Palmar-plantar axial sesamoidean approach to the digital flexor tendon sheath in horses

Diana M. Hassel, DVM, DACVS; Susan M. Stover, DVM, PhD, DACVS; Thomas B. Yarbrough, DVM, DACVS; Christiana M. Drake, PhD; Kenneth T. Taylor, BS

The digital flexor tendon sheath (vaginae synoviales tendinum digitorum manus) is a synovial structure that envelops the superficial and deep digital flexor tendons as they pass over the palmar and plantar aspects of the metacarpal- and metatarsophalangeal (fetlock) joints. It extends from the distal portion of the third metacarpal or metatarsal bone to the proximal half of the second phalanx. The tendon sheath encircles the tendons except at the palmar or plantar aspects of the fetlock canal where the superficial digital flexor tendon is attached to the tendon sheath and forms the palmar or plantar walls of the sheath. There are 2 major pouches in the sheath; 1 pouch is at the most proximal aspect between the suspensory ligament and the deep digital flexor tendon, and the other pouch is located distally, between the proximal and distal digital annular ligaments, at the bifurcation of the superficial digital flexor tendon. The tendon sheath is 14 to 20 cm in length and is composed of an outer fibrous layer that provides the vascular supply to the sheath and an inner visceral layer that contains synoviocytes.

Synoviocentesis is an important technique for the diagnosis and treatment of various infectious, traumatic, and inflammatory disorders of the digital flexor tendon sheath in horses. The most common clinical indication for centesis of the digital flexor tendon sheath is septic tenosynovitis, which develops commonly as a consequence of trauma to the limb; the digital flexor tendon sheath is the most commonly affected site. As with any infectious process, early diagnosis and immediate treatment for septic tenosynovitis are important for successful management. Prompt identification of tendon sheath involvement in lacerations of the distal portions of the limb can be achieved through distention of the tendon sheath with sterile infusing solutions to assess whether communication with a wound exists. Once identified, reliable needle access to the sheath is essential for successful management of septic tenosynovitis by use of intrathecal antimicrobial treatment and lavage. When wounds involving the tendon sheath are actively draining, distention of the tendon sheath may be absent, and access to the tendon sheath is important to establish whether communication with the wound exists. Limitations for access to the tendon sheath may also exist, depending on location of the wound. In addition to septic processes, other reasons to gain access to the tendon sheath have been described for diagnostic intrathecal anesthesia, synovial fluid sampling, intrathecal contrast radiography, tenoscopy, through-and-through lavage, and therapeutic infusion of anti-inflammatory agents.

Commonly, synoviocentesis is performed by penetration of the proximalateral pouch proximal to the palmar or plantar annular ligament and palmar or plantar to the lateral or medial suspensory branch. When prominent synovial fluid distention is present, this is a useful location for obtaining synovial fluid samples or medicating the sheath. However, when fluid distention of the sheath is absent, or the contents of the sheath consist predominantly of fibrin or proliferative synovial intimal tissue, the proximal approach to the tendon sheath may be difficult and may be associated with hemorrhage within or around the tendon sheath.

The purpose of the study reported here was to describe and compare a palmar-plantar axial sesamoidean (PAS) approach with the conventional proximolateral (PL) approach for synoviocentesis of the digital flexor tendon sheath in horses.

Procedures

Anatomic studies—The position, shape, and capacity of the digital flexor tendon sheath was determined by use of intrathecal casts in 8 cadaveric limbs of 2 mature Thoroughbred geldings (estimated body weight range, 450 to 500 kg [990 to 1,100 lb]). Casts were prepared by injecting 25 ml of plastic by use of a PAS approach. The fetlock joints on each cadaver were manually held in the following positions prior to injection of plastic: 1 flexed forelimb, 1 extended forelimb, 1 flexed hind limb, and 1 extended hind limb. Fetlock angles of flexion and extension were manually fixed at 225° and 150°, respectively, as measured from the dorsal surface of the limb. After the intrathecal casts hardened, gross anatomic dissection of the limbs of 1 horse was performed, and anatomic relationships between the digital flexor tendon sheath and surrounding bone and soft tissues were recorded. In the limbs of the other horse, the digital flexor tendon sheaths were injected with plastic in a similar fashion, and the limbs were subsequently frozen and cut with a bandsaw into 2-cm transverse sections. Evaluation of all specimens was performed to determine the optimal position for needle entry into the tendon sheath and identify palpable anatomic landmarks for each approach.

In vitro evaluations—Synoviocentesis by the PAS and PL approaches was compared by use of paired forelimbs and paired hind limbs from 8 equine cadavers. Cadavers had no observable musculoskeletal abnor-
nalities of the distal half of the limbs, and injections were performed within 6 hours of death. Forelimbs and hind limbs were injected with the limbs intact and the joints maintained at defined angles, as described. The PAS approach was used to perform synoviocentesis in 1 forelimb of each cadaver, and the PL approach was used in the contralateral forelimb. Approaches were alternated between the left and right limbs for successive cadavers. A similar alternating approach was used for hind limb pairs.

The horses were positioned in lateral recumbency with the assigned leg oriented upward to facilitate access to the lateral surface of the limb. Injections were performed with the limb intact to avoid anatomic irregularities associated with transection of tendons and ligaments proximally. In the forelimbs, the carpus was manually maintained in full extension, and the fetlock joint was maintained in extension at an angle of 150° for the PL approach. In the hind limbs, the tarsus was maintained in full extension, and the distal portion of the limb was positioned in a manner similar to the forelimbs during injection. A 20-gauge 2.5-cm needle was used to attempt entry into the tendon sheath. After clipping and aseptic preparation, synoviocentesis was performed by the PL approach on the lateral aspect of the limb, 1 cm proximal to the proximal border of the palmar or plantar annular ligament and 1 cm palmar or plantar to the lateral branch of the suspensory ligament. Following initial needle placement, the needle was attached to a 12-ml syringe containing 8 ml of radio-opaque solution; criteria for probable entry into the tendon sheath included lack of resistance to injection combined with distention of the tendon sheath. The number of times the needle was repositioned after initial skin penetration and the time required to obtain entry to the tendon sheath were recorded. All injections were performed by a single investigator (DMH), and limb position was manually maintained by the same individual throughout all procedures. The limbs were subsequently transected at the level of the proximal aspect of the metacarpus or metatarsus for radiographic evaluation and gross anatomic dissection. Dorso palmar, dorsoplantar, and lateromedial radiographic views were taken.

The PAS approach was used in the assigned limb of each cadaver specimen. The fetlock joint was flexed to a standardized angle of 225° as measured from the dorsal cortices of the third metacarpus or metatarsus and the first phalanx. The needle was placed at the level of the most proximal and distal portions of the sheath. No anatomic variability was identified within each individual between forelimbs and hind limbs, and there were minimal changes in the distribution and sites of accumulation of casting material associated with flexion or extension of the limb. An optimal site for access to the proximal synovial recess was 1 cm proximal to the proximal border of the palmar or plantar annular ligament and 1 cm palmar or plantar to the lateral branch of the suspensory ligament. For the PL approach, needle access was identified at the level of the midbody of the lateral proximal sesamoid bone, through the palmar or plantar annular ligament, and 3 mm axial to the palpable palmar or plantar border of the lateral proximal sesamoid bone. The needle was inserted into the transverse plane and directed 45° from the sagittal plane toward the midline (Fig 2). Manual manipulation of the flexor tendons was not performed by use of either the PL or the PAS approaches.

**Results**

**Anatomic studies**—A 25-ml volume of plastic casting material resulted in adequate filling of the digital flexor synovial sheath with moderate distention of the most proximal and distal portions of the sheath. No anatomic variability was identified within each individual between forelimbs and hind limbs, and there were minimal changes in the distribution and sites of accumulation of casting material associated with flexion or extension of the limb. An optimal site for access to the proximal synovial recess was 1 cm proximal to the proximal border of the palmar or plantar annular ligament and 1 cm palmar or plantar to the lateral branch of the suspensory ligament. For the PAS approach, needle access was identified at the level of the midbody of the lateral proximal sesamoid bone, through the palmar or plantar annular ligament, and 3 mm axial to the palpable palmar or plantar border of the lateral proximal sesamoid bone (Fig 1). The recommended position of needle insertion was immediately palmar or plantar to the palmar or plantar digital neurovascular bundle, in the transverse plane, and directed approximately 45° from the sagittal plane toward the midline (Fig 2). Manual manipulation of the flexor tendons was not performed by use of either the PL or the PAS approaches.

**In vitro studies**—Horses included 2 Thoroughbreds, 4 Quarter Horses, 1 Arabian, and 1 Hanoverian. Median age was 11.3 years (range, 3 to 28 years), and estimated body weight ranged from 400 to 600 kg (880 to 1,320 lb). Access to the tendon sheath was achieved in 16 of 16 limbs by use of the PAS approach and in 14 of 16 limbs by use of the PL approach. Differences in measured variables between the forelimbs and the hind limbs were not observed. The time required for synoviocentesis was significantly (P = 0.02) shorter for the PAS approach (mean, 39.2 seconds; median, 28.0 seconds), compared with the PL approach (mean, 79.8 seconds; median, 52.3 seconds).
required to access the tendon sheath were significantly
(\(P = 0.03\)) fewer for the PAS approach (mean, 3.4;
median, 2.0), compared with the PL approach (mean,
9.1; median 6.0). Subcutaneous deposition of radio-
graphic contrast material was identified in 0 of 16
limbs by use of the PAS approach and 3 of 16 limbs by
use of the PL approach, but this difference was not sta-
tistically significant (\(P = 0.22\)). For either approach,
gross anatomic evaluation did not reveal evidence of
soft-tissue injury to the palmar annular ligament, inter-
semaidean ligament, neurovascular bundle, or flexor
tendons. However, needle penetration of the peripher-
al region of the flexor tendons likely occurred during
during both approaches.

**Discussion**

Advantages of the PAS approach over the PL
approach include reliable access to the tendon sheath
when synovial fluid distention is absent and reduced
time required for successful entry. Percutaneous access
to the sheath was accomplished with fewer attempts at
repositioning the needle by use of the PAS approach.
This is desirable, because manipulation and reposi-
tioning of the needle increases the likelihood of induc-
ing hemorrhage. Additionally, the anatomic bound-
daries of the PAS approach ensure successful access to
the digital flexor tendon sheath. Substantial increases
in syringe pressure would develop if the needle was
inserted into the flexor tendons, intersesmaidean lig-
ament, and palmar or plantar annular ligament, and
subcutaneous deposition would result in a readily
identifiable localized swelling under the skin.

As with all approaches to synovial structures,
identification of palpable landmarks is critical for suc-
cess. The most distinct landmarks for the PAS
approach are the proximal sesamoid bones and the
neurovascular bundle. When identifying the midbody
of the lateral or medial proximal sesamoid bone on its
palmar or plantar border, it is essential to remember
the anatomic changes that occur with flexion of the
distal portion of the limb. The proximal sesamoid
bones move proximal and palmar or plantar in relation-
to the third metacarpus or metatarsus, respec-
tively, during fetlock flexion. The neurovascular bundle is readily identifiable across the palmar or plantar aspect of the fetlock joint. For the PAS approach, percutaneous puncture should be performed immediately palmar or plantar to the neurovascular bundle. The needle should be inserted 3 mm axial to the palmar or plantar border of the midbody of the proximal sesamoid bone and perpendicular to the skin surface (45° from the sagittal plane). If palpation of the neurovascular bundle and proximal sesamoid bones is not possible because of swelling or injury to the soft tissues, an alternative approach to the tendon sheath is recommended.

Obtaining a representative sample of fluid from the tendon sheath may be difficult. When traumatic or septic tenosynovitis of the digital flexor sheath is present, chronic synovitis, substantial fibrosis, adhesion formation, and accumulation of fibrin and debris may develop within the proximal recess of the tendon sheath.3,7,9,13,15,16 These inflammatory changes may be associated with increases in blood supply, capsular fibrosis, and intimal proliferation, resulting in reduction in sheath volume and making access to the lumen difficult.14 Hemorrhage from inflamed synovium or occlusion of the needle by synovial villi may occur during synoviocentesis of the proximal pouch. Proximally, the synovium is more villous, cellular, and mobile, compared with the smooth filamentous region between the intersesamoidean ligament and digital flexor tendons.17 Traumatic, inflammatory, or infectious synovitis may be more difficult to diagnose if blood contamination of the synovial fluid sample occurs.17

An alternative site for synoviocentesis is the distal pouch at the palmar or plantar midline of the pastern. This site may be advantageous when there is palpable synovial fluid distention, because it can be performed with the limb in a flexed or weight-bearing position, is unlikely to induce iatrogenic damage to the flexor tendons or induce hemorrhage, and is likely to result in the acquisition of a diagnostic synovial fluid sample. Because penetration of tendon tissue with a needle is less likely by use of this method, compared with the PAS approach, it may be a preferable technique in many circumstances. During through-and-through lavage for treatment of septic tenosynovitis, the distal pouch may provide an additional portal for lavage. However, access via this route may be limited when palmar or plantar lacerations involving the pastern region are present.

Synovial fluid sampling was not attempted in our study because of an absence of fluid distention within the tendon sheath. Because of the anatomic restrictions of the digital flexor tendons, intersesamoidean ligament, and palmar or plantar annular ligament, pooling of fluid at the PAS site does not develop, regardless of joint angle. However, fluid sampling from this site has been successfully performed by the authors in horses with clinical septic tenosynovitis when moderate distention of the tendon sheath was evident. Although use of the PAS technique may not consistently provide a fluid sample for diagnostic evaluation when the tendon sheath lacks fluid distention, it remains a reliable technique for intrathecal injection of pharmaceuticals or lavage fluids and assessment of whether communication with a wound exists.

A flexed fetlock joint angle was selected for the PAS approach in our study, because the non–weight-bearing flexed position is most likely to be applied in clinical situations. This provides greater control against movement by the patient during synoviocentesis. The technique can effectively be accomplished by 1 individual holding the limb in flexion in 1 hand and the needle in the other, using a single sterile glove. Because penetration of the periphery of the digital flexor tendons may occur in many instances when using the PAS approach, guarding against excessive motion may help minimize trauma associated with movement of the needle. Because of the anatomic restrictions associated with the sesamoid bone, intersesamoidean ligament, flexor tendons, and palmar or plantar annular ligament, manual manipulation of the flexor tendons during needle placement would likely be ineffective in avoiding needle penetration of the peripheral regions of the tendons. Although substantial needle-induced trauma was not identified via gross dissection of the limbs in our study, it is likely that needle penetration of the abaxial region of the flexor tendons occurred by use of the PL and PAS approaches. Access to the digital flexor tendon sheath can also be achieved by use of the PAS approach with the limb in an extended or weight-bearing position; however, this method is not recommended because of the potential for injury to the flexor tendons during limb movement.

The extended or weight-bearing position was selected for the PL approach, because in the authors’ experience, this is a commonly used method for access to the tendon sheath; however, this may not reflect the experience of others. Maximal distention of the proximal pouches develops during weight bearing, which facilitates access to the fluid-filled lumen of the tendon sheath and allows sufficient drainage of excess fluid from the synovial cavity. However, the PL approach can also be successfully used during fetlock flexion, with the similar advantage of increased control of limb movement, as described for the PAS approach.

Thus, the PAS approach offers an option for synoviocentesis of the digital flexor tendon sheath in horses that is reliable, technically simple, and rapid. Use of the PAS technique for intrathecal injection should be considered when synovial fluid distention is absent, synovial proliferation within the proximal pouch is suspected, an additional portal for lavage is necessary, or other techniques for access to the tendon sheath have failed.

References

3. Honnas CM, Schumacher J, Watkins JP, et al. Diagnosis and...
treatment of septic tenosynovitis in horses. 


