How to Perform Ultrasound-Guided Tendon Splitting and Intralesional Tendon Injections in the Standing Horse

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Introduction
Superficial digital flexor tendon (SDF) and suspensory ligament injuries represent 20–30% of musculoskeletal injuries facing the equine practitioner. During the initial weight-bearing phase of the horse’s stride, the SDF is loaded first and the central fascicles of the midbody of the SDF are loaded more than the peripheral fascicles. In an extended trot, the suspensory ligament is loaded preferentially which helps to explain the high incidence of SDF lesions in racehorses and suspensory ligament problems in trotters and dressage horses.

Acute tendonitis is characterized by collagen fiber damage and an increase in cross-sectional tendon area (CSA) due to intratendinous hemorrhage and inflammatory fluid accumulation within the defect. These structural defects occur commonly in the center of the unsheathed portion of the SDF and are commonly called core lesions. These core lesions have been defined as type 1–4 (Table 1) based on the ultrasound echogenicity of the lesion, although recording the CSA and length of the visible core enhances the accuracy when determining severity of the lesion.

The goals of therapy are to decrease tendon inflammation and edema, minimize the deposition of fibrous scar tissue, promote restoration of normal tendon structure, and protect the tendon from further injury. Initial treatment (first 5–7 days) includes systemic and local anti-inflammatory therapy. Phenylbutazone (4.4 mg/kg daily), dimethyl sulphoxide (DMSO) applied topically and ice or cold water therapy 20–30 min twice daily for 5–7 days depending on severity of the lesion is indicated initially. Removing racing plates and keeping the toe length short decreases tendon stress. Bandaging the lower limb with a support wrap will help increase interstitial fluid pressure and counteract fluid loss from the vasculature thereby decreasing edema and swelling of the tendon.

The next stage of therapy is aimed at improving the rate and quality of tendon repair. Use of hyaluronic acid injections locally peritendinously and/or intralesionally improved histologic appearance and
This percutaneous tendon split technique involves multiple stab incisions into the swollen portion of the tendon to decompress the core lesion. Ultrasonic guidance of the tendon splitting technique ensures that only the affected core lesion and associated disrupted tendon fibers are split, reducing damage to the normal tendon fibers. It is imperative to clip or shave and aseptically prepare the involved limb. The horse is sedated with a combination of detomidine (0.01 mg/kg) followed by butorphanol (0.05 mg/kg). A high four-point nerve block is completed with local anesthetic. The 7.5 MHz transducer, which is covered with sterile lubricant, is placed on the sterile obstetrical sleeve and taped to the scanhead cord. The sterile lubricant, which serves as the ultrasound contact material, is placed over the aseptically prepared palmar aspect of the limb. The superficial flexor tendon (SDF) is visualized with the ultrasound in the transverse plane (short axis). The full extent of the core lesion is visualized. The stab incision or splitting begins at the most distal aspect of the core lesion to avoid blood contamination of the next stab incision. A #11 scalpel blade is inserted into the medial or lateral surface of the SDF, perpendicular to the ultrasound probe (Fig. 1). If the core lesion is eccentrically located, it is split from the side closest to lesion to avoid damaging normal tendon fibers. The entry and location of the scalpel blade is observed by ultrasound. The blade is advanced through the core lesion to a point just into the normal tendon fibers on the far side of the core lesion. The blade handle is then rotated in an upward and downward motion parallel to the long axis of the tendon. The blade is removed and subsequent stab incisions are made as needed to split the entire length of the core lesion.

Post-operatively, no sutures are needed. A sterile support bandage is placed on the limb immediately after surgery and changed after 24 h. The

<table>
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<th>Table 1. Description of Core Lesions, Types 1–4</th>
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<td>Type 1 lesion—Diffuse loss of fiber density with hypoechoic image.</td>
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<tr>
<td>Type 2 lesion—Anechoic (black) core lesion in 50% or less of CSA of tendon.</td>
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<td>Type 3 lesion—Core lesion affecting 50% or more of CSA of tendon.</td>
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<tr>
<td>Type 4 lesion—Core lesion affecting majority of CSA of tendon considered a rupture.</td>
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maturation of tendon fiber repair at 8 wk after injury in a collagenase model of tendon injury.\(^5,6\) Hyaluronate acts as an anti-inflammatory agent reducing the production of inflammatory mediators and has also been shown to have a direct stimulatory effect on migrating repair cells promoting cellular differentiation into collagen-producing cells.\(^7\)

Based on the existing evidence, it appears that hyaluronate may be beneficial to the repair process after acute tendonitis and should be used soon after injury, although further investigation is warranted.

Increased tissue pressure from the fluid accumulation within the epitenon and paratendon results in a “compartment syndrome” within the tendon exacerbating perfusion deficits causing a slow resolution of inflammation and healing. Since tendon healing is based on proliferation of vasculature from longitudinal and peripheral vessels, stimulating revascularization is beneficial. Tendon-splitting of acute to sub-acute injured tendons that contain core lesions led to significant reduction in lesion size, tendon diameter, and lesion grade within 8–12 days after surgery.\(^3\) It is suggested that splitting creates a communication between the tendon core and peritendinous tissues which “decompresses” the core lesion, allowing evacuation of accumulated inflammatory fluid and promotes vascular ingrowth within the lesion.

The intralesional hyaluronate injection and tendon-splitting techniques can be performed blindly into the thickened aspect of the tendon; however, the accuracy of depositing the medication into the exact location of the core lesion is uncertain, and blind splitting of the tendon can cause iatrogenic damage to normal tendon fibers, both of which may decrease rate of tendon healing. The ultrasound-guided procedure described here is easy to perform and allows precise deposition of medications and visualization of the scalpel as it is directed into the core lesion.

**Materials and Methods**

**Percutaneous Ultrasound-Guided Tendon Splitting**

The materials we use include an Impact VFI\(^a\) ultrasound machine with a 7.5 MHz fluid stand-off transducer,\(^a\) sterile water-soluble lubricant,\(^b\) sterile obstetrical sleeve, sterile surgical gloves, sterile leg bandage, and #11 scalpel blade.

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**Fig. 1.** Photograph of ultrasound probe within a sterile obstetrical sleeve guiding the direction of scalpel blade into the superficial digital flexor tendon.
support bandage is maintained for 2 wk until the stab incisions have healed. Phenylbutazone is administered (2.2 mg/kg, orally) for 7 days.

Percutaneous Intralesional Tendon Injection

The same materials are required as for the tendon-splitting procedure except a 1.5-inch 18 gauge sterile hypodermic needle is used in place of the scalpel. The palmar aspect of the limb is clipped and aseptically prepared but local anesthesia is not necessary. The scanhead is used to visualize the lesion and the needle is guided into the core lesion. Once the needle is visualized within the core lesion (Fig. 2), any fluid and serum is allowed to drain. After drainage, 20 mg of sodium hyaluronate and 50 mg of amikacin are deposited within the core lesion. We will occasionally add 6–8 mg of triamcinolone to the hyaluronic acid if we feel a potent anti-inflammatory is needed, although we realize that it may delay tendon healing. The limb is then placed in a sterile support bandage and the exercise protocol followed.

Post-Operative Exercise Program

The exercise protocol following tendon splitting and intralesional injection is as follows:

Week 1–2  Stall rest with 10 min of handwalking twice daily.
Week 3–4  Stall rest with 15 min of handwalking twice daily.
Week 5–6  Stall rest with 20 min of handwalking twice daily.
Week 7–8  Stall rest with 30 min of handwalking twice daily.

Recheck ultrasound exam.

At this point the progression of the lesion is evaluated both sonographically and clinically. Progress is regarded as good if pain and heat on palpation are absent, the core lesion is filling in with collagen so that it is only faintly visible, and if the cross-sectional area or size of the affected SDF tendon has decreased. Progress is regarded as fair if clinical signs are absent, the core lesion is filling in with collagen but still present, and the SDF size has stayed the same or increased. Poor progress is given if any clinical signs are present, the ultrasound lesion is clearly visible, and tendon fiber pattern has not improved. If a poor prognosis is given the horse should continue with stall rest and 15 min of daily handwalking twice daily and have a re-examination after 30 days. The following exercise protocol is followed if a good or fair progression of the lesion is seen.

Weeks 9–10  Stall rest or equivalent sized paddock with 45 min handwalking twice daily.
Weeks 11–12  Stall and/or stall-size paddock with 20 min of riding at a walk.
Weeks 13–14  Stall and/or small paddock with 30 min of riding at a walk.
Weeks 15–16  Stall/paddock with riding at walk for 30 min and 5 min trot.

Recheck ultrasound exam.

Progress is good if no observable ultrasound lesion is present and SDF size is decreasing. The progression is fair if a lesion is present on ultrasound and poor if the SDF size has increased. Do not proceed to Week 17 in the protocol if the SDF tendon size is increasing.

Weeks 17–18  Stall/paddock and ride at walk for 30 min and trot for 10 min.
Weeks 19–20  Stall/paddock and ride at walk for 45 min and trot 15 min.
Weeks 21–22  Stall/paddock and ride at walk for 45 min and trot 20 min.
Weeks 23–26  Stall/paddock and ride at walk 30 min and trot 30 min and add 5 min of cantering (loping) every third ride.

Recheck ultrasound exam.

If tendon area is reduced and fiber pattern is improving, continue with exercise program. If tendon size is increasing or fiber pattern is not improving, go back 4 weeks in the exercise protocol and continue.

Weeks 26–32  Stall/paddock and ride but add 5 minutes to walk, trot and canter time every third time the horse is ridden. After this time full flat work can begin but no galloping, racing, jumping or full work (roping steers, cutting) until after 300–330
Results
We have treated multiple tendon core lesions with intralesional hyaluronate and/or tendon splitting using ultrasound guidance in the standing horse. The procedure is easy to perform and is very helpful in treating specific locations within the affected tendon. Horses tolerate the procedure well and thus far we have had no adverse complications from the procedure. Oftentimes after needle placement for the intralesional injection, serum and blood will drain from the needle after which the hyaluronate is deposited. Our clinical response has been a decrease in gross size of the tendon or ligament and reduced pain and heat upon palpation within 5–7 days of injection. The horse in Figure 2 with the rupture (type 4) of the inferior check ligament was injected 7 days after injury at the time of the initial exam with 20 mg hyaluronic acid and 50 mg amikacin. The horse returned for a recheck exam after 30 days (Fig. 3) and the lesion has significant improvement to a type 2 lesion.

Discussion
The use of intralesional injections and tendon splitting for adjunct treatment of acute tendon injuries is still controversial. We feel that there is a beneficial effect of treatment based on repeat clinical and ultrasound examinations. We recommend tendon splitting be used to treat tendon and suspensory branch core lesions. If the quality of the horse and size of the core lesion is amendable to warrant proximal superior check ligament desmotomy, then the tendon split is used in combination with this procedure; however, it is then performed while the horse is under general anesthesia.

Acute inferior check ligament lesions that involve a core lesion are usually treated with intralesional hyaluronate. We feel that ligament splitting is rarely needed since most of these lesions heal without the surgery. Splitting the affected ligament is reserved for lesions that are refractory to rest and intralesional injection where the core lesion is still apparent after 2 months of rest and conservative therapy.

The branches and mid portion of the suspensory ligament can be split using the ultrasound-guidance technique. Proximal suspensory core lesions are injected intralesionally using ultrasound guidance. We have not split a proximal core lesion in the suspensory ligament since most core lesions resolve with rest and injection. Caution must be taken when attempting to split a proximal suspensory lesion due to the palmar vessels and nerves within the area. In addition, surgical access to the proximal suspensory can be difficult due to its location relative to the palmar flexor tendons.

References and Notes

KY Jelly, Johnson and Johnson Medical, Inc., Arlington, TX.