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Tenosynovitis of the digital flexor tendon sheath and annular ligament constriction syndrome caused by longitudinal tears in the deep digital flexor tendon: a clinical and surgical report of 17 cases in Warmblood horses

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Keywords: horse; tenosynovitis; PAL constriction; longitudinal tear; digital flexor tendon; tenoscopy

Summary

Reasons for performing study: **Inflammation of the digital flexor tendon sheaths is a chronic and nebulous condition often unresponsive to medical and surgical treatment.**

Objectives: **To evaluate the incidence of longitudinal tears (LT) as the underlying cause of chronic tenosynovitis and annular ligament constriction syndrome (ALCS) in warmblood horses.**

Methods: **The records of 25 horses with chronic tenosynovitis and ALCS in which tenoscopical inspection of the digital flexor tendon sheath (DFTS) was performed between 1999–2000 were reviewed. Of 25 horses, 17 were diagnosed with an LT in the deep digital flexor tendon (DDFT). All horses had a history of distension of the DFTS and/or signs of an ALCS. All cases presented typical signs of a chronic inflamed DFTS on ultrasonography and 11 horses showed ultrasonographic changes (echogenic material or an irregular outlining) at the lateral or medial border of the DDFT. The diagnosis of LTs of the DDFT was established in all cases by tenoscopy. Surgical treatment consisted of removal of the torn collagen fibrils using a mechanical resector and decompressing the fetlock canal by a transection of the palmar annular ligament (PAL) using a hook knife under tenoscopic control.**

Results: **Ten horses became sound and resumed their previous level of work, 3 horses remained lame, 4 horses returned to previous level of work but needed intrasynovial treatment of the DFTS and reduced competition frequency to remain sound.**

Conclusions: **Horses presented with chronic inflamed DFTS and/or ALCS might suffer from LTs in the DDFT; however, the diagnosis cannot be established with absolute certainty using only ultrasonography. Longitudinal tears should be suspected if ultrasonographic changes are present lateral or medial to the border of the DDFT but tenoscopical examination of the tendon sheath is essential to establish an accurate diagnosis and an effective treatment.**

Potential relevance: **The presence of these LTs might explain why some cases of chronic tenosynovitis of the digital flexor tendon sheath and/or ALCS do not respond on surgical transection of the PAL alone without tenoscopy.**

Introduction

The digital flexor tendon sheath (DFTS) surrounds the superficial (SDFT) and deep digital flexor tendon (DDFT) palmar or plantar to the fetlock joint. The DFTS begins 4 to 7 cm proximal to the proximal sesamoid bones and extends distally to the middle third of the second phalanx. At this level a thin wall separates the DFTS from the proximal recess of the podotrochlear bursa and the proximopalmar recess of the distal interphalangeal joint (Denoix 1994). The DFTS is surrounded by the palmar/plantar annular ligament (PAL) and the proximal and distal digital annular ligament. The PAL attaches on the palmar/plantar aspect of the sesamoid bones and creates an inelastic canal between the sesamoid bones, intersesamoidean ligament and the PAL itself. The proximal digital annular ligament is a thinner quadrilateral sheet located over the palmar/plantar aspect of the proximal phalanx. This ligament is mostly adherent to and, in sound limbs, very difficult to differentiate from the DFTS. The distal digital annular ligament is located further distally in the pastern and is adherent to the palmar/plantar surface of the distal part of the DFTS (Denoix 1994). Just proximal to the proximal sesamoid bones the SDFT encircles the DDFT. This ring is called the *manica flexoria* (MF). The distal aspect of the MF is located underneath the PAL (H. Wilderjans, personal data). Proximal to the MF the DDFT is attached to the DFTS by a medial and lateral band, called the mesotendon. It can easily be recognised on a transverse ultrasound image especially if the tendon sheath is distended (Dik *et al.* 1995). On the palmar aspect of the fetlock, the SDFT is also attached sagittally with a mesotendon to the DFTS (Dik *et al.* 1995; Nixon 1990). This band can be visualised clearly on an ultrasound image of a distended DFTS when there is no important constriction of the PAL (H. Wilderjans, personal data).

Lameness associated with either a distension of the DFTS and/or constriction of the PAL has been attributed to many causes. For example, direct trauma with overstretching or compression of the DFTS (Stashak 1987), superficial flexor tendonitis (McIlwraith 1987), deep digital flexor tendonitis (Barr *et al.* 1995), desmitis of the PAL (Dik *et al.* 1991), chronic synovitis of the digital flexor tendon sheath of unknown origin (Gerring and

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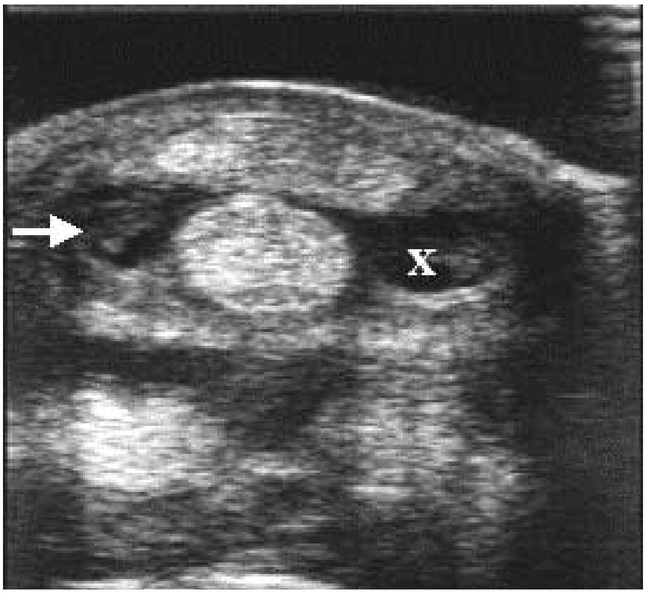

Fig 1: Transverse ultrasonograph of the proximal part of a chronic inflamed digital flexor tendon sheath (DFTS). There is echogenic material (arrow) lateral to the deep digital flexor tendon (DDFT) and increased fluid (X) within the DFTS associated with a longitudinal tear in the lateral edge of the DDFT.

Webbon 1984), infectious tenosynovitis (Bertone 1995) and, more recently, longitudinal tears (LT) of the digital flexor tendons (Wright and McMahon 1999). Wright and McMahon (1999) were the first to describe longitudinal tears (LTs) as an underlying cause of tenosynovitis of the DFTS in 20 horses. They suggested diagnosis and treatment by tenoscopy in 9 cases and treatment by an open surgical approach in the remaining cases. This paper describes another 17 cases where tenosynovitis of the DFTS was caused by LTs in the DDFT. The purpose is to report on the diagnosis, surgical technique and results after treatment of LTs of the DDFT using a tenoscopical approach.

Materials and methods

Cases

Seventeen of the 25 horses with lameness originating from the DFTS, in which diagnostic tenoscopy was performed, demonstrated LTs as the underlying cause. The case histories of those 17 horses were reviewed. These included 11 mares, 4 geldings and 2 stallions, age 5–13 years, mean 8.3 years, showjumpers, 3 dressage horses and 3 eventers.

Duration of lameness varied from 1 month to 24 months. All horses where treated with several weeks of rest and systemic nonsteroidal anti-inflammatory drugs, 2 with local rubefacients and 7 with intrasynovial injections with corticosteroids. All the horses had a history of visible distension of the DFTS and some degree of lameness. Clinical signs improved with rest and/or local or systemic treatment but re-appeared when resuming work.

Diagnostic approach

Clinical signs: Fourteen horses were presented with a fluctuating distension of the DFTS. The swelling was most noticeable proximal to the PAL and distally at the palmar/plantar aspect of the pastern distal to the proximal digital annular ligament. Nine horses presented with typical ‘notching’ at the palmar/plantar aspect of the fetlock. Two horses had a firm and palpably thickened tendon sheath without an obvious fluctuating effusion. One horse, box-rested for several weeks before presentation, had no swelling at the time of examination but had a history of obvious effusion of the tendon sheath. The front limb was affected in 16 horses (11 right front, 5 left front), in one horse the left hindlimb was affected. Fourteen of the 17 horses were still lame at the time of presentation. All horses had a positive flexion test of the fetlock joint. Intrathecal anaesthesia was performed only in those horses without obvious effusion of the tendon sheath and lameness improved in all those cases.

Radiography: A lateromedial view of the fetlock was taken in 7 of 17 cases and no radiological abnormalities were seen.

Ultrasonography: Ultrasonography was performed on all cases using a 7.5 MHz linear transducer with detachable standoff (Toshiba Sonolayer SSH-140A)[1].

Fluid distension was visible in 16 horses. A thickened tendon sheath wall was present in 15 horses. Thickening of the PAL and soft tissue between PAL and skin was visible in 10 cases. In all cases with obvious distension of the DFTS the mesotendon was clearly visible as a thick echogenic line connecting the DDFT with the lateral and medial wall of the tendon sheath.

Eleven horses showed ultrasonographic changes at the lateral border of the DDFT, in 5 of these changes consisted in the

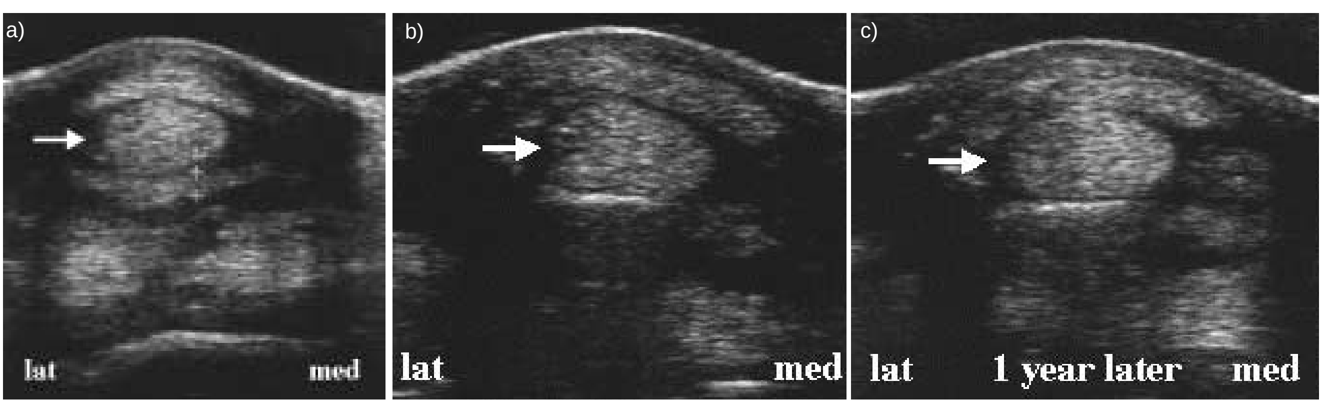

Fig 2: Transverse ultrasonographs of the proximal part of a chronic inflamed digital flexor tendon sheath (DFTS). There is (a) moderate and (b) severe irregular outlining of the lateral border of the deep digital flexor tendon (DDFT) associated with a longitudinal tear in the lateral edge of the DDFT. c) Ultrasound image 12 months after surgery of the same horse as in Figure 2b. The lateral edge of the DDFT is still slightly irregular.

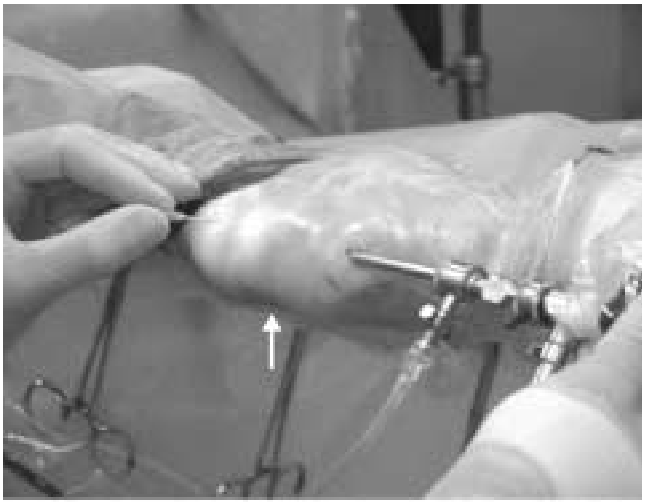

Fig 3: Tenoscopical approach of the lateral aspect of the digital flexor tendon sheath. The arthroscope is inserted just distal to the palmar annular ligament (PAL). A needle is used to locate the ideal position of the instrument portal. The constriction of the PAL is clearly visible (arrow).

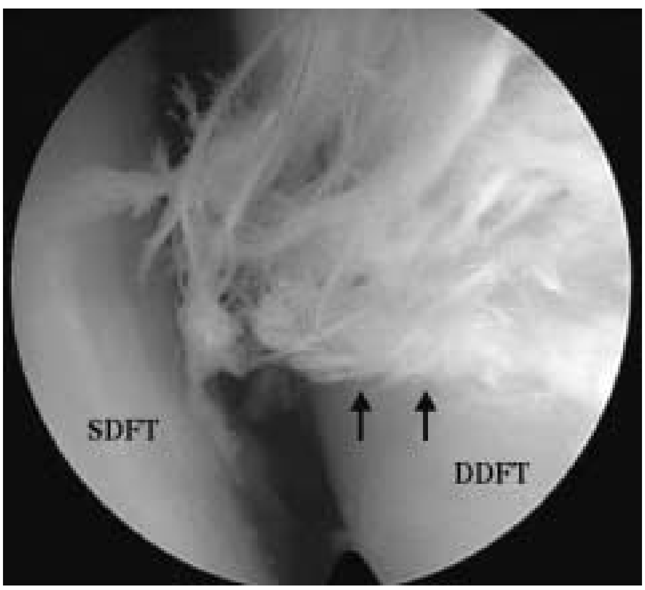

Fig 4: Tenoscopic view of the digital flexor tendon sheath looking between the deep (DDFT) and the superficial flexor tendon (SDFT) at the level of the manica flexoria*. There is a longitudinal tear present in the lateral edge of the DDFT. The largest mass of protruding tendon fibres (arrows) is often found in this area.*

presence of echogenic material in the tendon sheath lateral to the DDFT (Fig 1). In the 6 other horses there was an irregular outlining of the lateral border of the DDFT (Fig 2).

In the 7 horses where no LT where found on tenoscopical examination, ultrasonographic changes consisted of thickened tendon sheath wall, fluid distension and thickening of the PAL and soft tissue between PAL and the skin.

Surgery

Under general anaesthesia, horses were placed in lateral recumbency with the affected site of the limb placed uppermost. Tenoscopy was performed with a 4 mm 25° forward oblique arthroscope[2] with the limb in extension. The technique for tenoscopy of the digital flexor tendon sheath and desmotomy of the PAL as described by Nixon (1990 and 1993) was modified slightly for treatment. The tendon sheath was distended to facilitate entrance of the arthroscopic sleeve using a blunt trocar. The arthroscope was inserted just below the PAL almost halfway between the digital neurovascular bundle and ergot (Fig 3). The lateral or medial entrance portal were positioned lateral or medial to the respective edge of the SDFT. This position allowed both easy passage between the SDFT and the PAL and between SDFT and DDFT. A complete inspection of the tendon sheath and it’s contents was performed.

In all cases a desmotomy of the PAL was performed using a hook knife[3]. This procedure created more space within the fetlock canal especially in those cases with a clearly visible notching over the palmar/plantar aspect of the fetlock. The instrument portal was made 5 to 10 mm proximal to the PAL almost lateral to the SDFT (Fig 3). The PAL was easily transected in a distoproximal direction. Complete division of the PAL often resulted in an important separation of both edges of the cut ligament. Because the most distal part of the PAL was located close to the arthroscope portal, switching portals was recommended to check for complete division of the most distal aspect of the PAL. This also allowed better visualisation of the most distal part of the digital flexor tendon sheath.

Once the PAL was completely transected a hook probe was introduced through the same instrument portal to palpate the flexor tendons. The LTs themselves were not easy recognised by only viewing the tendons. Palpation of the flexor tendons was necessary to appreciate the full depth and extend of the LTs (Fig 5b). In all cases, torn tendon fibrils protruding from the edge of the DDFT indicated the presence of an LT. In 15 horses, the largest mass of protruding collagen fibrils was present within the MF with often long floating tendon fibrils visible between the DDFT and SDFT (Fig 4). Palpating the edge of the DDFT within the MF using the ‘desmotomy’ instrument portal was only possible if a small stab incision was made through the MF. The instrument portal used to perform a desmotomy of the PAL was located just proximal to the PAL and, at this level, the MF still surrounds the DDFT. This precluded visualisation and free passage of instruments to the lateral edge of the DDFT at this level. In most of the cases, a third instrument portal was made after performing the desmotomy of the PAL. This portal was located as proximal as possible in the tendon sheath between the deep and superficial flexor tendon. This portal allowed full access to the LT not only within but also distal to the MF (Fig 5). The MF was never cut to gain access to the most proximal part of the tear.

In 14 cases the lateral edge of the DDFT was affected, in 2 cases the medial edge and in one case both were affected. In 16 cases, the LT extended from very proximal within the MF to halfway the pastern (Fig 6). In the remaining case, the tear started from just distal to the MF to halfway the pastern. In 14 cases, the tear was classified as superficial (<5 mm) in 3 cases as deep (>5 mm). Synovio-synovial adhesions were present in 5 of 17 cases. Other less common findings were free floating collagen fibrils, fibrin clots, hypertrophic synovium, rough or fibrillated palmar/plantar surface of the SDFT or intersesamoidean ligament. In all cases, the torn fibrils were resected using a motorised synovial resector (Dyonics)[4]. Fibrous synovio-synovial adhesions were cut and removed when present. No adhesions were found between the flexor tendons and the synovial wall. Skin portals were closed with single interrupted vertical mattress suture of 3 metric polydioxanone (PDS)[5]. A padded bandage was applied to the lower limb.

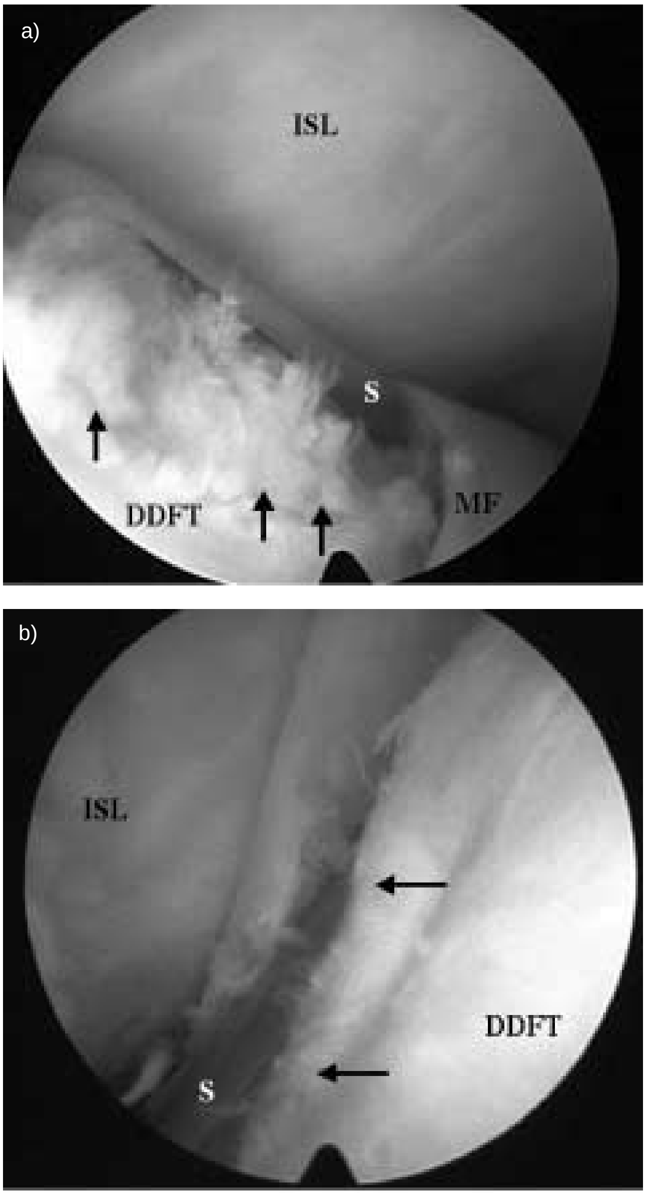

Fig 5: (a) Tenoscopic view of a longitudinal tear (LT, arrows) in the lateral edge of the deep digital flexor tendon (DDFT) within the tendon sheath. The instrument portal should allow full access to the LT not only within but also distal to the manica flexoria *(MF). (b) Palpation of the LT (arrow) is necessary to appreciate its full depth and extend. ISL = intersesamoidean ligament. S = resector blade.*

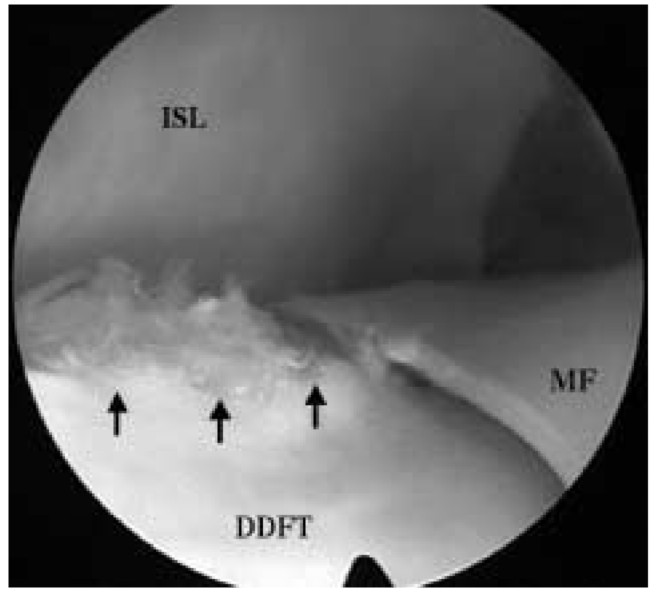

Fig 6: Tenoscopic view of a longitudinal tear (LT, arrows) in the lateral edge of the deep digital flexor tendon (DDFT). In most cases the LT starts from halfway the pastern, continues underneath the manica flexoria *(MF) and ends very proximal within the tendon sheath. ISL = intersesamoidean ligament.*

Drug therapy

All horses received preoperative procaine penicillin G (22.000 iu/kg bwt i.m., b.i.d.)[6] and phenylbutazone (2.2 mg/kg bwt i.v, s.i.d.)[7]. This treatment was continued post operatively for 3 days.

Post operative care

The bandage was changed 4 days after surgery, maintained for 2 weeks post operatively and changed every 4–6 days. Skin sutures were removed 2 weeks after surgery. Horses were box rested for the first 3 months after surgery but a controlled ascending walking exercise programme was started 10 days after surgery. Ridden walking exercise was allowed 4 weeks after surgery. Walking-time was gradually increased from 15 min to 45–60 min/day. At the end of this period, owners were asked to present their horse for clinical and ultrasonographical re-evaluation. Horses which were sound received 3 months walking, trot and light canter work for the next 3 months. After this period the horses were re-evaluated and, if sound, they gradually returned to normal work. Owners were asked not to resume the normal work level until 8 months post surgery.

Results

Eleven horses were presented for re-examination at 3 and 6 months post operatively. In 6 horses re-examination was performed by the referring veterinary surgeon and the information obtained by telephone.

One horse improved but remained lame at 3 and 6 months post surgery. Two horses where still lame at 3 months but sound at 6 months after surgery. Two horses were initially sound but lameness recurred on return to work.

After 12–24 months, 10 horses (58.8%) were sound and resumed their intended level of work. Of the remainder, 3 horses (17,7%) were variably lame and 4 (23.5%) were sound and returned to the previous level of competition but at reduced frequency and with intrathecal hyaluronan and corticosteroid treatment.

Only one horse showed no improvement in tendon sheath distension after surgery, remaining sound. This effusion was also refractory to intrathecal treatment with hyaluronan and corticosteroids. The other patients had reduced distension of the DFTS but none of the limbs returned to normal shape.

On ultrasound examination all cases which had a thickened tendon sheath wall, PAL or soft tissue between PAL and skin reduced in size but never returned to normal thickness. Thickened mesotendons reduced to normal or almost normal size in all horses. The presence of echogenic material in the tendon sheath lateral to the DDFT disappeared in all the 5 horses.

Of the 4 horses re-examined, which had displayed an irregular outlining of the lateral border of the DDFT, only one remained irregular (Fig 2c) and all 4 remained sound at work. The 3 horses that remained lame included one showjumper, one dressage horse and one eventing horse.

Discussion

A previous study (Barr *et al.* 1995) described 24 cases of tenosynovitis of the DFTS associated with deep digital flexor tendonitis. Ultrasonography revealed small focal hypoechogenic areas within the DDFT. In 6 of the 24 horses echogenic material was visible adjacent to the DDFT. Eight of the 24 horses were treated surgically by performing a PAL desmotomy. Of those only 2 made a full recovery. Although these authors used an open technique as described by Gerring and Webbon (1984), with an 8 cm incision through skin and subcutaneous tissue, no LTs were noticed. The position of the MF surrounding the DDFT proximal in the surgical wound and the absence of fluid distension may preclude diagnosing torn fibrils protruding from the edge of the DDFT. Wright and McMahon (1999) were the first to report LTs in the DDFT as a cause of tenosynovitis of the DFTS. Tenoscopical examination of the tendon sheath was essential to establish a definitive diagnosis.

In this series, 25 Warmblood horses with chronic tenosynovitis and ALCS were examined tenoscopically. Seventeen (68%) were diagnosed with LTs in the DDFT. Lesions were seen predominantly in the front limbs of middle aged horse. In 16 cases (94%), the forelimb was affected, in contrast to only 65% (Wright and McMahon 1999) in a similar aged survey.

The reason why predominantly only forelimbs were affected in this series may be coincidental. In this report, all the horses were Warmbloods and most were showjumpers (65%). The numbers of cases are too small to draw statistical conclusions.

Ultrasonography findings in our case series suggest that LTs can be suspected as the underlying cause of chronic tenosynovitis and annular ligament constriction. In many cases, ultrasonography confirms the changes generally seen in a chronic inflamed DFTS but the primary pathological factor often remains unclear. Thickening of the tendon sheath wall, increased synovial fluid, thickening of the PAL or the soft tissue palmar to the PAL were all common findings in our cases. Mesotendon thickening of the DDFT was also a common but a nonspecific finding in chronically inflamed DFTS. The most consistent ultrasound finding (65%) was that of changes at the lateral border of the DDFT. These changes were best visible just proximal to the proximal border of the PAL. At this level the DDFT is still surrounded by the MF. Most of the severe injuries to the DDFT seen at surgery were at this level. Six horses showed an irregular outlining of the lateral edge of the DDFT and, in 5 horses, echogenic material was present at this level. Several other studies noted these irregularities (Barr *et al*. 1995; Dyson and Dik 1995) and the former suggested adhesion formation as a possible explanation for this echogenic material. All the horses in our study, with echogenic material lateral to and/or irregular outlining of the border of the DDFT, demonstrated LTs during tenoscopy. When performing PAL desmotomy, through a stab incision or even through a larger open approach, the MF would mask any LT of the DDFT.

Therefore, if the above described changes are visualised on ultrasonography, tenoscopical inspection of the tendon sheath should be recommended to eliminate LTs as the underlying cause for chronic inflammation of the DFTS. This has the added benefit of allowing treatment to be performed immediately. If the damage to the DDFT is too extensive surgery can be converted to a large open approach as described by Wright and McMahon (1999).

Disrupted collagen fibrils protruding from the tendon are the most likely cause of chronic irritation of the DFTS, creating distension of the sheath, thickening of the sheath wall, synovial hypertrophy and ALCS. Within a tendon sheath there are no mechanisms available that can remove disrupted collagen fibres (Wright and McMahon 1999). Failure to remove those torn fibrils might explain the poor results after desmotomy of the PAL, in cases suffering from chronic synovitis of the DFTS and ALCS. In our cases, the tenosynovitis of the DFTS, caused by LTs, was treated both with mechanical resection of the torn collagen fibres and a desmotomy of the PAL. Removing the protruding tendon fibrils is effectively possible only with a sharp cutting motorised synovial resector (Dyonics)[4]. Suturing the LTs, as described by Wright and McMahon (1999), was not considered as a first surgical approach because the edges were always in close apposition. Furthermore, suturing the edge of the DDFT requires a large open approach with a longer surgical time and more risk of post operative complications, such as partial wound dehiscence and leakage from the tendon sheath. These complications were not described by Wright and McMahon (1999).

The method of performing the PAL desmotomy differs from the technique described by Nixon *et al*. (1993). A slotted cannula as used by Nixon *et al*. (1993), to perform the surgical procedure was considered unnecessary and time consuming. Instead, desmotomy may be safely and easily performed just palmar or plantar to the neurovascular bundle using a hook knife.

In the 6 cases of LTs, treated by tenoscopy (Wright and McMahon 1999), the PAL was left intact. In the remaining 14 cases, where an open approach was used, the PAL was transected to provide access to the tear but subsequently closed. These authors suggested that a desmotomy of the PAL was not needed to achieve good results in the treatment of LTs. They also suggested that primary closure of the PAL results in reduced scar tissue and less post operative adhesion formation. This could contribute to the reduced sheath distension, which was recorded in the majority of their cases. In our case series, all the PAL were transected and 94% showed a considerable reduction in the tendon sheath swelling. There was one exception and it remained sound after surgery.

There were several reasons why a desmotomy of the PAL was performed on all cases. First, almost all the cases showed signs of a chronic inflamed DFTS. These changes improved after the surgery but never completely resolved. This remaining fibrosis and thickening can be a source of pain partially through stenosis of the fetlock canal, leading to post operative pain and lameness. The decompression effect after transecting the PAL can have an analgesic effect in those cases. Second, more space was created within the fetlock canal, facilitating the tenoscopical procedures. This is particularly helpful in cases with an obvious constriction of the PAL. Third, a second surgery to decompress the fetlock canal in cases that did not respond on tenoscopical removal of the torn tendon fibrils alone was avoided. Transecting the PAL under tenoscopical control was considered to be a nonharmful procedure from which horses would benefit in cases of chronic tendon sheath inflammation. Wright and McMahon (1999) showed that transecting the PAL is not always necessary to achieve good results in the treatment of LTs but it would be interesting to know how much more improvement they could have had in the nonresponsive cases by also transecting the PAL.

A long and controlled post operative programme was considered to be important in the final outcome of the cases. Controlled exercise was started 10 days after the surgery but return to normal work was postponed until 8 months after surgery. In most cases, clinical signs improved quickly after surgery but a final evaluation is possible only after resuming the intended work level. The prognosis is considered reasonably fair after tenoscopical intervention.

It is important to note that, even after a successful surgery, the cosmetic result is never completely perfect. In most cases a firm nonpainful distension remains visible and palpable. The typical ultrasonographic changes improve but never disappear completely. The echogenic material lateral to the DDFT disappeared in all cases but the irregular outline of the DDFT might remain visible on ultrasound despite a clinically successful healing.

We recommend a tenoscopical approach in all cases regardless of how extensive the lesions. A desmotomy of the PAL using a hook knife should be considered in all cases with clinical signs of constriction of the PAL. In refractory cases, a tenoscopical re-examination is advisable. If the LT is still present, suturing the tendon through a large open approach as described by Wright and McMahon (1999) may be performed.

Manufacturers' addresses

[1]Toshiba Medical System, Wijnegem, Belgium.
[2]Wolf Endoscopie, Drongen, Belgium.
[3]Stortz Karl Benelux, Grimbergen, Belgium.
[4]Smith & Nephew, Brussels, Belgium.
[5]Johnson & Johnson, Ethicon, Dilbeek, Belgium.
[6]Mycofarm, Mechelen, Belgium.
[7]Equipalazone, Arnolds, Shropshire, UK.

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