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Case Report

Repair of the achilles mechanism in a miniature horse

A. BERTUGLIA* AND G. PUGLISI

**Dipartimento di Patologia Animale, Facoltà di Medicina Veterinaria, Università degli Studi di Torino, Via Leonardo da Vinci 44, 10095 Grugliasco (Torino), Italy.*

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Introduction

The equine achilles tendon is composed of the gastrocnemius tendon (GT), the tarsal tendon of the *biceps femoris*, semitendinosus and *gracilis* muscles, superficial digital flexor tendon (SDFT) and tendon of the *soleus* muscle (Sisson and Grossman 1953). These structures form a complex tendon mechanism (achilles mechanism). The main component is the GT tendon, which is the most powerful extensor of the hock. The achilles mechanism is part of the reciprocal apparatus of the hindlimb, which locks the tarsus correspondingly when the stifle is locked during the weightbearing stance.

Rupture of the lateral or medial head of the gastrocnemius muscle, and disruption of the superficial digital flexor muscle at its origin, have been previously reported during strenuous effort to stop or from other exertions in which stress is applied to the hock (Pascoe 1975; Stashak 1987; Reeves and Trotter 1991; Lescun *et al.* 1998; Reef 1998). Lacerations of the achilles tendon in the horse have also been described (Valdez *et al.* 1982; Stashak 1987). This injury is more common in hunting dogs and humans involved in road traffic accidents or as a consequence of sporting trauma (Inoue *et al.* 1990; Babu *et al.* 1994; Lee *et al.* 2000; Yajima *et al.* 2001).

This report describes a surgical approach to manage an extensive loss of GT as a consequence of a bite wound in a miniature horse.

Case details

Clinical history

A 4-year-old, 180 kg male miniature Italian breed horse (cavallino della Giara) presented at The Veterinary School of Turin with a history of a canine bite wound on the caudal surface of the right hind gaskin associated with severe destruction of the soft tissues including the achilles tendon. The case presented one week following injury and initially, the horse had been treated conservatively by the referring veterinary surgeon with a broad-spectrum antibiotic (sodium benzyl penicillin G 22.000 iu/kg daily) and the limb supported with a full limb bandage.

Clinical features

A large skin defect extended proximally from the apex of the *tuber calcanei* to the caudal surface of the thigh. Segmental loss of the GT and gastrocnemius muscles over the entire width of the tendon was apparent. The distal stump of the GT was detected, roughly lacerated, proximal to the *tuber calcanei* with digital exploration of the wound. The SDFT was exposed and contaminated but apparently uninjured (**Fig 1**).

At rest, the horse exhibited severe postural abnormalities. During the weightbearing phase of the right hindlimb, the *tuber calcanei* dropped about 10 cm below the opposite hock and the tibiotarsal joint showed excessive flexion. At no time was the stifle locked. An abnormal plantar flexion of the

Fig 1: Compound tissue defect in the region of the achilles tendon 1 week after the accident.

*Author to whom correspondence should be addressed.

Fig 2: An abnormal angle of the tarsocrural joint, dropped* tuber calcanei*, and plantar flexion of the metatarsophalangeal joint are evident in the case reported here.

Fig 3: Intra-operative appearance of the tenorrhaphy between the GT and the SDFT. The SDFT is luxated from the* tuber calcanei*. A double-locking loop suture is tightened between the 2 tendons to repair the achilles tendon.

metatarsophalangeal joint was noted (**Fig 2**). These features indicated failure of the achilles mechanism resulting in caudal reciprocal apparatus incompetence.

Surgical technique

The horse underwent surgery under general anaesthesia to repair the injured achilles mechanism receiving pre-operative antibiotic therapy with sodium benzyl penicillin G at 20.000 iu/kg b.i.d. and gentamycin sulphate 2.2 mg/kg b.i.d. The horse was positioned in lateral recumbency with the affected limb uppermost and supported at the fetlock joint. A skin incision was made on the lateral surface of the SDFT from 20 cm proximal which extended 10 cm distal to the *tuber calcanei* close to the primary wound. The skin was reflected and exposure maintained with Gelpi self-retaining retractors. The subcutaneous fascia, lateral retinaculum, and calcaneal bursa were incised. The SDFT was luxated medial to the *tuber calcanei* allowing exploration of the GT. At maximal flexion of the tibiotarsal joint, the GT was under no tension. Excessive granulation tissue was excised close to the proximal stump of the transected GT. A suture was positioned between the proximal stump of the transected GT and the dorsal surface of the SDFT with a No. 2 USP monofilament nylon (Ethilon)[1] in a double-locking loop suture pattern (Easley *et al.* 1990) while an assistant maintained the hock joint at the physiological angle of 135° (**Fig 3**). Following tightening of the suture the margins of the tendons were apposed with an interrupted sutures of No. 6 USP polyglactin 910 (Vycril)[1]. The lateral retinaculum was repaired with a far-near-near-far suture pattern of No. 6 USP polyglactin 910. This was followed by a No. 2/0 USP polydioxanone (PDS)[1] continuous suture pattern in the subcuticular layer and a No. 3/0 USP monofilament polyamide (Ethilon)[1] simple interrupted suture in the skin.

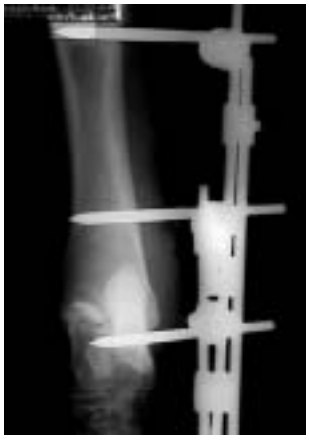
Immobilisation

With the tibiotarsal joint at the physiological angle, 2 pins were placed in the tibial diaphysis (Pins 1 and 2), one pin at the base of the calcaneus (Pin 3), and 2 pins in third metatarsal bone (Pins 4 and 5). The pins (6 x 100 mm length, negative thread profile stainless steel pins, Schanz screw)[2] were inserted in a lateromedial fashion perpendicularly to the bone surface. The pins placed in the tibia were introduced between the muscle bellies of the long digital extensor and lateral digital extensor. Prior to their insertion, the skin was incised with a No. 11 scalpel blade and the soft tissue dissected down to the bone with a periostal elevator. The holes for pins placement were drilled with a 3.5 mm drill bit followed by a 4.5 mm drill bit[2]. Correct placement of the pin in the calcaneus was monitored radiographically to prevent entry into the talocalcaneal articulation or injury to the deep digital flexor tendon. The ESF device was assembled positioning a sidebar (B) between Pins 3, 4, and 5 (the most distal) and a sidebar (A) between Pins 1 (the most proximal) and 2. These bars were fixed with a single clamp placed at the crossing point of both bars and with one long bridging bar (C) positioned vertically and clamped to each bar separately. Two horizontal bars were used to strengthen the ESF device, the first (D) connecting sidebars A and B, and the second (E) connecting sidebars A and C. Stainless steel bars (8 mm) were employed (**Figs 4a,b**). A well-padded bandage was applied to avoid soft tissue trauma from sharp extremities of the pins. The pony underwent assisted recovery after general anaesthesia.

Post operative management

Administration of sodium benzyl penicillin G and gentamycin was continued for 10 days at presurgical doses in conjunction with flunixin meglumine at 1.1 mg/kg bwt daily i.v., for the first

a)



b)

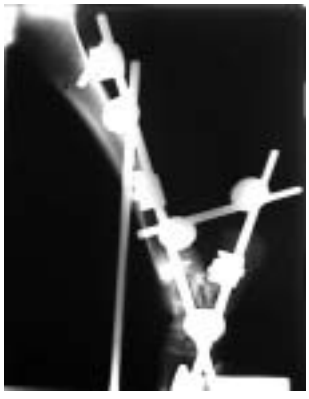


Fig 4: a) Caudocranial and b) lateromedial projections of the tibia and hock joint taken 2 days post surgery showing the ESF. a) Pins 1 and 2 are inserted in the proximal and distal diaphysis of the tibia. Pin 3 is positioned at the base of the calcaneus. Pins 4 and 5 are not visualised in this projection. b) Bar A is aligned with the tibial diaphysis, bar B aligned with the metatarsal bone, bar C is vertical, D is horizontal.

5 days, to encourage weightbearing on the leg. The pony was kept cross-tied in order to prevent recumbency and avoid high stress on the implants. Antiseptic preparation of the pin-skin interface was performed daily using standard chlorhexidine solution (**Fig 4c**). During the post operative period the pony appeared comfortable although the ESF device was slightly cumbersome. Clamps at the crossing point of the bars were progressively opened from the third week gradually increasing the load on the achilles tendon. A yellow drainage was evident 20 days post surgery at the skin-metal interface of pins 1 and 2. Penicillin G and gentamycin at the preoperative dosage were administered for 5 days until the drainage resolved. Restriction of movement was discontinued 4 weeks post operatively because the horse did not tolerate being cross-tied well. At 5 weeks post surgery the pony was found to be nonweightbearing on the affected limb and had signs of discomfort on palpation of the tibial diaphysis. Radiographic examination with a caudocranial projection of the tibial diaphysis demonstrated loosening of Pin 1 and an undisplaced fracture at the level of Pin 2 (**Fig 5a**). The fracture line started at the pin-bone interface at the level of the lateral cortex of the

Fig 4c: Appearance of the right hindlimb 3 weeks post surgery demonstrating the whole configuration of the ESF device and excellent correction of the postural abnormality.

distal third of the tibia progressing distally and medially into the medial malleolus. The fracture was repaired with 2 x 6.5 mm AO/ASIF partially threaded cancellous bone screws[2] and 1 x 4.5 AO/ASIF cortical screw[2] inserted in lag fashion. The proximal tibial pin, Pin 1, was replaced by two 6 mm pins inserted in the proximal and middle parts of the tibial diaphysis (**Fig 5b**). The horse was cross-tied again. Four weeks after fracture repair, a radiographic lucency had developed around the pins positioned in the tibial diaphysis (Pins 2 and 3). A decision to remove the ESF device was made. The horse was confined and cross-tied for 3 weeks, until a smooth periostal callus was radiographically apparent at the fracture site and subjected to stable rest for 2 further months. At radiographic follow-up taken 4 months after fracture fixation, the fracture line had disappeared.

Wound management

The wound was debrided carefully with a water-pik system and a tie-over dressing secured to the perimeter of the skin defect following the surgery to protect the achilles tendon and repair. The dressing was soaked 3 times daily with 50 ml of a solution containing 0.2% w/v gentamycin and replaced 3 times a week for 2 weeks until complete debridement of necrotic tissue was apparent and fresh granulation tissue covered the surface of the SDFT. Sixty days post operatively, a mature granulation tissue bed was apparent and the wound contraction considerably reduced the size of the primary defect. Ninety days post operatively and the skin had healed completely.

Outcome

Eight months post operatively, the horse was slightly lame at the walk on its right hindlimb. Observing the animal at rest, the right *tuber calcanei* was at the same height as the left and abnormal flexion of the right metatarsophalangeal joint had

a)

b)

Fig 5: a) Caudocranial projection of the tibia taken 5 weeks post surgery. A simple undisplaced fracture progresses from the interface between Pin 2 and the tibial cortex into the medial malleolus. The proximal pin undergoes loosening. b) The fracture has been repaired with 2 x 6.5 mm AO/ASIF cancellous bone screws and 1 x 4.5 mm AO/ASIF cortical screw inserted in lag fashion. Two 6 mm negative thread profile pins inserted in the proximal and middle diaphysis of the tibia are positioned in place of the removed pin.

full recovery (**Fig 6**). A slight atrophy of the gluteus muscle developed in the immobilised limb. A concave profile of the caudal surface of the right leg was evident, due to a defect in the gastrocnemius muscle. At the walk there was a lower arc of the foot flight and shortened caudal phase of the stride. An incomplete extension of the tibiotarsal joint was evident in consequence to the loss of the gastrocnemius muscles contraction at the end of the stride. At manipulation a 30° reduction in the hindlimb flexion test was noted in the affected limb. However, the horse was judged to have an acceptable locomotion for pleasure riding. The owner reported that it showed full activity at pasture.

Discussion

The achilles tendon is crucial to the reciprocal apparatus of the hind leg. The clinical case described in this report had an uncommon trauma on the caudal surface of the leg resulting

Fig 6: Appearance of the right hindlimb at 6 months post operatively. The tarsocrural joint and metatarsophalangeal joints show a normal angle at weightbearing demonstrating successful repair of the achilles mechanism.

in the avulsion of the gastrocnemius muscles and the main part of the GT. A marked dropping of the *tuber calcanei* and an abnormal angle of the tibiotarsal joint were also described in similar cases (Valdez *et al.* 1982; Stashak 1987; Reeves and Trotter 1991; Lescun *et al.* 1998). The 2 cases reported by Reeves and Lescun showed a reciprocal apparatus dysfunction because these horses suffered disruption of the gastrocnemius muscle heads as well as the superficial digital flexor muscle. The abnormal flexion of the metatarsophalangeal joint detected in our patient has not been described before. However, the flexion of the digits is a common finding in small animals with GT failure (Bonneau *et al.* 1983). This postural dysfunction results from the action of the SDFT, which undergoes excessive strain as a consequence of the abnormal angle of the tibiotarsal joint. Despite the anatomical differences this analogous observation appears to explain the flexural deformity of the metatarsophalangeal joint in our case. In this horse, tension of the SDFT on the *scutum medium* of the second phalanx could be a logical cause of contractural deformity at the fetlock joint.

Surgical correction of this postural abnormality was considered because the abnormal angle of the hock does not permit apposition and healing of the GT. Simple anastomosis, with or without a lateral digital extensor tendon autograft has been used to manage complete flexor tendon lacerations (Valdes-Vazquez *et al.* 1996). A segmental loss of the tendon needs more sophisticated procedures, such as suturing the tendon extremities with nonabsorbable plaited terylene (Smith and Webbon 1999), with carbon fibre (Valdez *et al.* 1980; Brown and Pool 1983; Vaughan *et al.* 1985), or with PLLA (Eliashar *et al.* 2001). The carbon fibre, pulled through a transverse hole in the *calcaneus*, could provide an attachment and secure the achilles tendon to the *tuber calcanei* in the presence of

tendon avulsion. Valdez *et al.* (1982) reported a successful result in a foal with this technique. Any of these surgical techniques were a reasonable option in this horse because apposition of the proximal and distal stumps of the GT was impossible. In small animals, achilles tendon defects have been reconstructed using *peroneus brevis* and *peroneus longus* tendon transposition reinforced with a free fascial strip graft (Sivacolundhu *et al.* 2001). In man, large combined tendon and skin defects are reconstructed with skin flaps and avascular or vascular tendon transplantation using the free *fascia lata* graft (Fumarola 1985), vascularised *fascia lata* graft (Inoue *et al.* 1990; Deiler *et al.* 1999; Lee *et al.* 2000), *extensor digitorum brevis* graft (Babu *et al.* 1994) or *peroneus brevis* transfer (Turco and Spinella 1988). The potential utilisation of denervated muscle flap may be an interesting alternative following the observation (Lee *et al.* 1999) that muscle tissue, when submitted to long term stress, loses its original mass and becomes a tendon-like fibrous tissue that in man could transmit efficiently the action of the calf muscle. A new approach to achilles tendon reconstruction has been realised by a cryopreserved achilles tendon allograft (Yuen and Nicholas 2000). Unfortunately, these reconstructive methods have limited application in the horse due to unavailability of local flaps for transfer, poor microvascular anastomosis techniques and potential donor morbidity.

In this case, the result of the procedure was assessed on the basis of the clinical course of the condition. Tenorrhaphy between the GT and the SDFT appeared a one-stage, simple and economic surgical option. The technique permitted restoration of the caudal reciprocal apparatus by formation of permanent adhesions between the 2 tendons in a physiological position for the tibiotarsal joint. Conservative treatment with a full-limb cast for stabilisation of the tarsus represent a reasonably alternative to promote natural healing of the tendon. Surgical tenorrhapy may reduce the time of immobilisation, reducing the costs and pain in the convalescent period. The horse was progressively able to load the leg 5 weeks post operatively because of the stability of the tibiotarsal joint but immobilisation was maintained for a further 4 weeks to stabilise the repaired fracture. The load normally sustained by the contraction of the gastrocnemius muscles shifted to the SDFT and muscle. Superficial digital flexor muscle avulsion should be taken into consideration in heavier horses as a possible complication. Incomplete extension of the hock was noted at the walk because the surgical procedure permitted reconstruction of the passive component of the achilles mechanism alone. Moreover, the adhesions between the SDFT and the GT resulted in 30° limitation of the hock joint flexion. However, this complication did not cause significant lameness in this horse in view of its use but large skin defect and heavy contamination of the wound presented a problem in management of the patient.

The need for further surgery and economics discouraged any attempts at skin grafting and second intention healing of the wound was elected. The tie-over dressing was extremely useful to resolve contamination of soft tissue and to encourage granulation tissue growth. An ESF device represent a useful technique to manage wound contamination and provide strict hock immobilisation. The technique is employed successfully in dogs after reconstructive surgery of the achilles tendon (Morshead and Leed 1984; De Haan *et al.* 1995; Sivacolundhu *et al.* 2001). A similar technique was reported by Stashak (1987) to obtain hock joint immobilisation in a mare after a calcaneus fracture repair. In this case, the configuration of the ESF device permitted a tibial-metatarsal fixation with a system of 2 sidebars locked with a single 6 x 8 mm clamp. A vertical bridging bar and 2 horizontal bars were applied to create a triangular configuration counteracting the high bending stress working on the device by limiting the stress on the vertical bar. The ESF was maintained for a total of 9 weeks with progressive opening of the system to increase the load on the tendon. During the last 4 weeks the ESF device was maintained to stabilise the repaired tibial fracture. Unfortunately, catastrophic injuries through the pin hole are common complications of ESF devices in horses since utilisation of large diameter pins size is required increase the strength of the device (Nixon *et al.* 1996). In this pony we observed a tibial stress fracture which required internal fixation. It was believed that loosening of the most proximal pin imposed high stress on the second pin bone interface which led to the fracture. Reasonably, the limitations of the ESF device in this patient included the large diameter and low number of pins inserted in the tibia. Generalised osteopenia was not apparent in the treated limb. Nixon *et al.* (1996) discouraged the use of uniplanar-unilateral configuration devices for fracture fixation in horses because of complications. In a series of horses treated with 3D devices in the tibia, Sullins and McIlWraith (1987) reported that the patients commonly developed complications leading to euthanasia. In this case, tibial fracture occurred 10 days after the horse was no longer cross-tied. Perhaps long-term immobilisation of the patient is essential for successful outcome. This method of immobilisation appears time-consuming because of the need for daily care of the skin-metal interface. In spite of the complication, this technique could be an alternative to full limb casts for managing achilles tendon trauma in light weight horses because the possibility exists to increase progressively the load on the repaired tendon by opening the clamps.

Tenorrhaphy between the GT and the SDFT as described in this patient has the potential for reconstruction of the achilles mechanism when there is an extensive defect in the GT and muscle. This procedure could represent an alternative to humane destruction in horses with severe trauma to the achilles tendon, even if a successful outcome for a heavier horse is doubtful.

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[1]Ethicon,
[2]Synthes,

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