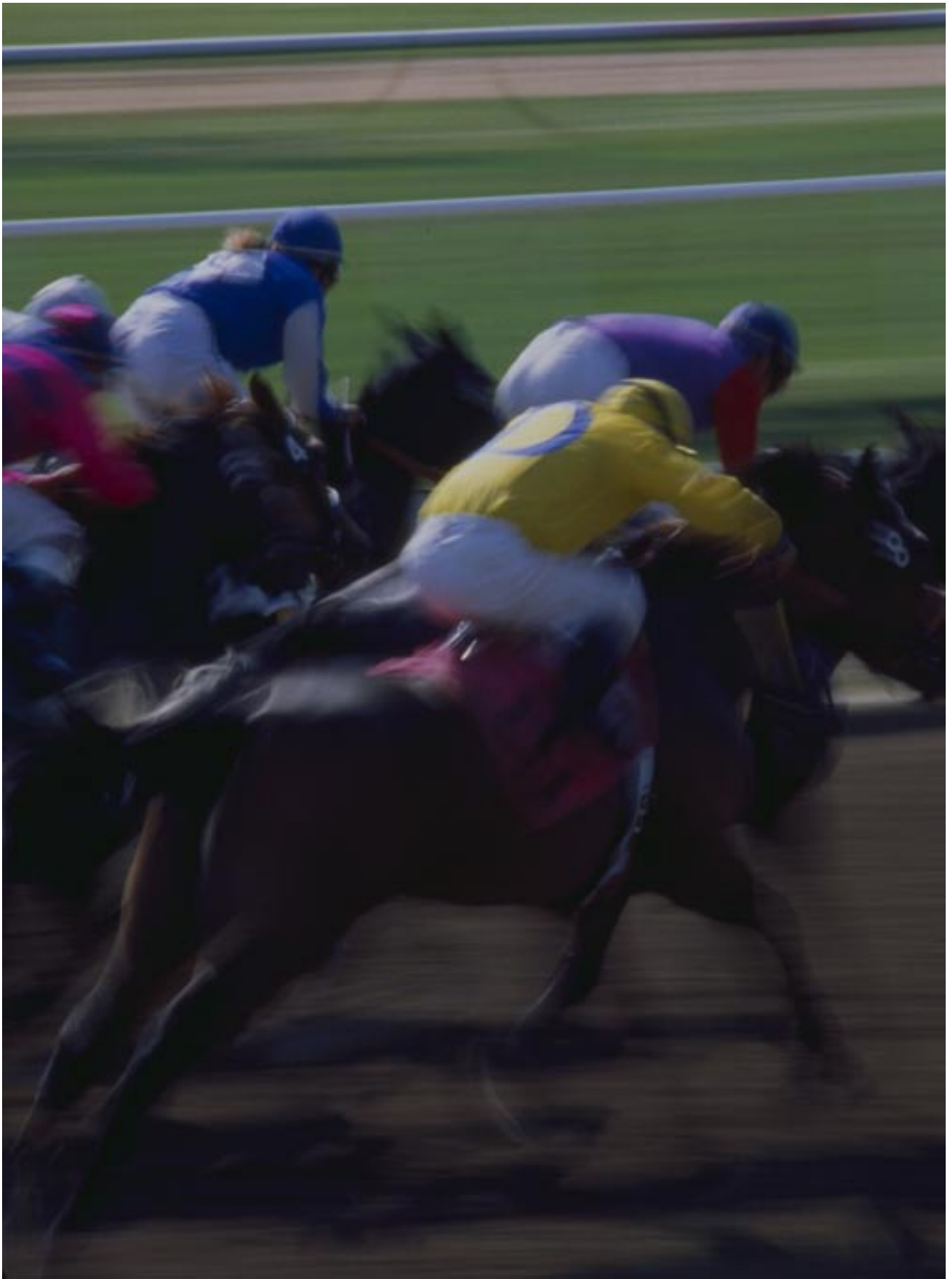
## Writing/Editing/Creative Design:

Barbara Meierhenry  
Senior Editor  
Center for Equine Health

## Photographs by:

Mary Beth Whitcomb, Lydia Nevzorova and Tracy Gantz (color photos on cover)  
Mitch Taylor, CJF (anatomical photo on cover)  
Ashley Hill, Susan Stover, Katey Barrett  
Illustrations by Robin Peterson  
Ultrasound images by Mary Beth Whitcomb

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# Introduction

All horses are subject to tendon and ligament injuries, regardless of breed or whether they are performance horses or ridden for the occasional trail ride. Of course, athletic horses by their occupation are at greater risk. These injuries can occur in both the forelimbs and hindlimbs and can be serious enough to end an athletic career or lifestyle.

In 1999, the Center for Equine Health conducted a survey of horse owners to determine the most common injuries or conditions affecting their horses. Next to colic, injuries to the suspensory ligament were most frequently cited.

What is a suspensory ligament? Where is it located? What does it do? How is it injured? This publication is intended to answer these questions for horse owners so they will better understand how such injuries affect a horse and why they can require many months to heal properly.

## Background

Ligaments and tendons play an important role in musculoskeletal biomechanics—the study of body movements and the forces acting on the musculoskeletal system. They represent an important area of orthopedics in which improvements in the treatment of injuries present significant challenges. Many of these challenges are in restoring the normal mechanical function of these complex, soft-tissue structures.

Tendons and ligaments are living tissues that contain cells. In human adult tendons, the cells occupy only a small proportion of the volume and have a negligible effect on the mechanical properties. Like other connective tissues, tendons

depend on protein collagen for their strength and rigidity. The arrangement of the long, thin collagenous fibers is essentially longitudinal, but incorporates a characteristic waviness known as crimp. The fibers lie within a matrix of aqueous gel. Thus, tendon is a fiber-reinforced composite (like fiberglass), but its collagen is much less stiff than glass and its matrix is very much less stiff than the resin.

Tendons join muscle to bone so that when the muscle contracts the bone moves. Most tendons are described as either flexor or extensor. Flexor tendons allow a joint to bend inward toward the body (close), while extensor tendons allow a joint to extend (open).

A ligament is a strong, flexible connective-tissue band that joins bone to bone. Most ligaments are composed of dense fibrous tissue formed by parallel bundles of collagen fibers. They have a shiny white appearance and are pliable, strong, and noncompliant. A second kind of ligament, composed either partly or almost entirely of yellow elastic fibers, is extensible or compliant and allows the connected bones to move apart. Thus, ligaments are stabilizing structures that hold the bones together and stop them from overextending, overflexing or over-rotating.

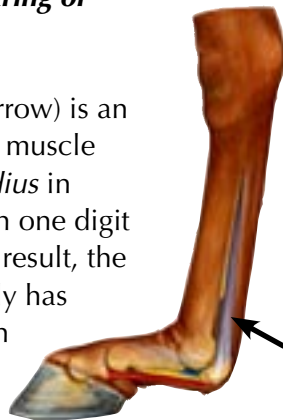
A suspensory ligament is a band of fibrous tissue that supports an organ or body part. In humans, there are a number of suspensory ligaments supporting organs such as the lens of the eye or the ovary. The suspensory ligament of the lens holds the lens of the eye in place, whereas the suspensory ligament of the ovary connects the ovary to the surface of the uterus.

## The Suspensory Ligament in Horses

In horses, the suspensory ligament is one part of the **suspensory apparatus** of the leg. It consists of a strong band of tendon-like tissue that lies along the back of the cannon bone between the splint bones. It originates from the top of the back of the cannon bone and continues down to the fetlock region. About two-thirds of the way down the cannon bone, the suspensory ligament splints into two branches (medial and lateral); each branch inserts into one of the paired (medial and lateral) proximal sesamoid bones. Smaller branches course obliquely to the front of the limb to join the major (common digital) extensor tendon of the limb.

***The primary function of the suspensory ligament is to prevent excessive extension of the fetlock joint during the weight-bearing or stance phase of the stride.***

The suspensory ligament (arrow) is an evolutionary derivative of a muscle called the *interosseous medius* in animals that have more than one digit (primates, dogs, cats). As a result, the ligament in horses frequently has remnants of muscle tissue in its most proximal portion. This fact can cause some confusion in ultrasound examination of the suspensory ligament because it can be difficult to differentiate between this “normal” vestigial (remaining) muscle tissue and damaged ligamentous tissue.



## The Suspensory Apparatus

The suspensory apparatus is a strong band of structures that lies on the back of the cannon, fetlock and pastern regions of each limb. This stiff band functions like a sling to support the fetlock joint so that the fetlock does not hyperextend and drop to the ground during standing and locomotion.

The suspensory apparatus consists of a series of structures—like links in a chain. The links consist of the suspensory ligament, the proximal sesamoid bones, and the distal sesamoidean ligaments. The chain is similar to one long ligament in which the sesamoid bones are interposed at the back of the fetlock joint. The ligaments are optimized to sustain tension with fetlock extension during loading of the limb, while the sesamoid bones sustain the compression experienced at the back of the fetlock joint during fetlock extension.

The suspensory apparatus acts like a spring. When the fetlock extends during gait, the spring stretches and stores energy. When the fetlock flexes during gait, the spring returns energy to the limb for locomotion. The suspensory apparatus also prevents excessive extension of the fetlock when the limb is loaded.

## Components of the Suspensory Apparatus

**Proximal Sesamoid Bones.** These pyramidal-shaped bones are often referred to as the sesamoid bones. They are located as a medial and lateral pair of bones located at the back of the fetlock joint. They are intimately involved in the formation of the joint capsule and are attached firmly in their position by that capsule and by their attachment to the suspensory ligament, the collateral sesamoidean ligament on each side of the fetlock joint, and by four pairs of distal sesamoidean ligaments. The medial and lateral branch of the suspensory ligament holds each of their corresponding sesamoid bones in place proximally (above).

**Distal Sesamoidean Ligaments.** These ligaments represent a continuation of the medial and lateral branches of the suspensory ligament down the leg to the posterior aspect of the pastern bones. There are four pairs of these ligaments and each of these ligaments originates from the bottom of their respective medial or lateral sesamoid bone and runs downward in different directions to attach at different locations at the back of the long and/or

short pastern bones. Together with the suspensory ligament and proximal sesamoid bones, the distal sesamoidean ligaments prevent excessive fetlock extension during weight bearing and locomotion.

## The Passive “Stay” Apparatus

The suspensory apparatus is a critical component of the much larger **stay apparatus**. The stay apparatus allows the horse to stand at rest for long periods of time with virtually no muscular effort.

How is this possible? A combination of anatomical structures in the fore- and hindlimbs provide passive resistance to flexion of joints in the horse’s leg. In both limbs, the suspensory apparatus, and the superficial and deep digital flexor tendons

with their respective (proximal and distal) check ligaments form major components of the stay apparatus for the lower portion of the limb.

In the forelimb, the accessory check ligaments act as tension bands for stability of the carpus, fetlock and digit. Several associated musculo-tendinous structures of the shoulder and elbow joints provide passive extension for these joints as well as the carpus.

In the hindlimb, a structure known as the “reciprocal apparatus” forces the hock and stifle to flex and extend in unison. As part of the “stay” system, the horse locks his patella (knee cap) in place using its medial patellar ligament, thereby preventing flexion of both the stifle and hock.



*The stay apparatus allows the horse to stand at rest for long periods of time with virtually no muscular effort.*

# Injury to the Suspensory Ligament

**T**endons and ligaments are composed of fiber-like connective tissue elements that are carefully aligned in longitudinal bundles that run in the direction of force or pull on the entire structure. These bundles of fibers are grouped together, beginning in small units, then combined with others to form larger and larger parallel fiber bundle groups—much like the structure of a cable on a bridge.

The alignment of fibers in the long axis of this “biological cable” is integral to the tendon or ligament’s ability to stretch under load while maintaining its strength and integrity. The parallel alignment of the fibers allows for maximum strength and longitudinal elasticity with minimal total cross-sectional area (size).

The tendon or ligament becomes injured when the load placed on it exceeds the combined strength of the entire fiber bundle groups (i.e., cable strength). The injury is similar to stretching a piece of elastic too far so that it does not return to its original size and cannot sustain the load it could before being overstretched.

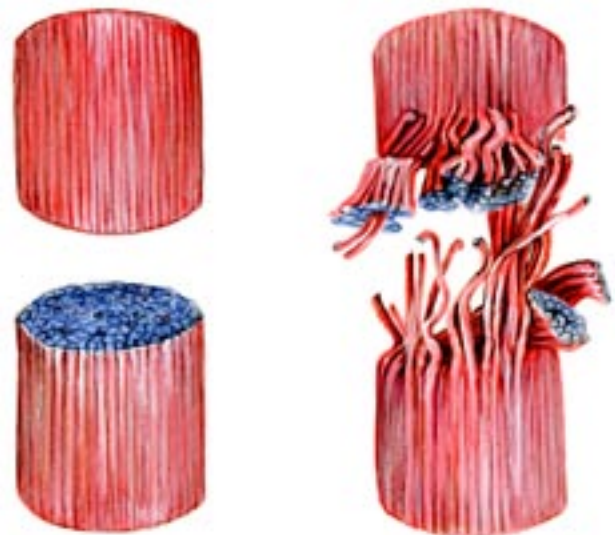
For the equine suspensory ligament, this most often occurs through overextension of the fetlock during the maximal weight-bearing that occurs at the middle of the stance phase of the stride.

Damage often involves tearing or rupturing individual fibers or fiber bundle groups. The fibers fray, tear, and lose their integrity perpendicular to the long axis (the direction of pulling force) of the tendon or ligament. The illustration on the right shows these fiber bundles and how the individual fibers fray upon injury. The degree of damage depends on the number of fibers torn.

## Signs of Injury

The clinical signs of a tendon or ligament injury can be quite varied. Acute (recent) injuries are often characterized by heat, swelling and pain on palpation of the affected area.

Lameness can range from mild to severe and may be somewhat transient, sometimes lasting only a few days. Chronic injuries often result in persistent thickening of the tendon or ligament and an intermittent or persistent lameness.

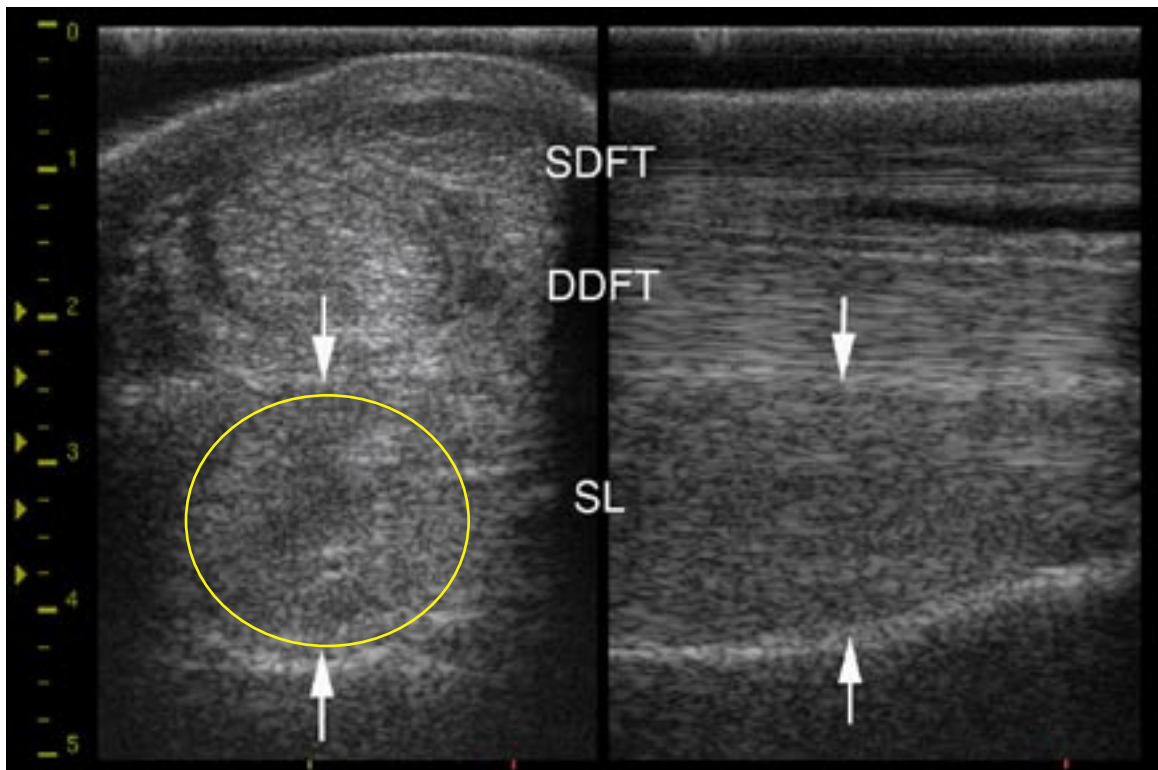


*A cut across normal, intact parallel fiber bundles (left) contrasts with injured fiber bundles (right), which fray and pull apart, making reconstruction of the normal architecture difficult.*

# Diagnosis of Tendon or Ligament Injuries

The gold standard for diagnosis of injury to the tendons and ligaments in horses is by ultrasound examination. Normal tendons and ligaments show a homogeneously echogenic (evenly white) appearance on ultrasound when viewed on cross-section. Normal tendons and ligaments demonstrate a long linear fiber pattern. Injuries show up as increased cross-sectional areas (size) with decreased echogenicity (black or gray appearance) and a disrupted fiber pattern.

The ultrasound images below show a severe chronic injury to the top of the suspensory ligament. The left-hand image (transverse view) shows severe enlargement (arrows) with a mottled, heterogeneous appearance (in the circle). The right-hand image (longitudinal view) shows enlargement (arrows), absence of normal fiber pattern, and short, croppy fibers. This can be seen by comparing the patterns of fibers of the superficial digital flexor tendon (SDFT) and deep digital flexor tendon (DDFT) above the suspensory ligament (SL).



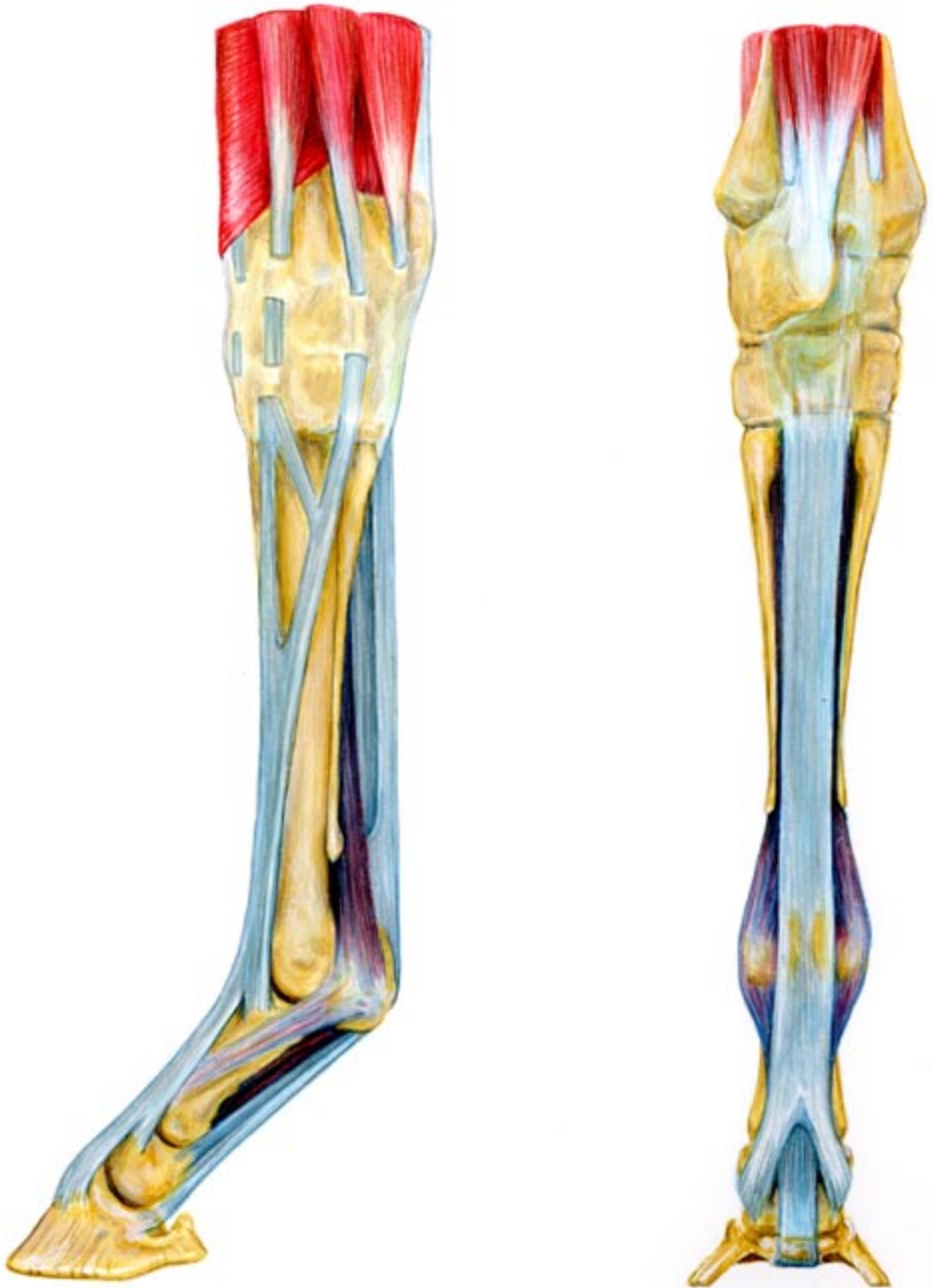




View 1 – Skin, surface topography



View 2 – Muscles are shown in red, tendons and ligaments are blue, fascia is shown in lighter blue, and bone is in tan. Artery, vein and nerve (dark blue, red and white) run together as a group in the lower leg.



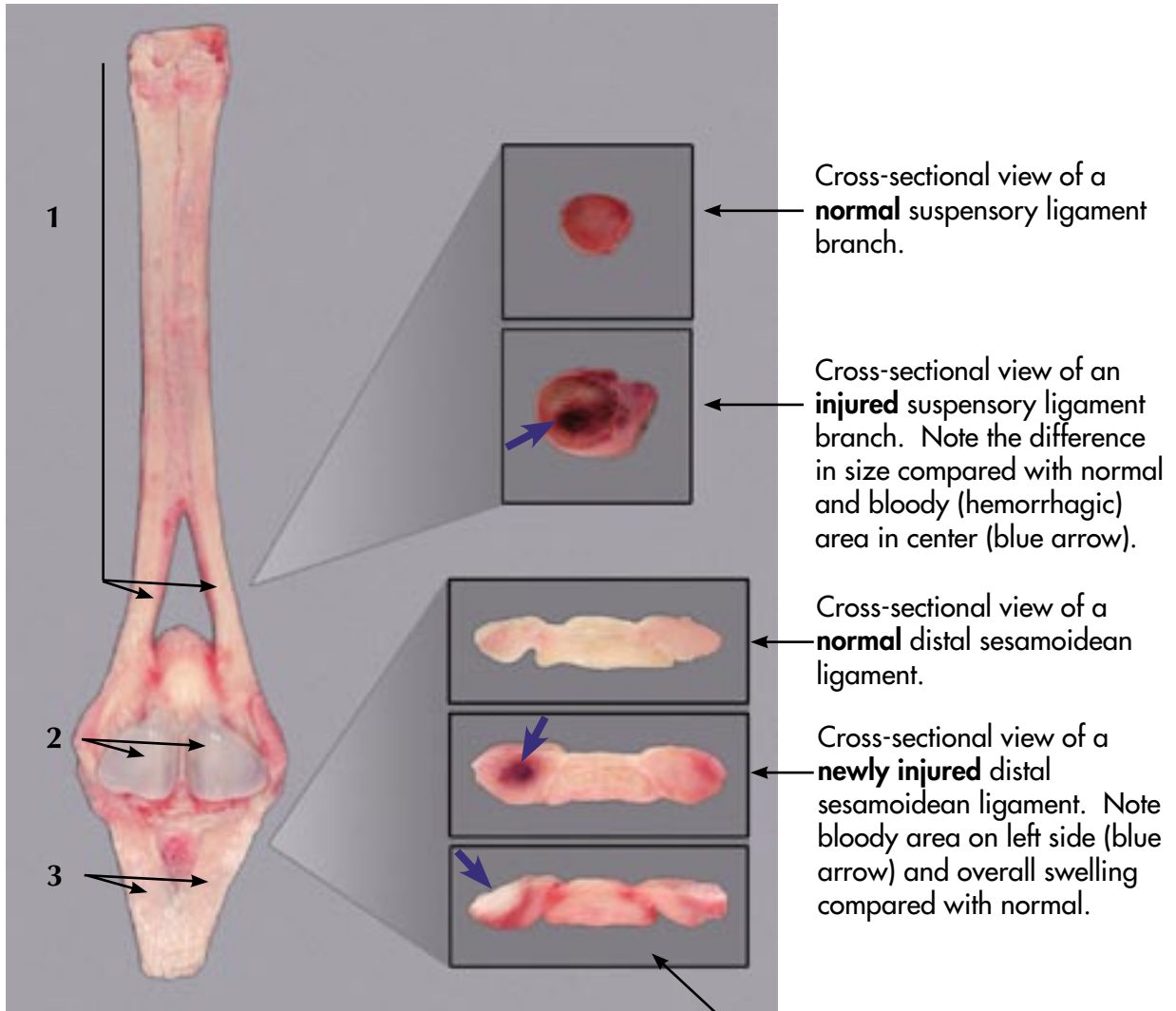
View 3 – Tendons are blue, same as in previous view. Suspensory ligament is dark blue/red. Anterior branches of the suspensory ligament are pink/light blue. Distal sesamoidean ligaments are black/red.



View 4 – Bone is tan, the suspensory ligament body and branches are blue, and distal ligaments are in red and yellow.

## THE NORMAL SUSPENSORY APPARATUS CONSISTS OF:

- (1) the suspensory ligament (body and two branches)
- (2) the paired sesamoid bones
- (3) the distal sesamoidean ligaments



Cross-sectional view of a **scarred** distal sesamoidean ligament. Scarring is visible in white region on left end (blue arrow). While this scar tissue may give the appearance of re-establishing the look and feel of the normal ligament, the repaired structure will rarely be as strong as before because the structural integrity cannot be duplicated.

# Primary Locations of Suspensory Injury

Any inflammation or damage to the suspensory ligament or its branches is referred to as **suspensory desmitis**. As stated earlier, suspensory ligament injuries are caused by excessive strain on the ligament during strenuous exercise. Extreme loading forces on the fetlock during intense exercise, along with fatigue of the flexor muscles, cause the fetlock to overextend. This overloads the supporting structures, including the suspensory ligament.

Overstretching of the suspensory ligament can cause fiber damage at the origin, or in the body or branches. The branches are more vulnerable to damage than the body because they have a smaller cross-sectional area.

## Proximal Suspensory Desmitis

As the name implies, these injuries occur near the origin (proximal part) of the suspensory ligament at the back of the top of the cannon bone, between the splint bones.

Initially, these injuries can be difficult to detect because this region of the suspensory ligament is under the deep and the superficial digital flexor tendons and is not easily palpable. The injury may manifest in just slight or intermittent lameness. Likewise, heat or swelling may also

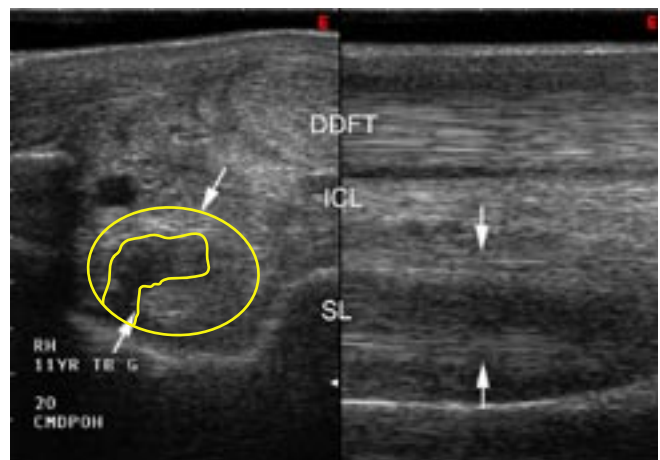
be difficult to detect because this region of the suspensory ligament is deep within the tissues and not easily palpable.

Proximal suspensory desmitis is usually diagnosed using a combination of diagnostic nerve blocks, ultrasound and/or nuclear scintigraphy. If the injury is severe or repeated, healing time may be lengthy.

Proximal fractures of the cannon bone at the suspensory ligament's origin occasionally occur at the same time the ligament sustains damage, as part of the ligament tearing process. These fractures are generally small "chip type" pieces of bone that are not loose but are attached to and surrounded by the suspensory ligament that has pulled away from its cannon bone attachment. The fractures tend to heal over time and are not the limiting factor for return to the previous level of activity. As always, a return to normal activity is dictated by the ligament repair processes.



Location of **proximal suspensory ligament**. Left image is side view of leg; right image is back view.



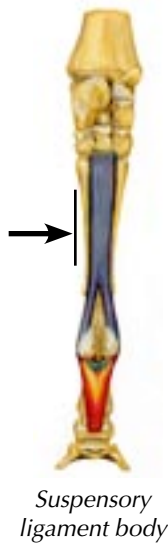
Images of an acute proximal suspensory injury in the hindlimb. Note the large anechoic (black) area within the suspensory ligament body (left, transverse view). Fiber tearing is visible on the longitudinal view (right).

## Suspensory Body Desmitis

The suspensory ligament body is located between the proximal quarter of the ligament and the point at which it separates into the two (medial and lateral) branches.

Injuries to the suspensory body are more common in the foreleg and are generally manifested in heat, swelling and pain on palpation during examination. Lameness is not always evident initially, but further damage to the ligament and a progression of clinical signs will occur with continued use.

Suspensory body desmitis is probably the most common type of injury to the suspensory ligament. Unfortunately, it often becomes chronic in nature because of the horse's ability to function in spite of the injury in its early stages. Chronic suspensory desmitis leads to a progressive thickening of the ligament, which can become so pronounced that it pushes on the splint bones and can result in splint bone fractures. Once prolonged swelling and structural damage occur, complete recovery is difficult. Affected horses tend to have chronic and progressive lameness throughout their athletic careers.



Suspensory ligament body

Therefore, **early diagnosis** during the period where damage is confined to heat and inflammation **carries a better likelihood for long-term recovery** and athletic performance.

## Suspensory Ligament Branch Injuries

Injury to one or both of the suspensory ligament branches is common in all types of athletic horses. It is easily recognized because swelling can be seen readily and the area of injury is often sore on palpation.

The onset of branch injuries often occurs suddenly. Branch injury can also be accompanied by injury or fracture of the proximal sesamoid bones at their attachments of the suspensory branches.

Poor foot balance is often implicated as a predisposing cause of these injuries. As with all suspensory ligament injuries, **early diagnosis is essential for optimal recovery**. Severe damage to the suspensory branches can be very debilitating and can lead to complete rupture, especially in Thoroughbred racehorses.



Suspensory ligament branches

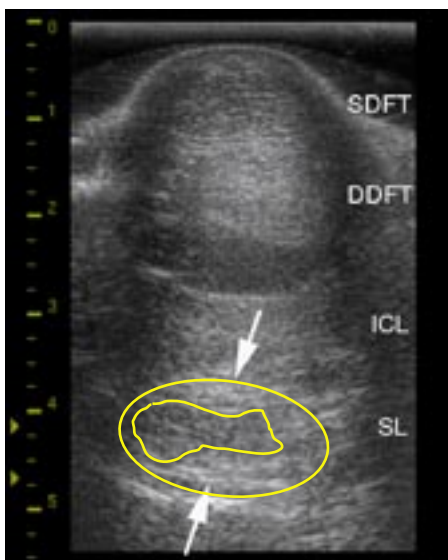


Image of midbody suspensory ligament damage. Large hypoechoic (dark gray) area within the center is depicted between the arrows (transverse view).

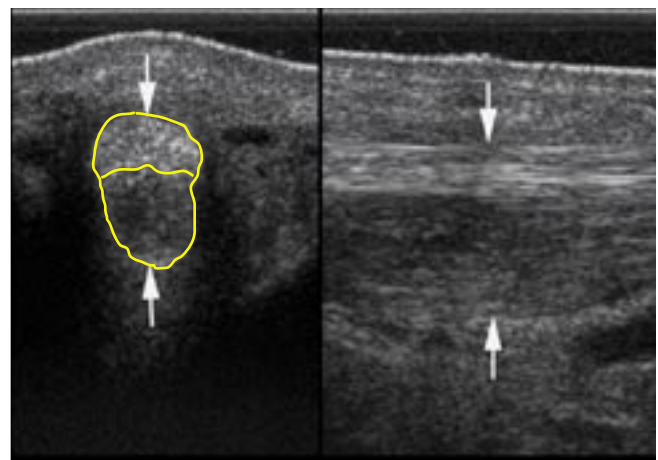
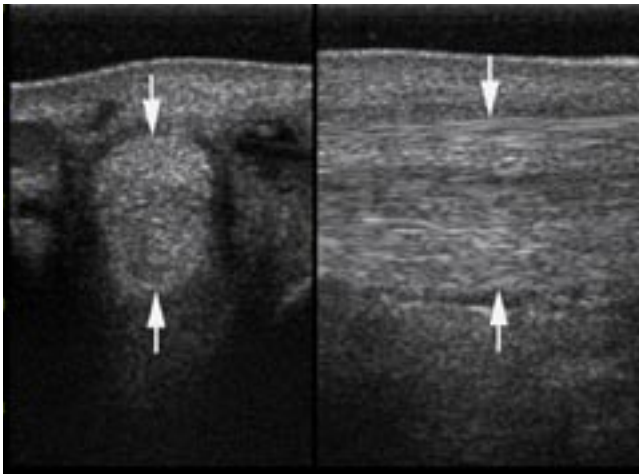


Image of an injury to the lateral branch of the suspensory ligament. Area between arrows in left view shows hypoechoic (dark) area in the mid-branch region. Right view shows a disruption in fiber pattern. See image top of next page for recheck after 4 months of healing.



Ultrasound images from a 4-month recheck. The hypoechoic (dark) area seen on the original image has improved significantly as has the fiber pattern. This injury showed significant healing because it was diagnosed early and the horse was treated appropriately with a controlled exercise program.

## Distal Sesamoidean Ligament Injuries

These injuries pose the greatest danger to the athletic health and welfare of the horse because of their importance to the structural integrity of the suspensory apparatus and the insidious nature by which they develop.

Early injury frequently goes unnoticed by horse owners and trainers, and diagnosis can also be challenging for veterinarians. The location of the distal sesamoidean ligaments deep within the tissues precludes easy visualization of inflammation or swelling and palpation for pain. Once damaged, these ligaments tend to progress in their severity and can become chronically affected.



Injuries can be accompanied by avulsion fractures off of the base of the sesamoid bones due to the pull at the origin attachment of these ligaments. In racehorses, these ligaments can rupture during competition, leading to proximal displacement of the sesamoid bones and complete loss of fetlock support.

**Early diagnosis is essential to maintain an athletic career.** Local nerve blocks are used during lameness evaluation with confirmation by ultrasound.

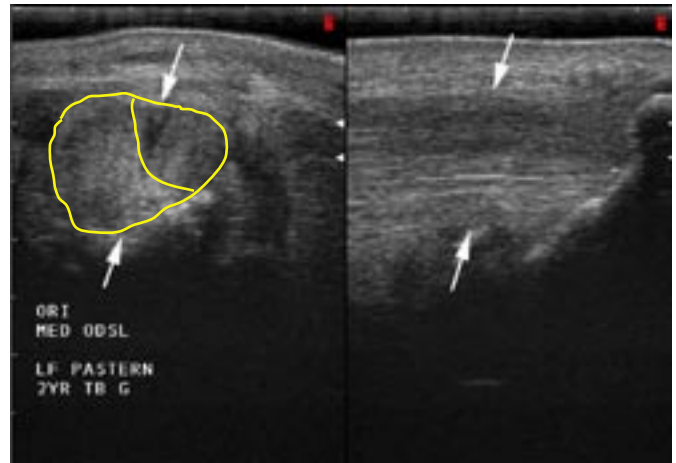


Image of distal sesamoid ligament damage. Left image (transverse view) shows a large hypoechoic (dark) area at the origin of the medial oblique distal sesamoidean ligament at the base of the medial sesamoid bone. Fiber tearing is easily visible in the right image (longitudinal view).





# Healing of the Suspensory Ligament

**K**ey to the success of returning your horse to work regardless of the medical therapy employed is regular ultrasound evaluations to check the progress of healing throughout the rehabilitation. Injured tendons and ligaments should show a progression toward a more normal appearance in size, echogenicity and fiber pattern at each recheck exam.

Some injuries are slower to demonstrate evidence of healing on ultrasound. This is often the case with suspensory ligament injuries.

Healing of tendons and ligaments is more difficult than healing of tissue in other parts of the body. While the body has the ability to produce new connective tissue for repair, with tendons and ligaments it does not organize the tissue into the original structure of longitudinal bundles of fiber. Therefore, the repair rarely recreates a structure that can match its original strength or function.

To use the bridge-cable analogy once again, while the wires of the cable are reproduced, they are not interwoven into the loose ends of the cable and thus do not usually form the integrated bundles found in healthy tendon or ligament. Rather, the body forms an abundance of connective tissue but merely wraps it haphazardly around the area of damage to form a dense scar in an attempt to glue or weld the damaged ends of the biological cable back together.

While this scar tissue response may give the appearance of re-establishing the look and feel of the normal ligament, the repaired structure will rarely be as strong as before because the structural integrity cannot be duplicated.

Consequently, the single most important factor to the recovery of athletic performance following tendon or ligament injury is to minimize the amount of damage to the structure to ensure that the fewest number of fibers within the ligament are torn. To do this, an early diagnosis of the damage is essential.

The second most important factor to recovery is to start effective anti-inflammatory therapy immediately. Injury to a horse's suspensory ligament is quickly followed by a pronounced inflammatory response characterized by increased blood flow and swelling within the ligament. While this initial response is designed to set the stage for eventual healing, if unchecked it can result in further damage to fiber bundle units adjacent to the damaged area and create an even larger loss of structural integrity.

Finally, the healing of tendons and ligaments occurs very slowly, over a long period of time. These structures have minimal numbers of blood vessels within them by nature of their tight configuration of fiber bundles. Without a large blood flow, the tissues are not able to clean away the debris of damage and institute repair processes rapidly. As such, convalescent periods for horses with substantial suspensory ligament injury are generally measured in months rather than days or weeks.

## Current Therapeutics

There are currently multiple products and techniques available to veterinarians that are purported to improve or speed healing of tendon or ligament injuries. While some of these may

eventually show promise, to date no long-term studies are available to document their effectiveness.

This lack of treatment modalities of proven viability point out the need for further research in this area. While human and veterinary medical scientists are hard at work on this problem, continued investment in support of this research will be required if a truly curative treatment for ligament injury is to be developed.

## Rehabilitation

Initially, stall rest with handwalking is required. Your horse should not have access to unrestricted exercise such as pasture or arena turnout during the first several months. The injured tendon or ligament cannot withstand sudden heavy loading during this time and is highly susceptible to injury. Your veterinarian can recommend a controlled

exercise program—complementary to the horse’s medical treatment—that allows gradual loading of the tendon/ligament in increasing amounts so that it can heal to the best of its ability.

Recheck ultrasound exams are generally performed every 60 days to assess healing and to prevent injury. Ultrasound can detect evidence of tendon or ligament damage before a new injury occurs.

Perhaps the most important factor in a horse’s full recovery from a tendon or ligament injury is patient and owner compliance. Some horses and owners tolerate confinement better than others. A rehabilitation program requires patience and commitment. Because it can be difficult to work with a fit horse that is suddenly not able to exercise, consult your veterinarian to develop a recovery plan that works for you and your situation. In the end, this plan will give you the best chance to have your horse return to his pre-injury level of function.

Continuing research is critical to advance understanding of the biology of tendon and ligament cells, including collagen, and of factors that promote healing. If you would like to support research in this area, please consider a gift to the Center for Equine Health. Such gifts provide our veterinary scientists with the assets needed to continue their work and allow the Center to continue publishing educational periodicals like this one.

Gifts as well as comments regarding this publication should be addressed to the CEH Director:

**Dr. Gregory L. Ferraro, DVM  
Center for Equine Health  
School of Veterinary Medicine  
University of California  
One Shields Avenue  
Davis, CA 95616**

## Summary Opinion

**T**he suspensory ligament is absolutely vital to the support of the horse's entire lower limb and essential for locomotion and athletic activity. Consequently, its health and integrity need to be protected from damage.

Currently, many different methods are employed to treat injured suspensory ligaments, but every one of them is palliative, not curative in nature. To date, there is no treatment or therapy that can reliably re-establish the structural integrity of tendons or ligaments.

Until medical advancements are made such that reparative fibrous tissue can be created that is effectively aligned and incorporated into the fiber bundle configuration of normal tendon tissue, a horse with an injured suspensory will have a problem for life. Therefore, the best approach for horse owners is to be pre-emptive at the first signs of inflammation to avoid these injuries.

***As soon as an abnormality is noticed*** – a little swelling, some heat, maybe a slight lameness – stop, look and evaluate. If your horse is not traveling or performing well on a given day, don't just keep going, hoping things will get better. That's like turning up the radio when your car starts to make a funny sound.

Take the time to check things out. As a matter of course you should examine your horse's legs every day before and after exercise. Ask your veterinarian to teach you how to properly examine and palpate a horse's tendons and suspensory apparatus for abnormalities. Make sure your horse is fit for the activity you are about to undertake

because fatigue is often a contributing factor to suspensory and tendon injury. Horses also need to be warmed up before exercise and properly cooled down following exercise to minimize all types of athletic injury.

Gregory L. Ferraro, DVM

*A horse can lend its rider the speed and strength he or she lacks-but the rider who is wise remembers it is no more than a loan. (Pam Brown, b. 1928)*

