Surgical Management of Superficial Digital Flexor Tendinitis

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Superior check desmotomy and annular desmotomy, alone or in combination, are valuable adjunct procedures in the management of superficial digital flexor tendinitis in the horse. Results of surgical management in Standardbreds are superior to those reported of conservative management and to those achieved in Thoroughbreds. Author's address: New Bolton Center, University of Pennsylvania, Kennett Square, PA 19348-1692.

1. Introduction

A detailed understanding of etiology and pathophysiology would be required to develop experimental protocols that could recreate naturally occurring tendinitis of the superficial digital flexor tendon (SDFT). Unfortunately, such a model and a clear understanding of etiology have yet to be determined, and therefore well-defined management protocols are difficult to develop. Large, well-controlled clinical studies with patients randomly assigned to treatment groups have likewise been lacking. Certain factors regarding prognosis after injury and tendon healing, however, have been useful to the author to justify and support the use of surgical management of tendinitis.

Tendinitis of the SDFT is the most common tendon injury in the sport horse, and it occurs most frequently in racehorses. Tendinitis can develop secondary to direct trauma from interference from the same or another horse or secondary to peritendinous injury caused by encircling bandages (bandage bows). The most common cause of tendinitis is thought to involve overload injury during exercise, which leads to tendon fiber disruption and swelling (bowed tendon). The etiology of tendinitis is undoubtedly complex and likely involves not only mechanical factors (overload injury and increased strain) but also vascular and conformational factors such as long pasterns, tied in behind the knee, and abnormally low hoof angle. Ischemia or hypoxia during maximal loading may play a role in the development of tendinitis and lead to hemorrhage, seen early after tendon injury.[1,2] Vascular injury may occur at higher speeds or during maximum loading, accounting for differences in prognosis between racing breeds, as prognosis is worse in Thoroughbred (TB) racehorses than in Standardbred (STB) racehorses regardless of management technique. A higher load is placed on the SDFT in the gallop, when compared with the two-beat gaits of the STB, the trot and pace. The SDFT heals with scar tissue formation within and external to the tendon. Inelastic scars within the tendon and peritendinous adhesions predispose the tendon to recurrent damage and reduce gliding function. Inelastic scar tissue reduces the elastic limit of healed tendon. Surgical procedures increasing the bone-ligament–tendon-bone length, thus protecting this inelastic scar and thereby improving elastic

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limit after injury, would be beneficial. Tendons likely never regain normal strength after injury, regardless of healing quality, and therefore any treatment that protects healed tendon would have benefit.

Using what is known about tendon healing and collagen formation has led to recent innovations in treatment. Limiting cross-linking of randomly arranged collagen fibers by the administration of beta-aminoproprionitrile fumarate and promoting later cross-linking of parallel fibers may limit scar tissue formation and has shown early promise in the management of tendinitis of the SDFT.[3] Prognosis appears better when peritendinous adhesions are minimized in both sheathed and nonsheathed regions, because in clinical practice those tendons regaining normal size and architecture after injury appear less subject to recurrent injury. Improving gliding function in sheathed and nonsheathed regions is a time-honored principle of tendon healing, and the surgical procedure, annular desmotomy, alone or in combination with other surgical procedures can greatly improve enlarged SDFT function in the distal metacarpal region.

Ultrasonographic evaluation has revolutionized our understanding of tendon injuries and allows the clinician to monitor healing. Within the first 2 weeks after injury, anechoic areas represent primarily areas of hemorrhage.[4] Hypoechoic areas represent granulation tissue in the area of previous hemorrhage and fiber damage, whereas in areas of healing, maturing fibers are more echogenic.[4] Tendon splitting, done to decompress areas of hemorrhage or to provide vascular access channels early after injury, makes theoretical sense when done in horses with early anechoic lesions, but it has questionable value if done in areas of granulation tissue or more mature tendon tissue.

Controlled exercise programs, to allow an increased loading of the healing tendon, promote collagen cross-linking without excessive loads. Uncontrolled exercise such as turn-out early after injury or early return to rigorous training is likely to cause excessive loads on damaged or weakened tendons. Individually tailored training programs based on serial sonographic examinations to assess tendon size and possible recurrence of injury during early training may account for the relatively high success rate of certain clinicians with conservative or other management techniques.

The ideal treatment for tendinitis has yet to be developed, but it would likely include a combination of medical and surgical management: (a) intralesional injections to limit early unwanted cross-linking; (b) peritendinous injections of anti-inflammatory agents to minimize edema, and other inflammatory changes such as hemorrhage and adhesions; (c) early surgical management with superior check desmotomy alone or combined with annular desmotomy; (d) controlled, vigorously monitored exercise; and (e) serial ultrasonographic evaluations to assess healing.

The surgical management of tendon and ligament injuries has been proposed for many years and has included tendon splitting, implant insertion, surgical division of restrictive adhesion, annular desmotomy, and, most recently, superior check desmotomy. Recent advances in surgical management and the widespread use of ultrasonographic evaluation have led to multiple reports detailing clinical experience with different management protocols. When results of published information are combined with clinical experience, it appears that surgical management in horses is part of the ideal treatment.

2. Superior Check Desmotomy

Since Bramlage first described transection of the accessory ligament of the superficial digital flexor muscle (tendon), superior check desmotomy (SCD), as a novel surgical treatment for tendinitis of the SDFT, controversy regarding efficacy of the procedure has existed.[5] Early, optimistic results were reported in TB racehorses and included 32 of 36 horses (89%) that returned to racing, and 25 horses that competed at a level equal to or above the preinjury level.[6] The results of that study were criticized, however, because the criterion for success, defined as completing two races and starting a third, was lenient and horses developing contralateral lameness including tendinitis were excluded. Recently, results from a larger group of TB racehorses, using a more strict definition of success, revealed that 97 of 137 horses raced (71%) and that 70 horses (51%) made more than five starts after surgery, but average earnings decreased in 58% of horses.[7] In that study, the mean time from surgery to first start was 353 days.[7] In a smaller, separate study evaluating the long-term effects of SCD and other treatments, 53% of flat racehorses, 58% of steeplechasers, and 73% of hurdlers competed in five or more starts after surgery.[8] Clearly, with a more strict definition of success the earlier results have been downgraded, but they still compare favorably with results from conservative therapy alone. For instance, it has been estimated that only 20% of TB racehorses will compete three or more races after injury.[9] In a separate study of TB horses treated without surgery, 52% returned to racing, but 48% had recurrent tendinitis.[10]

In the STB racehorse, results after SCD are clearly superior to those achieved in the TB racehorse and to published results in horses receiving conservative management. In our study, 35 of 38 horses raced after surgery (92%) and 33 horses (87%) started more than five races, but tendinitis recurred in six horses.[11] Using a strict definition of success, 71% of horses started five or more times after surgery, without recurrence of tendinitis. This type of retrospective study requires accurate follow-up conversations with trainers and referring veterinarians to

obtain detailed information about limb condition and evaluation of race records. Median earnings per start decreased significantly and mean time from surgery to first start was 237 days.[11] Suspensory desmitis developed in five horses, all of which had bilateral SCD.[11] Suspensory desmitis may be related to an increased load on the suspensory apparatus after SCD, or it may be unrelated to the surgical procedure. However, this experience has led the author to modify recommendations in horses with a history of suspensory desmitis in unaffected, contralateral limbs. In a similar study, 82% of STB horses raced after SCD, and 69% competed in five or more starts.[12] In that study, horses that raced before injury had a better prognosis.[12] Published results of conservative management in STB racehorses are scant, but in one study including STB with other performance horses, it was estimated that over 50% were able to successfully return to racing or a previous level of competition, but recurrences were common and horses were often racing in a lower racing class.[13] In a retrospective study, 31 of 41 (75%) STB racehorses completed two races and started a third, but tendinitis recurred in 43% of these horses.[4,a] In summary, SCD is clearly beneficial in the STB racehorse. Anecdotal information not included in published reports, including high-class racehorses returning to upper levels of competition (racing times in the range of 1:50–1:52) after SCD when recurrent tendinitis precluded racing before surgery, or horses unable to sustain training speeds less than 2:10 before surgery, supports the value of this technique in STB racehorse. Horses that race before surgery have a better prognosis, and results may be better in pacers than in trotters.

Results of SCD in other types of sport horses have not been published, but it is this author's impression that hunters, jumpers, event, and dressage horses have a prognosis somewhere between that published for the TB and STB racehorses. In a study of 33 horses in which 22 were non-racehorses, tendon splitting under ultrasound guidance combined in some horses with SCD resulted in a 68% return to the previous level of competition.[14]

The results of these studies are difficult to compare to earlier studies that evaluated conservative management for several reasons. There are differences in lesion severity, quality of racehorse, and exercise protocols, and in papers describing surgical management other techniques such as tendon splitting, annular desmotomy, or injections were performed. What is needed is a comprehensive study randomly assigning horses to treatment groups, while controlling for these factors as well as age, sex, breed, and time to first start or competition.

A. Surgical Procedure

The details of the surgical procedure have been well outlined since Bramlage's first description of the technique. The modification of the original description (used for the treatment of flexor deformities), use of a transthecal approach through the flexor carpi radialis tendon sheath, allows the surgeon to close the incision in three layers, providing a much more secure closure.[5] This modification also moves the incision through the ligament caudally, where it is well defined. The surgical procedure is performed by using a medial approach, with the horse in lateral recumbency without tourniquet application. The horse is then repositioned in the opposite recumbency if the surgery is to be performed bilaterally. The initial incision is made directly over or just cranial to the cephalic vein, and the vein is carefully dissected from the underlying antebrachial fascia and retracted caudally. The cranial approach to the vein is less vascular than the caudal approach, and in most horses the vein penetrating the antebrachial fascia is clamped and ligated. It is important to sever the superior check ligament *completely* because incomplete division does not allow immediate transfer of load to the muscle and intuitively would promote faster healing of the structure after surgery. In order to sever the ligament completely, it is often necessary to carefully dissect the proximal fibers of the ligament from the nutrient artery and vein; in some horses, these structures are either inadvertently cut or division is necessary. Division of the vessels causes no known clinical problem. Often the proximal aspect of the carpal canal is penetrated, because the superior check ligament is attached to this structure distally. A small portion of the palmar carpal retinaculum is also incised at the distal aspect of the incision, a procedure that is often accompanied by marked relaxation or release of the SDFT.

B. How Does SCD Work?

Originally, SCD was thought to reduce tendon strain, thereby reducing the risk of recurrence of tendinitis. If a gap remained in the check ligament after surgery, it was reasonable to propose that the load normally placed on the check ligament (bone-ligament–tendon-bone axis) would then be transferred to the superficial flexor muscle (muscle–tendon-bone). The muscle, rather than the healed and relatively inelastic tendon, would stretch and therefore the healed tendon would be protected. Experimental evidence in cadaver specimens suggests that following SCD, load is immediately transferred to the muscle, but tendon strain increases because of a decrease in the metacarpophalangeal joint angle (hyperextension).[13] It has been proposed that the superior check ligament likely heals after transection, but in an elongated fashion, allowing increased length of the bone-ligament–tendon-bone axis rather than a replacement of this load-bearing axis with muscle.[12] This, in theory, would increase the elastic limit of the damaged tendon and negate the intrinsic loss of elasticity found in healed but scarred tendon.[12]

C. When Should SCD Be Performed?

The author began to perform SCD with the idea that the procedure was useful in protecting the healed tendon and preventing recurrence of tendinitis based on the early work of Bramlage. Initially, no effort was made to encourage clients to consider surgery early after injury. However, it is this author's current recommendation that the procedure should be done as early as possible after injury. Obvious visible reduction in tendon size occurs early after surgery, within the first 5–10 days, indicating that the procedure might be useful in reducing early swelling and inflammation in the tendon. Neither confirmed improvement in healing nor convincing ultrasonographic evidence of reduced core lesion or tendon size can be presented to substantiate this clinical impression, but it is the author's belief that complete division of the ligament decompresses or releases the damaged tendon, promoting early resolution of inflammation. In some horses, immediate reduction in tendon size may result from mechanical factors such as a reduction in load and tension or may alter vascular supply to the tendon. Critics of the procedure question if the surgery can produce an obvious biomechanical change in the limb. In some horses a noticeable back-at-the-knee conformation will be apparent immediately after surgery. Reduction in tendon size and peritendinous tissue is most noticeable when SCD is combined with annular desmotomy. Adjunct treatments such as full limb bandaging, nonsteroidal anti-inflammatory drugs, and stall rest may also play a role.

D. Which Horses Should Have SCD?

The author is unaware of published guidelines specifying which horses should undergo SCD. Racehorses with mild diffuse tendinitis or those with core lesions involving $\leq$10% of the cross-sectional area of the tendon will likely heal with conservative management and are generally not surgical candidates. Horses with recurrent diffuse tendinitis, severe diffuse tendinitis, and core lesions involving $\geq$10–15% of the cross-sectional area of the tendon *are* surgical candidates. In other sport horses, SCD is recommended in the affected limb in upper-level performance horses that follow similar guidelines as racehorses, but in lower level horses, conservative management of more severe injuries is often successful.

E. Should SCD Be Done Bilaterally?

Early results of unilateral SCD in TB racehorses were complicated by the development of contralateral tendinitis when horses returned to racing. In both TB and STB racehorses, bilateral tendinitis is not uncommon. These facts, and ultrasonographic evidence of mild contralateral tendinitis in STB racehorses, led the author to recommend the procedure bilaterally in racehorses. Several factors, including the horse's age, existence of concomitant suspensory desmitis in the contralateral limb, gait in STB racehorses, performance type, and etiology of tendinitis have led to the following recommendations.

Bilateral SCD is recommended in horses with bilateral tendinitis, young 2- or 3-year-old TB or STB racehorses with unilateral tendinitis in which the contralateral limb is operated prophylactically, or in horses with subtle ultrasonographic evidence of contralateral tendinitis. If there is clinical evidence of pain on palpation of the opposite limb, ultrasonographic evaluation should proceed. Unilateral SCD (the surgical procedure performed in the affected limb only) is recommended in show horses, in young racehorses, particularly STB racehorses with suspensory desmitis in the contralateral limb, or in horses with tendinitis caused by direct trauma (tendinitis is unlikely to occur in the contralateral limb) such as a bandage bow. In older STB racehorses, the author will recommend the contralateral prophylactic procedure to be performed in pacers, but usually not in trotters.

F. Aftercare

Horses are given 2 weeks of absolute stall confinement, followed by 4 weeks of stall rest with handwalking for 10–15 min, twice daily. Therafter, a pro gressive handwalking program, swimming physiotherapy program, or walking in the jog cart (STB racehorses) is recommended for an additional 6 weeks. Follow-up ultrasound examinations are done at 6 and 12 weeks after surgery. Horses are usually then placed into a jogging program for 4 weeks and then into regular training. Time to first start in STB racehorses is approximately 8 months after surgery, assuming the surgery was done soon after injury. Turn-out is not recommended in the first 3 months because exercise is uncontrolled and recurrence of tendinitis is possible.

Large, full-limb support bandages are very important in limiting motion and swelling at the surgical site and maintaining support of the affected limb(s). An inner lighter wrap is augmented by a full-limb heavy padded bandage for a minimum of 2 weeks. It is common to have mild swelling and seroma formation at the surgical site, because dead space deep to the cephalic vein is impossible to minimize, and the region is highly vascular.

Concomitant use of polysulfated glycosaminoglycans or hyaluronate and SCD remains controversial, and clear beneficial effects have yet to be documented. Theoretical beneficial effects of both medications can be made, based on improvement in wound healing, enhancement of repair tissue maturation, adhesion reduction, inhibition of lysosomal enzymes, and a reduction in the inflammatory process.[15] Dramatic reduction in tendon size and improvement in ultrasonographic appearance occur when these substances, usually combined with methylprednisolone acetate, are injected in the *peritendinous* region. The effect likely results from the corticosteroid injection, but this treatment in combi-

nation with SCD has been quite effective in several STB racehorses. Currently, the author recommends 8 weekly intramuscular injections of polysulfated glycosaminoglycans after surgery. The oral administration of chondroitin sulfate and glucosamine or other products has yet to be shown to be beneficial. Phenylbutazone is recommended at a dose of 4.4 mg/kg, IV or PO, twice daily for a minimum of 10–14 days after surgery, and it appears to be useful in reducing edema and pain at the surgical site and the original tendon injury.

3. Annular Desmotomy

In the recent veterinary literature, much attention has been given to SCD and tendon splitting as adjunct surgical treatments for tendinitis, but there is little mention of annular desmotomy (AD). This procedure remains a most useful surgical treatment, usually combined with SCD, to manage distal tendinitis of the SDFT. There are two distinct clinical situations in which AD is recommended. The most important and most successful is adjunct use of AD in horses with tendinitis of the SDFT (discussed below). The second and less successful is use of the procedure in horses with chronic tenosynovitis without tendinitis of the SDFT or in horses with tendinitis of the deep digital flexor tendon.

The annular ligament is usually a passenger in the disease process that results in annular constriction of the SDFT. As the SDFT enlarges, the gliding function of the tendon is impeded by the annular ligament. Further tendon enlargement and inflammation may cause thickening of the annular ligament, but the primary disease process involves the SDFT, not the ligament. The annular ligament often becomes thickened and adhered to the underlying tendon sheath and SDFT. Once SDFT function is impeded by the annular ligament, lameness, continued swelling, and inflammation occur that can exacerbate the original lameness.

Annular desmotomy is usually combined with SCD but can be a career-saving procedure in racehorses of lower class, done as an independent surgical procedure. Based on clinical evaluation, if the function of the SDFT appears to be impeded by the annular ligament, the structure is severed. In most horses, ultrasonographic evaluation will show tendinitis, without evidence of desmitis, or mild ligament enlargement. Severing the annular ligament provides immediate decompression of the injured tendon in the early period after surgery. Improving gliding function of the SDFT is an important time-honored surgical principle. A substantial reduction in tendon size is usually seen within the first 5–10 days after surgery. The ligament likely reforms after surgery, but marked reduction in tendon size averts continued interruption in gliding function. It is not known if the surgical procedure induces adhesion formation in the sheath, but clinical experience suggests that the benefits outweigh the risks of adhesions. Care must be taken to avoid injury to the medial aspect of the SDFT when the initial incision is made.

In the surgical procedure, a 1.5-cm stab incision is made just proximal to the annular ligament through skin, subcutaneous tissues, and digital sheath, and a curved bistoury[b] is inserted deep to the annular ligament (superficial to the SDFT). The annular ligament is incised. Occasionally it is necessary to reverse the bistoury and incise in a proximal direction if adhesions are present, or if there is extensive thickening of the tendon sheath. Care should be taken to incise the distal aspect of the ligament completely. The small incision is then closed by using subcutaneous and skin sutures. Occasionally, a larger incision is necessary in horses with severe and chronic tendinitis, in which the annular ligament is enlarged and adhered to the SDFT. The procedure is usually done in conjunction with SCD and therefore the surgical incision is usually located medial in the limb.

Tenoscopic evaluation and transection has been elegantly described and is a novel visually pleasing surgical procedure, but in our hospital it is expensive and time consuming to perform.[16] The procedure as described above can be completed in less than 10 min of surgery time and involves little additional equipment. The evaluation of tendon sheaths by using the arthroscope has been useful to the author in documenting adhesions, retrieving foreign material, evaluating unusual bony projections, or as an adjunct procedure in infectious tenosynovitis, but it is not routinely used for AD.

4. Tendon Splitting

There has been renewed interest in the use of tendon splitting as an adjunct surgical procedure in the management of tendinitis of the SDFT. The procedure was developed to promote vascularization of the tendon in horses with chronic tendinitis, and early use of the technique showed promise.[17] Subsequent experimental studies questioned the value of tendon splitting and in fact concluded that splitting induced excessive granulation tissue and slow healing of areas of tendon necrosis.[18,19] The use of this technique fell out of favor for a number of years, but interest was sparked by reports of combined use of the technique with SCD in a clinical study and improved healing and revascularization of collagenase-induced tendon injuries in an experimental study.[20,21] The author questions the relevance of this model to the naturally occurring disease, however. Various other authors have reported clinical use of this technique in conjunction with other surgical techniques, but clinical studies detailing results of this technique alone are lacking.[7,11,12,14] In our study, only 1 of 40 horses underwent tendon splitting with SCD.[11] The technique is generally used in clinical practice in horses with core lesions, early in the disease process, rather than in horses with chronic tendinitis, the group of horses for which the technique was originally designed. The ratio-

nale given for use in early lesions is to decompress the area of hemorrhage and to provide vascular access channels to improve vascularization by vessel ingrowth. Soon after injury, areas of hemorrhage noted ultrasonographically as anechoic areas become filled with granulation tissue, which appears hypoechoic.[4] Therefore, unless the surgical procedure is performed before granulation tissue develops (3–5 days in most tissues) or certainly within 2 weeks of the original injury, or in those horses with *anechoic* core lesions, the effect of decompression would be minimized. The additional damage caused to the surrounding intact tendon fibers and to the peritendinous tissue must be considered and likely outweighs beneficial effects.

The procedure has certainly been done in clinical practice with success (or without detrimental effects), which puts in perspective the theoretical potential dangers of the procedure. The rationale, however, of using tendon splitting remains unclear and the conflicting experimental evidence leads one to question its use. In clinical practice, the author has used the procedure when requested by referring veterinarians or in TB racehorses with anechoic core lesions. The preferred procedure used is the percutaneous procedure as originally described, using a double-edged tenotome or a #11 scalpel blade. The procedure is seldom used in STB racehorses managed with SCD alone or combined with AD. The author's current recommendation is that the procedure should be used only in horses with anechoic lesions of the SDFT early after injury, and in conjunction with SCD.

References and Footnotes

1. Goodship AE, Birch HL, Wilson AM. The pathobiology and repair of tendon and ligament injury. *Vet Clin North Am Equine Pract* 1994;10:323–349.
2. Kraus-Hansen AE, Fackelman GE, Becker C, et al. Preliminary studies on the vascular anatomy of the equine superficial digital flexor tendon. *Equine Vet J* 1992;24:46–51.
3. Genovese RL. Sonographic response to intralesional therapy with beta-aminoproprionitrile fumarate for clinical tendon injuries in horses, in *Proceedings.* 38th Annu Conv Am Assoc Equine Practnr 1992;265–272.
4. Reef VB, Martin BB, Stebbins K. Comparison of ultrasonographic, gross, and histologic appearance of tendon injuries in performance horses, in *Proceedings.* 35th Annu Conv Am Assoc Equine Practnr 1989;279.
5. Bramlage LR. Superior check ligament desmotomy as a treatment for superficial digital flexor tendinitis: initial report, in *Proceedings.* 32nd Annu Conv Am Assoc Equine Practnr 1986;365–370.
6. Bramlage LR, Rantanen NW, Genovese RL, et al. Long-term effects of surgical treatment of superficial digital flexor tendinitis by superior check desmotomy, in *Proceedings.* 34th Annu Conv Am Assoc Equine Practnr 1988;655–656.
7. Bramlage LR, Hogan P. Career results of 137 Thoroughbred racehorses that have undergone superior check ligament desmotomy for treatment of tendinitis, in *Proceedings.* 42nd Annu Conv Am Assoc Equine Practnr 1996;162–163.
8. Ordidge RM. Comparison of three methods of treating superficial digital flexor tendinitis in the racing Thoroughbred by transection of its accessory ligament alone (proximal check ligament desmotomy) or in combination with either intralesional injections of hyaluronidase or tendon splitting, in *Proceedings.* 42nd Annu Conv Am Assoc Equine Practnr 1996;164–167.
9. Wheat JD. New aspects on the pathology of tendon injury, in *Proceedings.* 8th Annu Conv Am Assoc Equine Practnr 1962;27–31.
10. Rooney JR, Genovese RL. A survey and analysis of bowed tendons in Thoroughbred racehorses. *Equine Vet Sci* 1981;1: 49–53.
11. Hawkins JF, Ross MW. Transection of the accessory ligament of the superficial digital flexor muscle for the treatment of superficial digital flexor tendinitis in Standardbreds: 40 cases (1988–1992). *J Am Vet Med Assoc* 1995;206:674–678.
12. Hogan PM, Bramlage LR. Transection of the accessory ligament of the superficial digital flexor tendon for treatment of tendinitis: long term results in 61 Standardbred racehorses (1985–1992). *Equine Vet J* 1995;27:221–226.
13. Shoemaker RS, Bertone AL, Mohammad LN, et al. Desmotomy of the accessory ligament of the superficial digital flexor muscle in equine cadaver limbs. *Vet Surg* 1991;4:245–252.
14. Allen AK. Experience with ultrasound-guided tendon puncture or splitting, in *Proceedings.* 38th Annu Conv Am Assoc Equine Practnr 1992;273–277.
15. Henninger R. Treatment of superficial digital flexor tendinitis. *Vet Clin North Am [Equine Pract]* 1994;10:409–424.
16. Nixon AJ, Sams AE, Ducharme NG. Endoscopically assisted annular ligament release in horses. *Vet Surg* 1993;22: 501–507.
17. Asheim A. Surgical treatment of tendon injuries in the horse. *J Am Vet Med Assoc* 1964;145:447–451.
18. Stromberg B, Tufvesson G, Nilsson G. Effect of surgical splitting on vascular reactions in the superficial flexor tendon of the horse. *J Am Vet Med Assoc* 1974;164:57–60.
19. Silver IA, Brown PN, Goodship AE, et al. A clinical and experimental study of tendon injury, healing and treatment in the horse. *Equine Vet J* 1983;1(suppl):5–32.
20. Henninger R, Bramlage L, Schneider R. Short-term effects of superior check ligament desmotomy and percutaneous tendon splitting as a treatment for acute tendinitis, in *Proceedings.* 36th Annu Conv Am Assoc Equine Practnr 1990;539–540.
21. Henninger RW, Bramlage LR, Bailey M, et al. Effects of tendon splitting on experimentally induced acute equine tendinitis. *Vet Comp Orthop Trauma* 1992;5:1–9.

[a]Reef VB. University of Pennsylvania, Kennett Square, PA 19348 (personal communication), 1988.

[b]Sontec Instruments, Inc., Englewood, CO 80112.