Biomechanical comparison of two suturing techniques during Achilles tendinoplasty in dogs: preliminary results

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1. Introduction

Tendon rupture in animals is a frequent injury that may cause intense lameness and pain, depending on severity and duration. Reparative surgery consists in re-apposition of the tendon ends using various types of sutures, but no consensus has yet been found on the most suitable type of suture or the best type of suturing material to be used (Putterman et al. 2019a). Various factors may influence the outcome of the surgery, such as the surgeon's experience, the suturing technique chosen and the type of thread used (Putterman et al. 2019a; Burgess et al. 2010). The objective of this study was to test the maximal failure strength of two suturing techniques used to repair an Achilles tendinoplasty.

2. Methods

The method used here was based on the study by Morton and colleagues in 2015.

2.1 Sample preparation protocol

Four hind limbs from 2 adult dogs between 35 and 45kg were taken. Each anatomic sample was dissected to leave the gastrocnemius muscle and tendon as well as the femur intact. The extremity of the femur was fixed with resin onto a support.

2.2 Suturing techniques of the UHMWPE implant

The gastrocnemius tendon was longitudinally incised over half of its diameter, from the incision made at the level of the enthesis up to the musculotendinous junction, over 5 cm. The UHMWPE implant (Novaten 8000®, Novetech Surgery, Monaco) was placed proximally over the whole length of the half-split tendon and placed within the tendon incision. It was then secured with two different suturing techniques: (i) 8 simple interrupted sutures of 5 metric polypropylene (Prolene®, Ethicon, Inc., Somerville, N.J.), spaced 5 mm apart, about 4 cm along the implant, similar to the technique used in the study by Morton and colleagues in 2015 (Fig 1a) (Morton, Whitelock, et Innes 2015); (ii) overlock sutures made with 5 metric UHMWPE thread (FiberTech®, Novetech Surgery, Monaco), as in the study published by Postl and colleagues in 2015 (Fig 1b) (Postl et al. 2015).

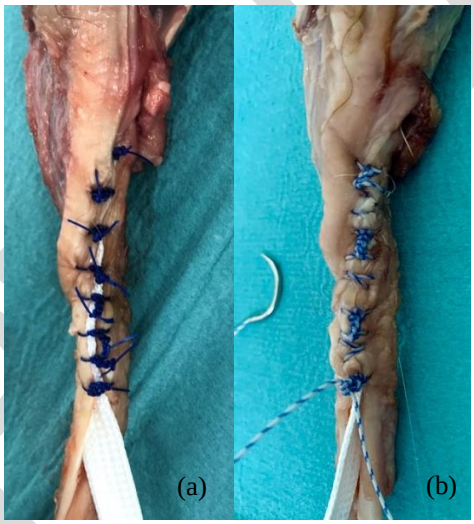

Figure 1: Two suture patterns tested biomechanically (a) 8 evenly spaced simple interrupted polypropylene sutures, (b) overlock sutures made with UHMWPE thread.

2.3 Biomechanical testing

The two types of suture techniques were tested separately but with the same mechanical test as in the study by Morton and colleagues. Eight static tensile tests were carried out using a traction system (AGS- X Shimadzu, Japan) with a pre-test of 20mm/min traction until the load reached 30N, to straighten the system. The tensile test consisted in a 25mm/min traction until failure and the sampling rate for data acquisition was set at 100Hz. In total, 8 experimental set-ups were investigated in a random order: 4 testing the mechanical resistance to tearing of the 8 polypropylene sutures (S1D&G, S2D&G) and 4 others to the tearing of the overlock sutures made with UHMWPE thread (SF3D&G, SF4D&G).

2.4 Data acquisition and processing

The TrapeziumX (Shimadzu, Japan) software was used for data acquisition (Shimadzu, Japan) during tests. For each technique, two parameters were measured: (i) maximum strength (M_s), and (ii) failure mode (FM).

Microsoft Excel was used to process the data.

3 Results and discussion

	8 simple polypropylene sutures		Overlock suture with UHMWPE thread
Test name	Failure strength (N)	Test name	Failure strength (N)
S1D	679	SF3D	851
S1G	745	SF3G	904
S2D	809	SF4D	748
S2G	534	SF4G	953
Mean	692	Mean	864
SD	102	SD	88
Failure mode	Suture thread break (4/4)	Failure mode	Tendon delamination (4/4)

Table 1: Results, mean and standard deviation of 8 static tensile tests until failure, performed on two types of suturing techniques using Prolene and FiberTech.

The mode of rupture with the first and second suturing techniques turned out to be very homogeneous, with the same rupture mode by fixation. With the 8 simple interrupted sutures, as soon as the most distal suture ruptured, the others gave way a few moments later. With the other technique, progressive delamination of the gastrocnemius tendon was observed without rupture of the UHMWPE thread. The failure strength of the second suturing technique was found to be greater than that of the first (864 N ± 88 vs. 692 ± 102). In view of these preliminary results, using a UHMWPE implant as a mechanical support seems to offer greater maximum strength than the conventional suture techniques currently used to treat tendon ruptures in small animals (Putterman et al. 2019b). Maximum failure strength was increased by 24.9% with UHMWPE thread overlock sutures, compared to the 8 simple interrupted polypropylene sutures. These results are encouraging as they close to the physiological failure strength of the proximal insertions of the gastrocnemius tendon: proximal fixation (mean ± sd): 864 N ± 88 / 1031.3 N ± 317.6 with overlock sutures made with FiberTech® (Jopp et Reese 2009). These preliminary findings now need confirmation by further mechanical tests. However, it is clear that the most efficient technique and the best thread should be used to optimize the mechanical resistance of the proximal tendon fixation during Achilles tendinoplasty, using a UHMWPE implant as a mechanical support.

4. Conclusions

Failure strength with the technique using 8 simple interrupted sutures in the gastrocnemius tendon and the UHMWPE implant was 692 N ± 102 (mean ± sd). With the overlock technique using 5 metric UHMWPE fiber in the gastrocnemius tendon and the UHMWPE implant, it was 864 N ± 88 (mean ± sd). No rupture of either the UHMWPE implant or thread was observed during any of the tests.

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