Article published online: 2024-05-10

Achilles Tendon Rupture Treated with Flexor Digitorum Lateralis Tendon Transposition and Transarticular External Skeletal Fixator in Ouessant Sheep

Kévin Schreiber[1] Philippe Haudiquet[1] Martin Hamon[1]

[1] Department of Small Animal Surgery, VETREF – Referral Veterinary Clinic, AniCura Group, Beaucouzé, France

VCOT Open 2024;7:e46–e51.

Address for correspondence Kevin Schreiber, DVM, Department of Small Animal Surgery, VETREF – Referral Veterinary Clinic, AniCura Group, 7 Rue James Watt, 49070 Beaucouzé, France (e-mail: k.schreiber1@outlook.fr).

Abstract

Objective To describe the appositional augmentation of a complete Achilles tendon rupture in Ouessant sheep, using the intact flexor digitorum lateralis tendon, and immobilization with a type II transarticular external skeletal fixator.

Clinical Report A 1-year-old neutered male Ouessant sheep was presented for Achilles tendon rupture and multiple bite wounds, secondary to a dog attack. The Achilles tendon was torn entirely, and a significant 3-cm gaping defect was present. The remnants of the Achilles tendon were debrided and attached using locking-loop and epitendinous sutures. The intact flexor digitorum lateralis tendon was then transposed and secured over the tendinous repair to increase the tendon strength. The bite wounds were closed with a primary repair. Finally, a type II transarticular external skeletal fixator was used to immobilize the tarsocrural joint for 6 weeks.

Results A mild lameness, associated with a decreased range of motion of the tarsocrural joint, was present at the time of external skeletal fixator removal. Four months postoperatively, the lameness had completely resolved. A slight decrease in the range of motion of the tarsocrural joint was conserved.

Clinical Significance In a small ruminant, transposition of the flexor digitorum lateralis was successful for the repair of an Achilles tendon rupture with a large musculotendinous gap and infected open wounds. To the authors' knowledge, this is the first such case described in sheep.

Keywords
- sheep
- Achilles tendon rupture
- flexor digitorum lateralis
- tendon transposition
- common calcaneal tendon

Introduction

Achilles tendon (AT), also called common calcaneal tendon, is formed from three separate musculotendinous parts in animals, comprising the paired gastrocnemius tendons (GT) associated with soleus muscle in human and sheep, the superficial digital flexor tendon (SDFT), and the common calcaneal tendon composed of the tendons of the gracilis, biceps femoris, and semitendinosus muscles.[1] AT injuries can be divided into three types. Type 1 is defined as a complete rupture with a plantigrade stance and a palpable gap between tendon ends. Type 2 injuries are partial ruptures, divided into three forms: a musculotendinous rupture, a rupture with an intact paratenon, or a GT avulsion with an intact SDFT. Type 3 injury is defined as a tendinosis and/or peritendinitis.[2] Acute traumatic injury of the AT with complete rupture and plantigrade stance is the most common

received
July 29, 2023
accepted after revision
January 19, 2024

DOI https://doi.org/10.1055/s-0044-1786187.
ISSN 2625-2325.

Georg Thieme Verlag KG, Rüdigerstraße 14, 70469 Stuttgart, Germany

clinical presentation.[3,4] Chronic injuries of the AT associated with avulsion of the GT, but intact SDFT are also described.[3,4]

Surgical management is the treatment of choice for complete or partial rupture of the AT,[3,4] and for type 3 injury when conservative management for nondisruptive lesions are ineffective. Several surgical repair techniques have been described in small animals, depending on the type and location of the lesion. Primary repair with postoperative immobilization for 6 weeks is most often performed.[3,4] However, because of complications, often associated with postoperative immobilization devices,[5] and the very slow increase in strength of the tendon during the healing period,[6] the surgical augmentation of the repair is strongly recommended to shorten the postoperative immobilization period. Several tendon augmentation methods have been described in both animals and humans, including V–Y plasty,[7] tendon transposition,[8,9] fascia lata autograft,[10] tendon autograft,[11,12] tendon xenograft,[7] synthetic prosthesis,[13,14] tendon plating,[15] or central gastrocnemius aponeurotic flap.[16,17] Several experimental studies have been performed on sheep to evaluate the AT healing rate, with[18] or without,[6] plasma addition (like plasma-rich platelet or plasma-rich in growth factor). However, no clinical cases related to the management of AT rupture or avulsion have been described in small ruminants. In humans, transposition of the *flexor hallucis longus* (FHL) is commonly used for augmentation of the AT repair[7,19] and has good to excellent results.[19] In small animals, the *flexor digitorum lateralis* (FDL) (corresponding to the *flexor hallucis longus* in humans) transposition for AT augmentation has been reported in only two cases of complete AT rupture treated with FDL augmentation[20] or transposition[21]; one in a toy Poodle and one in a Domestic Shorthair cat. The FDL arises from the caudal surface of the fibula and the caudolateral border of the tibia and runs caudolaterally until the sustentaculum tali (the medial process of the calcaneus) where it passes on its plantar side. More distally, it fuses with the minor tendon of the *flexor digitorum medialis* (FDM) to form the deep digital flexor tendon, acting as a flexor of the digit and an extensor of the tarsus.[22]

We report the use of the FDL tendon transposition to augment the primary repair of the AT in an Ouessant sheep with a completely severed AT.

A 1-year-old neutered male Ouessant, kept as pet and weighing 15 kg was referred for left pelvic limb, nonweight-bearing lameness, and multiple bite wounds following a dog attack 3 days prior. Multiple bite wounds were present on both pelvic limbs and in the right periocular region. A large penetrating bite wound severing completely the AT was present on the left side, with a plantigrade stance.

Lateral and caudocranial radiographs of the left crus confirmed a complete rupture of the AT without any bony abnormalities (►**Fig. 1**). Blood biochemistry and red blood cell counts were normal.

For surgery, the sheep was premedicated with medetomidine (30 µg/kg intramuscular [IM], Dormilan, Axiences SAS, Pantin, France) and morphine hydrochloride (0.5 mg/kg IM). Anesthesia was induced with ketamine (3 mg/kg intravenous [IV], Ketamidor, Axiences SAS, Pantin, France) and maintained with isoflurane (Isorane, Axiences SAS, Pantin,

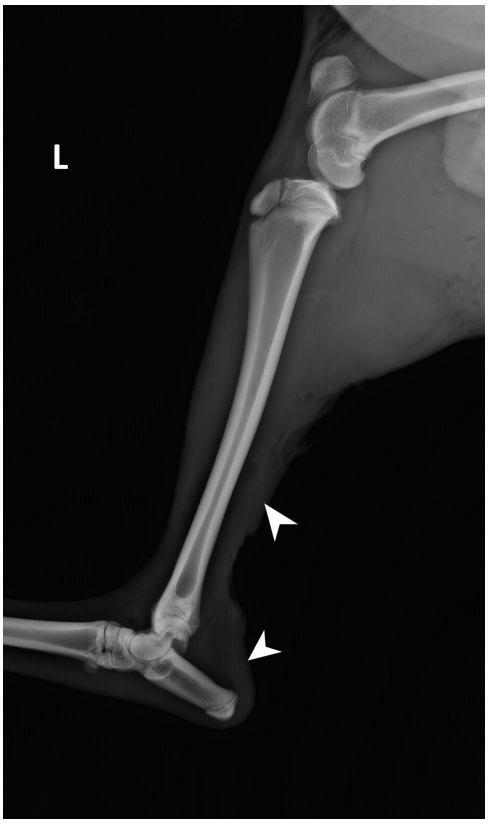

Fig. 1 Laterolateral radiographic view of the left crus. Note the complete rupture of the Achilles tendon with a significant gap between each end (white arrows).

France) in 100% oxygen via an endotracheal intubation. Enrofloxacin (5 mg/kg IV, Baytril 10%, Bayer, Leverkusen, Germany) and meloxicam (0.5 mg/kg subcutaneous, Metacam 5 mg/mL, Boehringer Ingelheim, Ingelheim-Am-Rhein, Germany) were administered 30 minutes before incision, and Ringer's lactate solution (5 mL/kg/h IV) was administered perioperatively. In right lateral recumbency, the area of injury on the caudal aspect of the crus were exposed through a caudolateral incision. The AT was completely ruptured with an approximately 3-cm gap. The three anatomical parts of the AT could not be identified (►**Fig. 2**). Any avascular tissues and severed ends of the AT were debrided. Apposition of the tendon stumps was achieved using three locking-loop and peritendinous sutures with polydioxanone decimal 3.5 (PDS II, Ethicon, Neuilly-sur-Seine, France), whereas the tarsus was held in extension (►**Fig. 3**). The primary repair of the AT was deemed too weak to support external forces without reinforcement. Thus, transposition of the FDL tendon was employed to strengthen the primary repair. The FDL tendon was elevated and isolated from the medial head of the deep digital flexor tendon while preserving its origin on the tibia. It was then caudally transposed and secured to the lateral and medial part of the AT, using two rows of sutures of polydioxanone decimal 3 in a modified Krackow pattern (►**Fig. 4**). The stability and strength of the repaired AT were evaluated intraoperatively and deemed excellent proximal to the rupture. The torn gastrocnemius and superficial digital flexor muscles were sutured. The facial layers were

Fig. 2 Complete rupture of the Achilles tendon with a significant gap between each end (yellow arrows). Note the preservation of the flexor digitorum lateralis tendon (*).

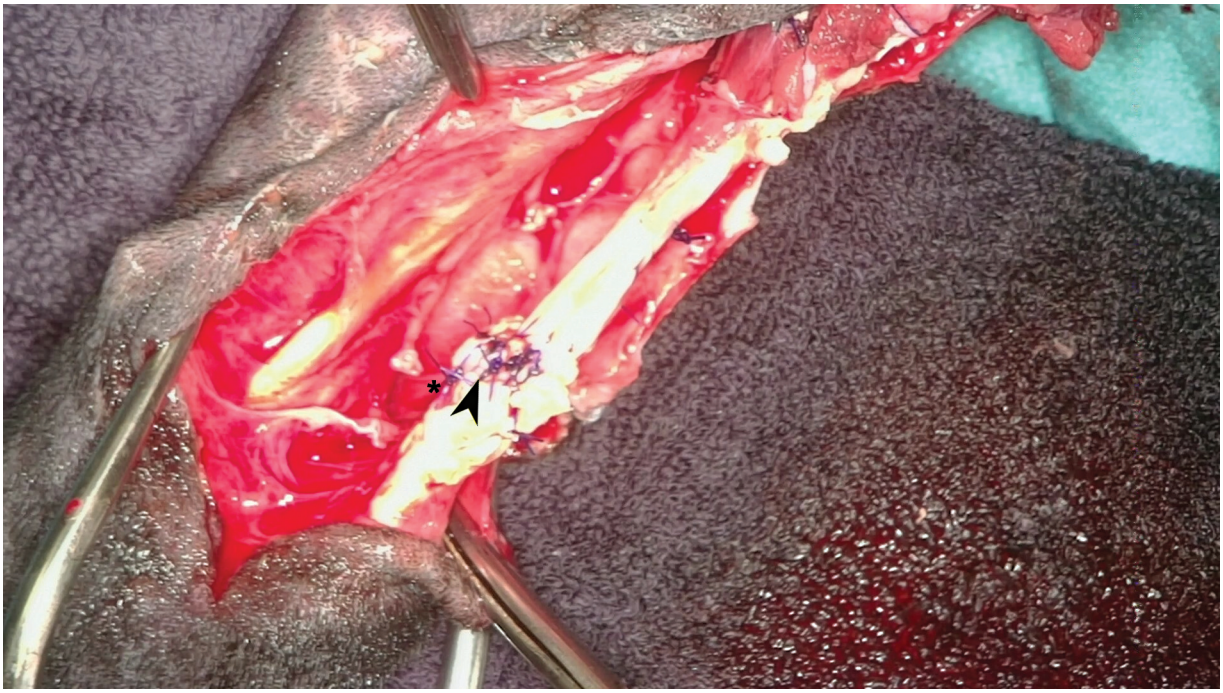

Fig. 3 Primary repair of the Achilles tendon using locking-loop suture pattern (black arrow) and epitendinous sutures (*) with a polydioxanone decimal 3.5. The tarsus is held in extension.

closed using an interrupted suture pattern with a polydioxanone decimal 2. Subcutaneous and cutaneous layers were closed using a continuous suture pattern with polydioxanone decimal 2 and nylon decimal 2 (Nylon, Vetsuture, Noevia SAS, Paris, France), respectively.

The bite wounds on each thigh and in the periocular region were then debrided and flushed with sterile saline followed by primary repair.

A type II transarticular external skeletal fixator (TESF), composed of four 3.2-mm positive-profile-threaded pins,

Fig. 4 Transposition of the flexor digitorum lateralis (FDL) (*) tendon to augment primary repair of the Achilles tendon (AT) (black arrow). FDL tendon is sutured to AT using two suture lines in a modified Krackow suture pattern with a polydioxanone decimal 3.

connected with plastic tube and acrylic material (Technovit6091, Kerbl France, Soultz-Haut-Rhin, France), was placed to immobilize the tarsus in extension. The two proximal pins were placed in the diaphysis of the tibia. The two distal pins were anchored in the third metatarsal bone.

The sheep was discharged on the day of the surgery and ambulatory on four limbs (►**Fig. 5**).

Meloxicam (0.5 mg/kg) and enrofloxacin (5 mg/kg) were administrated postoperatively for 5 days and 15 days, respectively. Daily cleaning and application of local antiseptic

Fig. 5 Immediate after recovery the limb was weight-bearing. The external skeletal fixator was protected with a cohesive strip (*). Note sutured bite wounds on the left thigh (red arrow).

at the skin–pin interface was performed by the owner. Healing of all wounds was obtained after 2 weeks without any complication, and sutures were removed by the owners. Exercise restriction was enforced until the removal of the external skeletal fixator at 6 weeks, where upon activity was gradually increased. At this time, a mild lameness of the left pelvic limb with a decrease of approximately 30 degrees of the tarsocrural joint in flexion was present. Clinical reevaluation, at 4 months postoperatively, showed only a slight reduction in the range of motion of the tarsus while in flexion (~10 degrees), without evidence of lameness.

Discussion

Transposition of the FDL tendon was an effective technique to strengthen the primary repair of a complete AT rupture, in conjunction with a TESF, in this sheep.

Maintenance of sufficient strength for the primary repair of the ruptured tendon is very important during the tendon healing process. It has been shown previously that a tendon gap of more than 3 mm leads to an increased risk of rerupture, due to the deposition of mechanically inferior scar tissue.[23] Rerupture or poor functional outcomes are observed in 11 to 16% of small animals.[3,4]

The strength of the primary repair of the tendon is improved by increasing the number of suture strands crossing the repair, increasing points of suture purchase from the transection site, and depth of suture penetrance.[24,25] This is obtained using locking-loop, three-loop pulley, and Krackow suture patterns. Furthermore, the three-loop pulley is considered to be the suture pattern of choice for rounded-tendon primary repair.[26,27] Recently, novel suture patterns have been described, with superior strength than with the three-loop pulley alone.[25] Epitendinous sutures have been shown effectiveness in increasing tendinous strength in primary tendon repair.[28] In this case report, the primary repair was obtained using three locking-loop suture patterns and epitendinous sutures. A locking-loop suture pattern was preferred based on the flat and narrow conformation of the AT in sheep, and a monofilament suture was used due to the presence of infected bite wounds.

Tendon strength at the primary repair site is increased with tendon augmentation techniques. In the present case, the decision was made to use transposition of the intact FDL tendon, because of proximity to the ruptured AT. An excellent functional outcome was obtained, as previously described in feline and canine case reports.[20,21] Several advantages are obtained with the FDL tendon transposition. The two main advantages are: (1) the FDL transposition corresponds to an autograft of the tendon, which limits the inflammatory reaction that could be observed with foreign device presence like polyethylene or polypropylene implants,[13,14] (2) there is a low risk of infection as compared with synthetic implants.[13] In the presence of bite wounds, contamination and infection, the use of a tendon autograft should be preferred over any implanted materials. The main disadvantage of a tendon transposition of the FDL is that it can affect the flexor function of the digits. This possible complication was not observed in two previously reported small animal cases.[20,21] In this sheep, no functional complication after the transposition of the FDL tendon was observed.

During the postoperative period, stress shielding the tendon is also most important, and immobilization may be required for at least 6 weeks until sufficient strength is regained.[5] An experimental human study performed on sheep showed that only 30 and 57% of the normal strength is restored after 6 months and 1 year, respectively.[6] Several methods of postoperative immobilization have been described, including the use of casts or splints,[3–5] TESF,[5] transarticular T- or L-plates,[29] or calcaneotibial screws.[30] Most of the reported postoperative complications were related to the immobilization device, with similar complication rates.[5] However, a higher rate of major complications is associated with the presence of TESF.[5] In this case report, a TESF was chosen because of the presence of bite wounds, as this technique would limit implant–bone contact near the infected site.

Conclusion

This is the first report of a complete AT rupture in a sheep treated surgically by primary repair augmented with transposition of the FDL tendon. This augmentation technique has previously been reported only in one toy-breed dog and one cat. We showed herein that this technique can be successfully used also in a heavier weight animal such as in this skeletally mature sheep with a gapping and infected AT laceration.

Funding
None.

Conflict of Interest
None declared.

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