COMPLEX SUSPENSOARY INJURY
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Key Points:
- Complex suspensory injury includes a plethora of ligamentous and associated bony abnormalities.
- Accurate diagnosis is confirmed with selective “sub-carpal” and “sub-tarsal” regional perineural analgesic techniques and elimination of distally located limb injuries.
- Surgical management includes one or combination of fasciotomy, neurectomy, and bone marrow (stem cell) or other novel injections.
- Long term prognosis is dependent on location, duration, and extent of the injury.

Suspensory desmitis should be classified according to the affected limb (forelimb, hindlimb), duration of injury (acute, chronic-recurrent), level of injury (origin, body, branch or branches, insertion), coexistent (concurrent) injury to the distal sesamoidean ligaments, and if there is complex injury, suspensory desmitis and involvement of adjacent bony structures. In order to understand and compare various methods to manage simple suspensory desmitis you are compelled to consider these important classification criteria. For instance, horses with hindlimb proximal suspensory prognosis have a much worse prognosis than those with a similar degree of injury in the forelimb. Horses with recurrent suspensory desmitis cannot be expected to respond as those with acute injury. Horses in which the body of the suspensory ligament (SL) is injured as a result of extension either from initial injury at the origin, or by incremental injury originally involving only a branch but subsequently the body of the SL, have a guarded to poor prognosis.

Complex suspensory injury occurs at the origin (avulsion fracture of the palmar cortex of the third metacarpal [McIII] or third metatarsal bone [MtIII], longitudinal fracture of the proximal palmar/plantar cortex of the McIII/MtIII, chronic insertional osteitis [increased radiopacity indicating chronic bony change]), at the body (adhesions between the second and fourth metacarpal [McII/MtIV] and metatarsal [MtII/MtIV] bones), at the level of the branches (chronic recurrent branch desmitis with or without involvement of the distal aspects of the Mc/Mt II/IV bones), and at the insertion of the branches to the proximal sesamoid bones (PSBs) (chronic sesamoiditis, abaxial avulsion fragments, apical fractures of the PSBs). Clinical characteristics and management of complex suspensory injury are detailed below. Many other important factors such as the horse’s use and level of competition, conformation, and breed play important roles in determining prognosis.

Accurate diagnosis

An in-depth discussion of diagnosis of complex suspensory injury is beyond the scope of these notes but to determine the authentic source of pain causing lameness is paramount. A few comments regarding diagnostic analgesia of this important area are in order. The high plantar/palmar perineural block should be used to localize pain to the metatarsal/metacarpal region. For the metatarsal region the medial and lateral plantar nerves and medial and lateral
plantar metatarsal nerves are blocked just distal (approximately 1.5 cm) to the tarsometatarsal joint (TMTJ). Variations of this block are often used but it is important to recognize that sub-tarsal analgesic techniques targeting the lateral plantar nerve, or its deep branch, will not block the medial plantar nerve and false negative results could be obtained. More importantly, false positive results incriminating the proximal aspect of the SL as a source of pain can occur. Sub-tarsal analgesia should be performed only after result of low plantar analgesia are observed, since most injection techniques in the sub-tarsal region are likely to desensitize the plantar metatarsal nerves, important contributors to innervation to the metatarsophalangeal joint. A recent injection technique was described and has become popular in the diagnosis of proximal suspensory desmitis; the deep branch of the lateral plantar nerve (DBLPN) is blocked approximately 15 mm distal to the head of MtIV, just axial to MtIV, at a depth of 25 mm. While in theory this block is done in close proximity to the DBLPN, it is within the same fascial compartment as the parent branch, leading to the possibility of blocking this important contributor to distal limb innervation. However, from the DBLPN arise the important medial and lateral plantar metatarsal nerves, which descend to innervate the fetlock joint (see below). If completed as a stand-alone technique without first performing low plantar analgesia sub-tarsal analgesia may lead the clinician to the erroneous impression pain is emanating from the proximal SL. In a recent study horses were managed for desmitis of the origin of the SL with desmoplasty and fasciotomy but criteria for inclusion of cases suggested that pain was localized to the proximal metacarpal/metatarsal regions by use of only sub-carpal or sub-tarsal analgesia without first blocking the distal limb.

In the forelimb distal palmar outpouchings of the carpometacarpal joint complicate interpretation of diagnostic analgesic techniques. In the hindlimb distal plantar outpouchings of the TMTJ can potentially be penetrated when high plantar analgesic techniques are performed, but outpouchings of the joint were not seen in magnetic resonance images in a recent study comparing imaging modalities in the plantar metatarsus. In only 5% of limbs was the TMTJ inadvertently penetrated when high plantar analgesia was performed at a level of 1.5 cm distal to the TMTJ, although in the same study inadvertent penetration of the tarsal sheath occurred in 40% of limbs. Care must be taken when interpreting diagnostic analgesia. The lateral plantar nerve, which courses plantar to the origin of the SL, gives off a deep branch that innervates the proximal aspect of the SL and gives off branches, which continue distally as the lateral and medial plantar metatarsal nerves that course on the axial aspects of each respective splint bone. Blocking the DBLPN provides analgesia of the origin of the SL, the plantar cortex of the MtIII and partial analgesia of sites more distal to the level of and including the metatarsophalangeal joint. Accurate interpretation of diagnostic analgesia is critical when planning the surgical procedure, neurectomy of the DBLPN (NDBLPN), which has received considerable attention recently as a surgical approach to management of proximal suspensory desmitis. Histological changes consistent with nerve compression were identified in horses undergoing NDBLPN and nerve compression was proposed as a possible cause of for residual pain in horses even after desmitis resolved. In that study, 62% of horses returned to soundness after neurectomy, whereas 19 of 20 horses with neurectomy and laminar fasciotomy were reported to have returned to the previous level of performance. The DBLPN that is resected and was studied lies within the dense metatarsal but outside the laminar fascial planes. Recognition of neuritis in this
segment indicates compression of the deep branch may be occurring within this fascial compartment.

*Longitudinal fracture of the palmar cortex of the McIII*¹⁰ *and the MtIII*

This fracture involves most commonly the palmar cortex of the McIII but occasionally occurs in the hindlimb affecting the MtIII. This fracture occurs most commonly in young horses, 2 and 3-year-olds in race training, but can occur in non-racehorses and in older horses. Horses often have mild undiagnosed forelimb lameness that becomes acute and pronounced, are painful to palpation along the proximal, palmar metacarpal region, and lameness is abolished or substantially improved with both sub-carpal and middle carpal diagnostic analgesic techniques. Occasionally, mild improvement is seen using low palmar analgesia. In general affected horses have a simple fracture near the origin of the SL on the McIII without concurrent suspensory desmitis. This fracture can only be seen reliably in a dorsopalmar (DP) radiographic image and courses roughly in a longitudinal direction, medial to the axis of the McIII. Fractures can easily be misconstrued as course trabeculae because of surrounding increased radiopacity and lack of a crisp fracture line. In a lateromedial or flexed lateromedial radiographic image increased radiopacity of the endosteal surface and medullary cavity of the McIII is often seen. Scintigraphic examination is quite useful and most often reveals focal mild-to-intense increased radiopharmaceutical uptake (IRU), roughly in a triangular pattern in lateral scintigraphic images and often in a linear pattern in dorsal images. Incongruity of the palmar cortex of the McIII can be seen ultrasonographically, and if associated suspensory desmitis is present the situation becomes complex suspensory injury. Fractures occur distal to the origin of the SL but it is compelling to assume the presence of this important structure concentrates forces in this general area predisposing to fracture. The presence of proximal suspensory desmitis worsens prognosis considerably; palpation to determine the presence of swelling associated with the proximal aspect of the SL and ultrasonographic examination to confirm the diagnosis are important. Magnetic resonance imaging (MRI) can be useful if horses have stress reaction or stress fracture of the McIII or the MtIII without obvious radiological evidence of fracture. Fractures heal with 4-6 months rest and it does not appear necessary to combine surgical management such as forage or internal fixation with proper rest. What is proper rest? A minimum of 4 months of rehabilitation without early race training and without turn out exercise is recommended (4 weeks stall rest, 4 weeks stall rest with hand walking, 4 weeks walking in a mechanical walker or with a rider up, and 4 weeks walking and light trotting in a mechanical walker, with a rider up, in a jog cart or some other suitable step up in exercise program without rigorous training). Turn out exercise is avoided in particular in horses with surrounding suspensory desmitis and to limit the possibility of recurrence or aggravation of suspensory injury.

*Avulsion fracture of the palmar cortex of the McIII/MtIII*

The clinical characteristics, diagnosis and management of horses with this injury are quite similar to that described for longitudinal fracture. This injury occurs more frequently in the forelimbs and while occurring in the hindlimbs radiological identification of an actual fragment is more difficult in the hindlimbs. Fragmentation occurs at the distal aspect of the origin of the SL and horses with this injury more often have concurrent suspensory desmitis. Horses with chronic suspensory desmitis can become suddenly, acutely lame and radiographic images reveal
obvious increased radiopacity reflective of chronic injury. Small avulsion fractures occur in already weakened bone. The separation between horses with chronic recurrent suspensory desmitis and associated osteitis of the palmar/plantar cortex of the MIII/MtIII without fracture and those with a radiological identifiable fracture fragment is likely arbitrary. Prognosis is good in horses with fracture without surrounding suspensory desmitis and guarded to poor in those with complex suspensory injury. Some consideration should be given to aggressive management such as fasciotomy, bone marrow injection, NDBLPN, or a combination of various surgical and conservative approaches in horses with chronic, recurrent hindlimb suspensory desmitis and avulsion injury of the MtIII.

**Adhesions of the SL to the McII/MtII and McIV/MtIV and associated suspensory desmitis**

Without using MRI the diagnosis of a “blind splint” can remain a mystery and even using this modality there are sources of pain that remain undiscovered. However, MRI is useful in the diagnosis of adhesions between the SL and the associated small metacarpal bones. Horses most often have chronic, recurrent lameness and have been managed using local injections, rest, anti-inflammatory agents, extracorporeal shock wave therapy, and therapeutic ultrasound among other modalities. Pain causing lameness is localized to the metacarpal region using sub-carpal analgesia. A unilateral 2-point block, blocking the palmar metacarpal and palmar nerve on the affected side of the limb above the painful region of the suspected adhesion, provides more comprehensive analgesia than does simply locally infiltrating the suspected region. Infiltration of local anesthetic solution along the abaxial surface of a splint exostosis will not resolve pain resulting from adhesions on the axial surface of the splint bone. Radiographs usually reveal an abaxially located exostosis that may be smooth or mildly proliferative; but there is often subtle evidence of extension, axially. Axial extension of a splint exostosis could encroach on the nearby SL and cause pain or localized suspensory desmitis without adhesions. Ultrasonographic examination can reveal suspensory body desmitis and dynamic imaging with the limb elevated from the ground will often show the ligament is adhered to the axial aspect of the affected small metacarpal bone. Exostoses can be seen in longitudinal images and focal suspensory desmitis is confirmed. MRI can be quite useful in defining the lesion; however, given lack of clinical response, chronic pain refractory to therapy and pain causing lameness localized to the site, surgery can be recommended without the use of MRI. Surgical exploration of painful splints suspected of causing complex suspensory injury should be reserved for horses with chronic, refractory pain, in which conventional methods have failed.

The horse is placed with the affected side of the affected limb uppermost and a dorsal-based curvilinear incision is used to approach the affected region. Most often extensive adhesions between all tissue planes are encountered, and may involve other nearby soft tissue structures such as the accessory ligament of the deep digital flexor tendon, or peritendonous tissue over the digital flexor tendons themselves. It can be difficult to determine what is adhered to what, but in most horses the actual fibers of the SL are not adhered, but it is the superficial and laminar fascia surrounding the SL, which is adhered. Perhaps it makes little difference since it appears there is constriction of the SL and restriction of movement. Adhesions often involve the axial aspect of the involved splint bone at the actual exostosis, which is removed using an osteotome, and smoothed using a bone rasp. A liberal amount of the adhered superficial and deep fascia is removed (fasciotomy) and adhesions are sharply incised (adhesiolysis).
portion of splint bone is left intact (neither is the distal aspect removed nor is segmental ostectomy performed). Some consideration could be given to segmental ostectomy, but removing the splint bone from the site, distally, potentially causes additional adhesions and pain after surgery. Local injections into the SL if desmitis exists (bone marrow, bone marrow concentrate, and platelet-rich plasma) can be performed; if bone marrow derived mesenchymal stem cells were cultured, the cells can be injected at the time of surgery, or injected under ultrasonographic guidance after surgery. Hyaluronan is injected between the SL and smoothed axial aspect of the involved splint bone. Only the subcutaneous tissues and skin are closed; no attempt is made to suture the metacarpal/metatarsal fascia, since this tissue was removed (fasciotomy) and is the very tissue causing compartment syndrome and contributing to adhesions. The horse is given 2 weeks of stall rest and then 4 weeks of stall rest with deliberate hand walking program, followed by 4-6 weeks of walking with a rider up. Length of rest is determined by the degree of suspensory desmitis and preoperative lameness grade. Therapeutic ultrasound may help during rehabilitation. Shock wave therapy is delayed for a minimum of 45 days after surgery. The surgery site is always thickened and undoubtedly fibrous tissue forms in the deep portion of the incision; whether or not adhesions form is questionable, but they are likely. While the cosmetic appearance at the site is often questionable (firm fibrous swelling, smooth proliferative changes along the abaxial aspect of the involved splint bone form), outcome has been favorable in a limited number of horses (all of 4 horses became sound and went back into full work, but in one horse a similar condition developed in the contralateral limb 1 year after surgery, requiring surgery; and, in an elite event horse, recurrent lameness prompted re-operation in the original surgery site 14 months later. This horse returned to eventing after both surgical procedures). Inflammation and lameness do not resolve quickly but prognosis is likely 75%.

**Suspensory branch desmitis**

Chronic, recurrent branch desmitis can be a frustrating clinical problem. Be aware that pain associated with a branch desmitis can be abolished with intra-articular analgesia of the nearby metacarpo/metatarsophalangeal (fetlock) joint and commonly there is concurrent osteoarthritis of the fetlock joint. It is important to evaluate the distal aspects of the splint bones and the PSBs for the presence of fractures or small fragmentation. Ligament splitting (modified Asheim procedure), a time-honored technique, has value in horses with branch desmitis and avulsion injury at the distal attachment to the PSBs and can be combined with ostectomy of the small metacarpal/metatarsal bones and of apical and abaxial fractures of the PSBs. Branch desmitis can be chronic or recurrent and in some horses non-healing core lesions are found. These horses are prime candidates for ligament splitting, bone marrow injection or potentially debridement using palmar/plantar fetlock arthroscopic approaches. Pain can originate from the suspensory branch without the presence of an actual core lesion; enlarged painful branches may not appear to be active, ultrasonographically, but are painful to palpation and pain causing lameness can be localized using diagnostic analgesia. In a limited number of STB racehorses with chronic recurrent branch desmitis I have combined ligament splitting with bone marrow injection with fair success. In sports horses splint bone fractures are unusual but these horses are prone to the development of chronic, recurrent branch desmitis. To split the SL I prefer to use numerous linear incisions made in fan-like fashion with a double edged tenotome. Needle
decompression of core lesions in the SL lacks merit in my experience since many horses with suspensory desmitis lack distinct core lesions; the ultrasonographic and healing characteristics of horses with suspensory desmitis differs from those with superficial digital flexor tendonitis.

**Surgical management of suspensory desmitis**

I have used the combination of fasciotomy and bone marrow injection (fresh liquid bone marrow or bone marrow concentrate) in jumpers, dressage horses and STB racehorses with chronic, recurrent hindlimb lameness with large cross-sectional area measurements, involvement of the origin and body of the ligament, have fetlock drop, straight hock conformation and are upper-level horses. Fasciotomy is done to reduce the potential for compartment syndrome in the proximal metatarsal (metacarpal) region, to reduce compression on nearby nerves and to improve gliding function of the enlarged SL. Bone marrow injection is done to augment reparative healing in combination with fasciotomy. Return to previous level of competition is strict criteria for success given the pre-injury level of these horses but is estimated at 40-50%. Recurrence of desmitis is common, however.

Fasciotomy is performed most commonly using a medial approach. In the proximal metatarsal (metacarpal) region there is a dense fascia that is confluent with the tarsal and carpal retinaculum. There a loose, thin “lamellar” fascia overlying the SL deep to the deep digital flexor tendon. The dense and lamellar fasciae attach to the plantar/palmar aspect of Mt(Mc)IV. A 6-8 cm incision is made in the proximal medial metatarsal (metacarpal) region beginning approximately 3 cm distal to the TMTJ. The dense metatarsal fascia is incised first using a #11 scalpel blade on the plantar aspect of MtIV; the incision is extended both proximally and distally using a straight Mayo scissors from the level of the TMTJ to the distal extent of the lesion (usually mid-body). Since both dense and lamellar fascia attach to MtIV it appears fasciotomy cuts both layers. The origin of the SL can be palpated or seen by retracting the deep digital flexor tendon in a plantar direction. Liquid bone marrow (60-80 ml) is harvested from the sternum using a #11 Jamshidi needle and 60 ml syringe and injected directly into the SL (origin – through the incision) or through pre-placed needles (when there is concomitant branch desmitis). Bone marrow concentrate can be used but volume is usually between 10-12 ml if 60 ml of fresh bone marrow is harvested. Subcutaneous tissues and skin are closed routinely. Horses are given a minimum of 4 months of controlled exercise WITHOUT TURN OUT EXERCISE that includes 4 weeks of stall rest, followed by 4 weeks of stall rest with hand walking, followed by 4 weeks of walking with a rider-up (or in a jog cart) and followed by 4 weeks of walking a light trotting before beginning into an early training program.

Fasciotomy can be performed using a lateral approach and with this approach NDBLPN can be performed (while using plantar retraction of the deep digital flexor tendon, the DBLPN can occasionally be seen from a medial approach, the lateral approach is best if neurectomy is being considered). Lateral plantar neurectomy is performed using a 6-8 cm incision along the dorsolateral edge of the superficial digital flexor tendon (SDFT), centered at the level of the TMTJ. The DBLPN can be found between the SDFT and long plantar ligament, coursing parallel to the parent lateral plantar nerve. The DBLPN courses abruptly dorsally and enters a small depression in the proximal aspect of the SL. A 2-cm segment is removed. Occasionally the DBLPN is surprisingly hard to find. After NDBLPN horses do not immediately become
sound and it takes 2-4 months for substantial improvement, in particular in those horses managed
for chronic, recurrent suspensory desmitis in which cross sectional areas are greatly enlarged.
While catastrophic breakdown of the suspensory has not been reported experience is lacking.

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