The Equine Pastern

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Abstract: Injuries involving the pastern region are a common source of lameness in many types of performance horses. Knowledge of the common breed- and activity-associated injuries can aid veterinarians in making an accurate diagnosis because injuries of the pastern region are often breed- or use-specific. The differential diagnosis for disorders of the pastern region includes osteoarthritis, osteochondrosis, fractures, infection, and soft tissue injuries. In general, soft tissue injuries of the pastern region can be difficult to diagnose, and affected horses have a reasonable chance of returning to their intended uses; osseous injuries are typically easier to diagnose and have a good prognosis if arthrodesis is an option.

Anatomy

The proximal interphalangeal joint (PIJ; pastern joint) is a diarthrodial joint formed from the distal aspect of the proximal phalanx (P1) and the proximal aspect of the middle phalanx (P2). The pastern region is bounded dorsally by the common or long digital extensor tendon. Palmar/plantar support structures of the pastern region are formed by the distal sesamoidean ligaments (DSLs; straight, oblique, and cruciate ligaments), digital flexor tendons (superficial digital flexor tendon [SDFT] and deep digital flexor tendon [DDFT]), and proximal and distal digital annular ligaments within the digital flexor tendon sheath (DFTS). The medial and lateral collateral ligaments provide support in the sagittal plane.

Physical Examination

The physical examination begins with visual inspection of the limb and evaluation of range of motion and response to hoof testers. The pastern region should be symmetric and free of swelling or bony enlargement. Injuries involving the pastern region are rarely bilateral, but osteoarthritis (OA) may be; therefore, comparing the right and left limb or medial and lateral aspect of the same limb is helpful when identifying abnormalities. Abnormalities in the pastern region, such as swelling or bony enlargement, are usually obvious because of minimal soft tissue in the area. The severity of lameness associated with the pastern region ranges from subtle to severe, depending on the injury. Generally, injuries involving the PIJ or DFTS cause obvious lameness, whereas lameness due to early OA or strains of the sesamoidean ligaments may be mild. Pain in the pastern region is often exacerbated by distal limb flexion or lunging the horse with the affected limb on the inside of the circle. The differential diagnosis for disorders of the pastern region includes OA, osteochondrosis (OC), fractures, infection, and soft tissue injuries; however, the types of injuries are often breed- or use-specific.

Diagnostic Procedures

Regional nerve blocks are an important technique for isolating lameness in any horse. The PIJ is not always completely anesthetized by perineural anesthesia at the level of either the basisesamoid or the abaxial nerve block; thus, a low, four-point nerve block may be necessary. However, a palmar/plantar digital nerve block can desensitize the pastern region, depending on the location of the block and the amount of anesthetic used. Schumacher et al reported that the PIJ is unlikely to be anesthetized when the palmar digital nerves are anesthetized at the proximal margin of the collateral cartilages of the foot. Therefore, in a horse with a suspected stress fracture of P1 or P2, it is important to avoid performing a nerve block because perineural anesthesia would likely cause the horse to become more comfortable and displace the fracture. Response to intraarticular anesthesia varies depending on the injury, but improvement of lameness by 50% or more implicates the PIJ and is essential for accurate diagnosis. Several imaging modalities, such as radiography or ultrasonography, are important for initial characterization of the injury. Ultrasonographic evaluation of the pastern is an integral part of characterizing the extent of the soft tissue injury. Additionally, nuclear scintigraphy, computed tomography (CT), magnetic resonance imaging (MRI), or tenoscopy of the DFTS may help make a more accurate diagnosis and prognosis. In general, osseous and joint abnormalities are best evaluated using radiography or CT, whereas MRI offers optimal evaluation of soft tissue injuries.

Tendon and Ligament Injuries

In general, injuries to the SDFT occur most frequently in the forelimb, followed by injuries to the oblique DSL, DDFT, and straight DSL. Injuries to the DDFT in the hindlimb are usually
associated with a lower incidence of other soft tissue injuries compared with injuries to the DDFT in the forelimb.\textsuperscript{4–9} Collateral ligament injuries are more common in the forelimb but can occur in the hindlimb.\textsuperscript{9,10}

**Superficial Digital Flexor Tendon**

SDFT injuries at the level of the pastern most commonly involve the branches of the SDFT in the forelimb.\textsuperscript{4–9} Abnormal conformation such as a long pastern or an underrun heel may predispose a horse to injury of the SDFT branch. Lameness usually occurs at the onset of injury, with focal heat, swelling, and sensitivity noted on palpation. However, because these injuries are often missed, careful palpation and comparison of the medial and lateral branches are important for detecting differences in size, heat, and pain. In general, swelling develops within 3 to 4 days. Ultrasonographic examination in the absence of swelling may produce false-negative results. In general, swelling facilitates diagnosis of lesions because of a fluid–soft tissue interface. Core lesions, followed by diffuse injury to the affected branch, are the most common injuries identified by ultrasonographic examination.\textsuperscript{6,8} The medial branch of the SDFT appears to be injured more frequently than the lateral branch. Avulsion fracture of the insertion of the SDFT branch is not common.\textsuperscript{4,5} Horses with SDFT injuries in the pastern region have a poorer prognosis for return to racing and a higher recurrence of injury than horses with injuries in the metacarpal region.\textsuperscript{4,5} Conservative treatment options include a controlled rehabilitation program similar to that for any bowed tendon injury; however, 6 to 12 months of rehabilitation is typically needed. Surgical exploration of the DFTS via tenoscopy is often helpful for identifying the extent of the injury, recognizing longitudinal tears within the SDFT that are often missed with ultrasonography, and debriding the damaged tendon and possible adhesions.\textsuperscript{11,12} Additionally, annular ligament desmotomy may be performed during surgery, if appropriate. MRI may be superior to tenoscopy of the DFTS for characterizing the extent of damage to the SDFT; however, MRI does not allow debridement and treatment of the lesion. Regardless of treatment, routine ultrasonographic monitoring of tendon healing, typically at 30- to 60-day intervals, is very important for adjusting the rehabilitation process as needed. Additionally, it may be beneficial to medicate the DFTS with corticosteroids, hyaluronan, interlukin-1 receptor antagonist protein (IRAP), intralesional injection of platelet-rich plasma, or stem cell therapy.

**Deep Digital Flexor Tendon**

Deep digital flexor tendonitis affects various sport horses and typically presents as an acute-onset, persistent, unilateral, moderate to severe forelimb lameness.\textsuperscript{4,5} The lameness is often worse on a soft surface and generally improves with perineural anesthesia of the palmar/plantar nerves at the level of the proximal sesamoid bones.\textsuperscript{1,2} The DFTS is often distended in conjunction with the injury, possibly aiding the ultrasonographic evaluation. However, longitudinal tears of the DDFT cannot be definitively diagnosed using only ultrasonography, which typically reveals only nonspecific signs of chronic tenosynovitis.\textsuperscript{11,12} At the level of the pastern, the DDFT is bilobed, and the lobes are similar in size and shape. A lesion may involve one or both lobes and is typically characterized by enlargement and alteration of the tendon with or without a hypoechogenic region. DDFT injuries are occasionally seen in conjunction with DSL injuries.\textsuperscript{2} In chronic injuries, dystrophic mineralization may be seen.\textsuperscript{4} Additionally, MRI is superior to ultrasonography for characterizing the extent of the damage to the DDFT. If the DFTS is distended, intrasynovial anesthesia of the sheath is preferred for confirming the location of the lameness. However, tenoscopy of the DFTS is important for making an accurate diagnosis and administering specific treatment. Therefore, if DFTS-associated lameness is confirmed and effusion is present, we strongly recommend tenoscopy despite equivocal ultrasonographic findings. Surgical exploration of the DFTS via tenoscopy is often helpful for identifying the extent of the injury, recognizing longitudinal tears within the DDFT that are often missed with ultrasonography, and debriding the damaged tendon and possible adhesions.\textsuperscript{11,12} (FIGURE 1). Treatment options for DDFT injuries are similar to those for the SDFT; however, recurrence of DDFT injuries is common.

Rupture of the DDFT in the pastern region or within the hoof capsule is an infrequent sequela of neurectomy of the palmar digital nerves and is more commonly due to lacerations in the palmar/plantar pastern region. Preexisting lesions of the DDFT are likely to predispose horses to tendon rupture. Complete rupture causes the toe of the affected limb to flip up when it is bearing weight.\textsuperscript{1,2} Depending on the integrity of the DDFT, radiographic evidence of subluxation of the distal interphalangeal joint may be present. The prognosis for these horses returning to athletic soundness is guarded; however, if support-limb laminitis does not develop, reasonable options for these horses include making them serviceably sound for breeding or retiring them to pasture.
Corrective shoeing with an elevated heel and rolled toe can make these horses more comfortable.

**Distal Sesamoidean Ligaments**

Desmitis of the oblique, straight, and cruciate DSLs occurs in all types of performance horses, with injury to the oblique DSL being the most common.4–9 The medial branch of the oblique DSL is injured more often than the lateral branch, and injury to the medial branch is more common in the forelimb than the hindlimb.6 Hindlimb oblique DSL injuries are more common in horses that are not used for racing.2 Horses with a valgus or varus limb conformation or long, sloping pastern may be at increased risk for injury. Discrete core lesions, diffuse fiber tearing, and avulsion fractures at the base of the sesamoid bones are common ultrasonographic findings. However, because of the limitations of ultrasonography, MRI is often necessary for definitive diagnosis (FIGURE 2).

Injuries to the straight or cruciate DSL are infrequent and may occur alone or with other soft tissue injuries. Lameness is often present; however, soft tissue swelling may not accompany the injury. Avulsion fractures are less common at the origin of the straight DSL than at the origin of the oblique DSL.4–9 Ultrasonographic identification of cruciate DSL injuries is difficult due to the location of these ligaments; therefore, these injuries may be underdiagnosed.

Regardless of which DSL is injured, affected horses have a reasonable chance of returning to their intended use; however, the incidence of recurrence appears to be high.5,5 A prolonged, controlled-exercise rehabilitation program with periodic ultrasonographic evaluations is part of the preferred treatment, similar to programs for other tendon and ligament injuries. Additional treatments that may augment healing include extracorporeal shock wave therapy and local injection of stem cells or platelet-rich plasma; however, no studies have evaluated these options for treating DSL injuries.

**Orthopedic Injuries**

**Fractures**

P1 or P2 fractures are important causes of lameness in all breeds. P1 fractures occur most often in racing breeds, whereas P2 fractures occur most often in horses used for Western-type activities. However, either pastern bone may fracture in any horse during lunging or because of trauma (e.g., kicks, falls).1,2 In horses with incomplete P1 fractures, lameness may be subtle; however, substantial fetlock joint effusion is often present because nearly all of these fractures involve the fetlock joint and rarely enter the PIJ. Horses with complex P1 fractures typically exhibit obvious lameness, pain during manipulation of the pastern, and fetlock joint effusion.1,2 Radiographic evaluation of the affected limb is critical for the initial diagnosis. Multiple views at differing angles may be necessary to completely determine the characteristics of the fracture. Treatment options for incomplete P1 fractures typically include lag screw fixation through stab incisions and are associated with a good prognosis. More complex fractures should be treated with open reduction and internal fixation or partial reconstruction together with a transfixation cast or external fixator, which can result in a good outcome. In our opinion, treatment with a half-limb cast alone is not the best option for these complex fractures, although successful outcomes have been reported.1,2

Horses with P2 fractures typically demonstrate obvious lameness, severe pain when the pastern is rotated, and variable swelling of the pastern region. However, some horses with single P2 eminence fractures may not exhibit severe lameness but have persistent lameness that is localized to the pastern region. Typically, horses with any type of P2 fracture, including palmar/plantar eminence fractures or those involving the distal interphalangeal joint, should undergo arthrodesis of the PIJ with a single or double plate combined with a half-limb cast. Severely comminuted P2

**Figure 2.** Axial proton density image showing high signal intensity (arrow) consistent with focal fiber tearing and enlargement of the lateral oblique DSL in the pastern region consistent desmitis of the oblique DSL. (Courtesy of Dr. Barrett)

**Figure 3.** Dorsopalmar radiograph (A) and transverse CT image (B) of a closed, biarticular, severely comminuted and displaced P2 fracture. The degree of comminution is more apparent on the CT image.
fractures that are not amenable to internal fixation may be treated with a transfixation pin cast or external skeletal fixation. Although short-term survival was not improved by combined internal fixation and a transfixation pin cast in one study, we think that P2 fractures should be repaired with internal fixation when possible, especially when the distal interphalangeal joint is involved (FIGURE 3).

Because comminuted fractures of P1 or P2 are difficult to treat, CT evaluation before surgery may be helpful for presurgical fracture repair planning and may permit more precise screw placement for improved joint realignment (FIGURE 3). It is realistic to expect affected horses to have a good prognosis for becoming serviceably sound for breeding or being retired to pasture; some affected horses may return to athletic performance.

Osteoarthritis of the Proximal Interphalangeal Joint

Horses used for jumping, dressage, and Western-type activities appear to be prone to OA of the PIJ (i.e., high ringbone). Lameness may range from 2 to 4 (on a scale of 0 to 5) and typically improves with perineural (basesesamoid) and intraarticular anesthesia. Obvious enlargement of the pastern and/or varus deformity of the phalanges may be present in horses with advanced disease (FIGURE 4). Radiographic abnormalities include new bone formation, periarticular sclerosis, and loss of joint space, typically on the medial aspect of the PIJ (FIGURE 4). Comparative radiographs of the contralateral limb should be obtained in most horses because the condition may be bilateral.

Horses with mild OA of the PIJ that is unrelated to fracture are often good candidates for conservative management. Various treatment options are aimed at easing the breakover forces in the affected foot and decreasing the pain and inflammation associated with OA. Therapeutic shoeing is aimed at reducing toe length and elevating the heel to ease breakover forces. Intraarticular administration of corticosteroids and hyaluronan is most effective in horses with mild or moderate OA. NSAIDs are useful in the initial stage. The use of topical 1% diclofenac sodium cream (Surpass, Boehringer Ingelheim) may be a better option for local long-term pain relief; however, long-term use of systemic NSAIDs (e.g., phenylbutazone) can be successful if managed appropriately.

Additional treatments that may be beneficial, depending on the severity of OA, include joint-oriented nutraceuticals, intramuscular glycosaminoglycans, and intravenous hyaluronan or intraarticular IRAP.

In horses with advanced OA, particularly those with extensive periarticular bone proliferation and extensive loss of joint space, surgical arthrodesis is the preferred treatment. Natural ankylosis may occur but is often a long, painful process with variable results. Surgical arthrodesis is generally considered a better solution over the long term because it produces more consistent results. Many methods of arthrodesis have been described, and clinician preference varies. Current recommended techniques include a single dorsal midline plate with additional transarticular 4.5- or 5.5-mm screws or two dorsally applied plates with or without transarticular screws. We prefer a single, dorsally applied, 4.5-mm narrow, three- or four-hole plate with two 5.5-mm transarticular screws to try to improve patient comfort immediately after surgery and reduce the duration of casting (FIGURE 5). This method requires cast coaptation for 2 weeks to protect the incision site; however, we typically leave the cast in place for 3 weeks. After arthrodesis of the PIJ, 89% to 95% of horses with hindlimb lameness and 70% to 85% of horses with forelimb lameness return to their intended use, and 85% return to athletic soundness. The plate and two-screw method for arthrodesis of the PIJ is broadly applicable, including treatment of single eminence P2 fractures; however, comminuted P2 fractures are best repaired with two dorsally applied plates or specially designed plates such as a spoon plate.
There are anecdotal reports of intraarticular administration of ethyl alcohol in the PIJ, with or without cast immobilization, and the results have been variable. Intraarticular administration of ethyl alcohol into the tarsometatarsal joint can facilitate arthrodesis in a pain-free manner, but it is not a recommended treatment option. Based on the amount of motion of the PIJ, cast immobilization following injection has been used to help facilitate arthrodesis, and success has been variable. The use of ethyl alcohol may be considered in horses with aggressive degenerative changes and new bone formation, whereas horses with minimal radiographic changes typically do not do well after ethyl alcohol treatment. Because of very inconsistent results with using ethyl alcohol, we do not recommend it for arthrodesis of the PIJ.

**Osteochondrosis of the Proximal Interphalangeal Joint**

In horses, OC is less common in the PIJ than in other joints. Osteochondral fragments associated with OC tend to occur dorsally or on the palmar/plantar eminence of P2, causing variable lameness (FIGURE 6). These fragments may be incidental radiographic findings but can be accompanied by mild changes consistent with OA. It is important to identify the true source of lameness because surgical removal of osteochondral fragments can be difficult; however, the dorsal and palmar/plantar pouches of the PIJ are accessible with an arthroscope. Subchondral cystic lesions are more common in the hindlimb than the forelimb and can occur bilaterally. Some cystic lesions can be traumatically induced, but affected horses are often more lame and older than horses with developmental subchondral cystic lesions. Therefore, the clinical relevance of these lesions should be established using diagnostic analgesia. Management of subchondral cystic lesions includes intraarticular medications, arthrodesis of the PIJ, or periarticular drilling of the cyst and injection of a steroid or cancellous bone if it does not communicate with the joint.

**Subluxation of the Proximal Interphalangeal Joint**

Subluxation of the PIJ is uncommon, occurring in a medial/lateral or dorsal to palmar/plantar direction. Medial/lateral subluxation is due to severe injury to the collateral ligaments. Palmar/plantar subluxation usually follows a severe, traumatic soft tissue injury, such as a complete tear of the DSL, an SDFT branch injury, or a combination of these injuries. Treatment options for medial/lateral or palmar/plantar subluxations include conservative and surgical management. External coaptation is often successful in adult horses that receive acute care.

**Critical Points**

- Tenoscopy can be helpful for diagnosis and therapy in horses with equivocal ultrasonographic findings with effusion and lameness localized to the digital flexor tendon sheath.
- Multiple views at different angles are often necessary to completely characterize first and second phalangeal fractures.
- Osteochondrosis of the proximal interphalangeal joint (PIJ) may cause variable lameness, making it important for the clinician to identify the true source of lameness.
- MRI is more accurate than ultrasonography for diagnosing soft tissue injuries of the pastern region.
- Pain within the PIJ cannot be excluded when the palmar/plantar digital nerves are anesthetized at any site proximal to the proximal margin of the collateral cartilages of the foot. Therefore, when the palmar/plantar digital nerves are anesthetized, it is important to inject the anesthetic at the level of collateral cartilages to minimize the effect on the PIJ.
- Injuries involving the pastern region are rarely bilateral, but osteoarthritis may be; therefore, comparing the right and left limb or medial and lateral aspect of the same limb is helpful when identifying abnormalities.
- Treatment options for DDFT injuries are similar to those for SDFT injuries.

**FIGURE 6** Dorsopalmar (A) and lateral (B) radiographs of osteochondral fragmentation from the palmar aspect of the PIJ.
the PIJ include conservative and surgical management. The more chronic the subluxation, the more likely it will damage the soft tissue stabilizing the joint and require surgical arthrodesis for stability.

**Conclusion**

Injuries involving the pastern region are a common source of lameness in many types of performance horses. Knowledge of the common breed- and activity-associated injuries can aid veterinarians in making an accurate diagnosis. Pain within the PIJ cannot be excluded when the palmar/plantar digital nerves are anesthetized at any site proximal to the proximal margin of the collateral cartilages of the foot. Therefore, when anesthetizing the palmar/plantar digital nerves, it is important to administer the anesthetic at the level of the collateral cartilages to minimize the effect on the PIJ. In general, soft tissue injuries of the SDFT, DDFT, and DSL of the pastern region can be difficult to diagnose and can recur, and affected horses have a reasonable chance of returning to their intended use. Osseous injuries such as PIJ OA and phalangeal fractures typically have a better prognosis because horses can do very well after surgical arthrodesis of the PIJ. However, secondary involvement of the distal interphalangeal or metacarpal/metatarsophalangeal joint is often the limiting factor in horses with P2 and P1 fractures, respectively.

**References**

1. Horses with _____ should not undergo diagnostic perineural anesthesia before radiography.
   a. suspected P1 stress fractures
   b. injury to the medial branch of the SDFT
   c. OA
   d. dorsal subluxation of the PIJ

2. Which advanced imaging modality(ies) can help improve the accuracy of diagnosing pastern injuries?
   a. MRI
   b. CT
   c. tenoscopy of the DFTS
   d. all of the above

3. SDFT injuries at the level of the pastern most commonly involve
   a. the medial branch.
   b. the lateral branch.
   c. core lesions within the body.
   d. longitudinal tears within the body.

4. What diagnostic tool should be considered if DFTS-associated lameness is suspected, sheath effusion is present, and the ultrasonographic findings are equivocal?
   a. nuclear scintigraphy
   b. tenoscopy
   c. CT
   d. radiography

5. Which DSL is injured most commonly in all types of performance horses?
   a. straight
   b. oblique
   c. cruciate
   d. long

6. P1 fractures most often occur in _____ breeds, and P2 fractures most often occur in ________.
   a. racing; racing breeds
   b. racing; horses used for Western-type activities
   c. Western; racing breeds
   d. Western; horses used for Western-type activities

7. Radiographic abnormalities consistent with OA of the PIJ include
   a. new bone formation.
   b. periarticular sclerosis.
   c. loss of joint space.
   d. all of the above

8. Which condition may be an incidental radiographic finding?
   a. oblique DSL desmitis
   b. OA
   c. osteochondral fragments
   d. medial/lateral subluxation of the PIJ

9. Which of the following is not used for intraarticular treatment of OA of the PIJ?
   a. corticosteroids
   b. IRAP
   c. hyaluronan
   d. platelet-rich plasma

10. In general, horses with soft tissue injuries have a _____ chance of returning to their intended use, and osseous injuries typically have a _____ prognosis if arthrodesis is an option.
    a. reasonable; better
    b. reasonable; good
    c. good; poor
    d. good; good