Ex vivo biomechanical comparison of barbed suture and standard polypropylene suture for acute tendon laceration in a canine model

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Keywords

Barbed suture, tenorrhaphy, canine, tendon, biomechanical testing

Summary

Objectives: Evaluate performance and resistance to gap formation of a non-absorbable, barbed, monofilament suture, in comparison with a non-absorbable, smooth, monofilament polypropylene suture, in two different suture patterns: three-loop pulley (3LP) and modified Bunnell-Mayer (BM).

Sample size: Seventy-two medium-sized cadaveric superficial digital flexor muscle tendon units.

Methods: After manual transection and suture repair, individual specimens were placed in an electromechanical tensile testing machine and tested to monotonic failure using tensile ramp loading. Video data acquisition allowed evaluation of failure mode and quantification of gap formation.

Results: Incidence of gap formation between tendon ends was significantly greater in tenorrhaphies repaired with barbed suture compared to those repaired with smooth polypropylene. Use of a 3LP suture pattern caused significantly less gapping between tendon ends when compared to the BM pattern.

Conclusion: Smooth polypropylene suture was consistently superior in load performance than a unidirectional barbed suture. The 3LP pattern was more resistant than a BM pattern at preventing gap formation.

Clinical significance: Smooth polypropylene should be recommended over barbed unidirectional suture for use in canine tendinous repair to provide increased resistance to gap formation. The 3LP is superior to the BM suture pattern, requiring significantly more force to cause tenorrhaphy gap formation and failure, which may translate to increased accrual of repair site strength and tendinous healing in clinical situations.

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Introduction

Traumatic tendon injury is a relatively uncommon disorder in dogs accounting for only 0.7% of all appendicular musculoskeletal diagnoses according to one study (1). Tendon injury requiring repair can be a result of acute, chronic or iatrogenic trauma as well as secondary degenerative or inflammatory processes (1). Factors influencing successful tendon repair include, but are not limited to, the nature and location of injury, blood supply, type of repair, suture material, suture knotting, gap formation, immobilization, weight bearing, and passive motion (2, 3). Successful tendon healing is largely dependent on blood supply and the prevention of gap formation between tendon ends (3, 4). Gap formation of more than 3 mm has detrimental effects on tendon healing, including delayed healing time, reduction of repair-site strength, and an increase in the risk of re-rupture at the surgical site (3, 5, 6). In order to achieve a successful clinical outcome and return to normal function, repairs should sustain and withstand tensile forces placed on them by the dog in the postoperative period and be able to resist gap formation at the repair site (6). Various suture techniques have been described for tendinous injuries in dogs and cats including simple interrupted, vertical mattress, locking-loop (Kessler), Krackow, three-loop pulley (3LP), Bunnell-Mayer (BM), continuous cruciate, and Mason-Allen (6-15). *In vitro* comparison has demonstrated greater strength and ability to resist gap formation with the use of some suture patterns such as the 3LP, compared to others (9, 13).

Barbed suture was originally developed for use with minimally invasive surgery and it is manufactured to create protruding barbs that grasp the surrounding tissue, creating multiple anchor points that distribute tension along the suture line. Use of barbed suture allows secure tissue approximations while using less suture material, and potentially leading to improved scar aestheticism (16). As described by the manufacturer, barb size is correlated to suture size and exhibits unidirectional tensile pull strength equivalent to those of a barbless suture of the same material that is the same size or 1 USP size smaller (17, 18). Barbed suture is advantageous for use in laparoscopic techniques as there is a preconstructed end loop, allowing the suture needle to pass through the loop after the first tissue bite. This negates the need for knot tying, as the suture does not require knots for suture security, and can facilitate reduced operative times (19). At present, the US Food and Drug Administration has approved the use of unidirectional V-Loc[a] and bidirectional Quill[b] (double-swaged needles) barbed sutures for use in human and veterinary surgical patients. In canine patients, barbed suture has been evaluated for use in gastrostomy and enterotomy closure, intestinal anastomoses, laparoscopic gastropexy, and diaphragmatic herniorrhaphy repair (21–26). Use of a barbed suture for tenorrhaphy repair of canine gastrocnemius tendons has recently been described (27).

The purpose of this study was to evaluate the performance of a commercially available, non-absorbable barbed monofilament suture (V-Loc), in comparison with a comparably-sized, non-absorbable smooth monofilament polypropylene[c] suture in two different suture patterns, 3LP and BM, in canine cadaveric superficial digital flexor tendons.

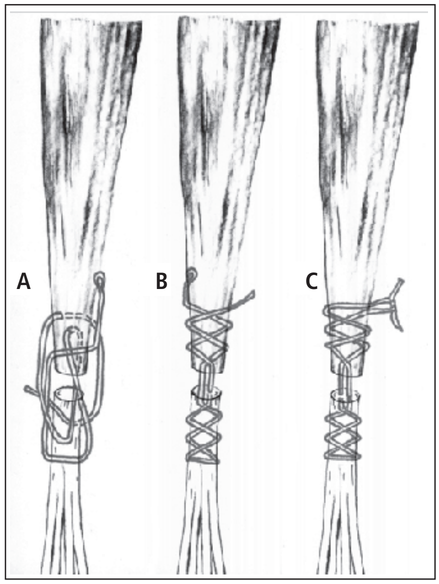

Figure 1 Diagram illustrating tenorrhaphy repair of the superficial digital flexor tendon using: **A)** three-loop pulley suture technique using 3.5 metric V-Loc unidirectional barbed suture, **B)** Bunnell-Mayer (BM) suture technique, using 3.5 metric V-Loc barbed suture, and **C)** BM suture technique using 3.5 metric polypropylene suture. Drawing by Dr. Daniel Duffy and David Williams.

We hypothesized that barbed suture would resist gap formation until a greater distractive force was applied compared to polypropylene suture, that 3LP would be superior to the BM pattern in preventing gap formation in both suture materials, and polypropylene would have a greater force at failure than barbed suture.

Material and methods

Specimen processing and preparation

Paired forelimbs devoid of any metabolic, orthopaedic or soft tissue disease were harvested from 36 medium-sized, purpose bred dogs, euthanized for reasons unrelated to this study, after approval by the animal care and use committee at the Purdue Veterinary Teaching hospital, Department of Veterinary Clinical Sciences. In each limb, the superficial digital flexor tendon was dissected to the level of branching prior to insertion on their respective phalanges, paying particular attention to the removal of all retinacular attachments. Metacarpal bones were severed at a level 5 mm distal to their respective carpo-metacarpal joint ensuring that the superficial digital flexor tendon was protected, and all tissue distal to this point on the manus was left intact. Proximally, all tissue other than the superficial digital flexor muscle and tendon was removed. The humerus was severed using a bone saw at the level of the distal diaphysis yielding a test specimen that consisted of only the distal humerus, the musculotendinous unit, and the insertions of the superficial digital flexor tendon on the remaining manus. After sample collection and individual identification, specimens were wrapped in saline (0.9% NaCl) soaked gauze and stored in a thermostatically controlled environment at –20°C until testing using a previously validated method (28). Before mechanical testing, each construct was thawed overnight (12–14 hours) at room temperature.

On the day of testing, a 5.6 mm diameter bone tunnel was drilled in the humerus in a craniocaudal plane, 1 cm proximal to the supratrochlear foramen. The tendon was then sharply transected in a transverse plane with a size 10 scalpel blade 1.5 cm distal to the level of the musculotendinous junction. After transection, the cut surface of the tendon was photographed alongside a calibrated mm rule with a digital camera[d] at a set distance of 7.5 cm, parallel with the cut edge of the tendon. The cross sectional area (CSA) of each tendon was measured four times using an imaging software program[e], and the mean was calculated.

Surgical treatment groups

Tendons were randomly assigned to one of four equally sized groups (n = 18 per group), however the two tendons from each dog were always placed in different groups. Group 1 specimens were repaired using a 3LP technique as previously described, using 3.5 metric polypropylene suture (9). Bites were taken at 0.5, 1, and 1.5 cm respectively from the transected ends

a V-Loc™: Covidien, Mansfield, MA, USA
b Quill™: Surgical Specialties Corporation, Vancouver, British Columbia, Canada
c Prolene: Ethicon, a Johnson & Johnson Company, Somerville, NJ, USA

d Canon PowerShot A2000IS 10 Megapixel digital camera: Cannon Inc., Tokyo, Japan
e Image J, version 1.47: National Institutes of Health, Bethesda, MD, USA. Available at: rsbweb.nih.gov/ij/index.html. Accessed May 24, 2014.

through tendinous tissue using a straight needle to aid suture passage. A surgeons knot was placed utilizing a total of four throws. The suture was cut 1 cm from the knot.

Group 2 was repaired using a 3LP technique with 3.5 metric V-Loc suture (▶Figure 1A). For the first bite, the suture needle was passed through the pre-constructed loop and then the pattern progressed as described for group 1. No closing knot was tied and the suture was cut 1 cm from the tendon surface.

Group 3 constructs were repaired using a modified BM technique, with 3.5 metric polypropylene suture (▶Figure 1C). Bites were taken at a 45 degree angle in a mediolateral plane every 0.5 cm, through the mid-substance of the tendon starting 1.5 cm from the transected site. This was repeated in the reverse order in the distal tendon segment. A bite was then taken 90 degrees to the long axis of the tendon and the pattern was repeated back across the anastomosis site until the suture exited the tendon site directly opposite to the initial entry point in the proximal tendon segment. Knots were tied as described for group 1.

Group 4 tendons were repaired with a modified BM technique, using 3.5 metric V-Loc suture (▶Figure 1B). For the first bite, the suture needle was passed through the pre-constructed loop and the pattern progressed as described for group 3. The suture was cut 1 cm from the tendon surface. All specimens were kept moist with 0.9% NaCl solution using a spray bottle. A single investigator (DJD) performed all suture repairs.

Mechanical testing

Custom testing jigs were created to secure the humeral bone segment through the drilled bone tunnel, and the manus was secured with a mechanical vice. Surgically repaired samples were mounted into a universal testing instrument[f] with a 1000N load cell (▶Figure 2). A high speed digital camera[g] was placed 25 cm from the construct, level with the tenorrhaphy site, and recorded each test at a frequency of 30Hz for visual documentation of potential gap formation and failure mode.

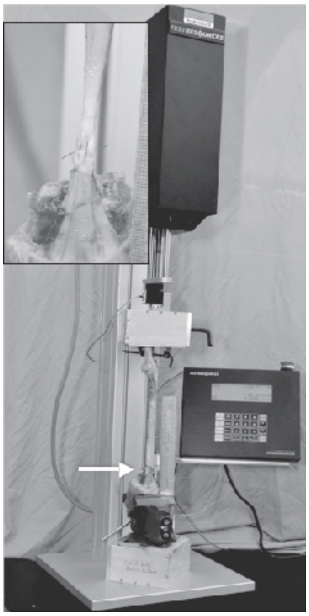

Figure 2 Electromechanical testing apparatus with a loaded superficial digital flexor tendon (SDFT) specimen loaded within the custom device prior to construct testing. The arrow indicates the level of tendinous transection. See insert showing a magnified photographic image of a transected SDFT construct repaired using a three-loop pulley suture pattern in 3.5 metric polypropylene.

Repairs were preloaded in tension to 2N, after which tension was applied at a rate of 20 mm/min until failure. Load (Newtons, N) and displacement (mm) data during uniaxial tension tests were collected by the test system software at a frequency of 64Hz. Failure was defined as the point at which the suture broke or pulled through the tendinous tissue. Yield force was defined as the greatest force achieved prior to the initial sharp decrease in the load-time curve. Peak force was defined as the maximum force measured during each test. An imaging software program[e] was used to determine the force required to produce 1 and 3 mm gaps. Tendon distraction was measured by a single investigator (DJD) four times for each test from different video frames, using a calibrated rule placed in the video field during recording to determine the force required to produce the respective gap formation. The mean of the four measurements was calculated. Gapping was determined using the minimum gap distance between the tendon ends to measure 1 and 3 mm respectively. Gap size was also determined at the point of yield and peak force. A manual trigger system, linking camera footage and tensile testing data, was utilized to allow simultaneous synchronization during each test after preloading of the construct was achieved. Gathered data, collected by the tensile testing system (time, load, displacement), were viewed in a commercially available spreadsheet software program[h] and high-speed camera measurements were used to extrapolate and determine the force applied to the anastomotic repair at 1 and 3 mm gaps. Values for yield and peak force were selected by hand graphically from a plot of load-displacement data using a custom program[i]. Times at which these peak forces occurred were recorded automatically by the same program and used to calculate the tendon gap distance from the video as described above.

Statistical analysis

Data were assessed for parametric distribution using the Shapiro-Wilk test for normality. Continuous variables that were normally distributed were described using mean ± SD, and means were compared using Student's t-test. Continuous data of non-parametrically distributed data were described using median (range), and compared using the Wilcoxon rank sum test. Proportional distributions in categorical data were compared using the Pearson chi-square test of association. All analyses were performed using commercially available software[j]. A p-value less than 0.05 was considered statistically significant.

f TestResources 100Q Servoactuators: TestResources Inc, Shakopee, MN, USA

g Oqus 3+: Qualisys , Gothenburg, Sweden

h Microsoft Excel, Microsoft Excel for Windows, Version 15: Microsoft Corp, Redmond, WA, USA

i MATLAB program: Mathworks, Natick, MA, USA

j STATA SE, v.12.1: StataCorp, College Station, TX, USA

Results

There were 22 male and 14 female dogs in the study, and both genders were evenly distributed among experimental groups. The mean CSA of all tendons was 0.25 ± 0.04 cm^2. Mean weight of all dogs was 19.5 ± 3.4 kg, and the median age was 5.6 months (range: 3.3–12.9 months). There was no significant difference between groups in respect to weight or age (p >0.96). There was no significant difference in CSA between samples from contralateral limbs or experimental groups (p ≥0.824). Suture material and pattern were each equally distributed to tendons of left and right specimens.

Yield force was significantly greater for repairs using polypropylene (107.5 ± 30.7 N) than for V-Loc (48.6 ± 20.5 N) (p <0.0001). Ultimate force to failure significantly differed by suture material and by pattern, but not by tendon CSA (p <0.0001). Significantly more force was required for failure of repairs using polypropylene (109.3 ± 30.2 N) than for V-Loc suture (57.7 ± 18.9 N) (p <0.0001). There was no significant interaction between suture pattern and material (p = 0.378).

Force required to create a 1 mm gap, did not significantly differ between polypropylene (56.5 ± 38.1 N) and V-Loc (40.3 ± 21.2 N) (p = 0.052), however incidence of 1 mm gap formation was significantly greater with V-Loc (33/36; 91.7%) compared to polypropylene (20/36; 55.6%) (p = 0.001). Similarly, incidence of 3 mm gap formation was significantly greater with V-Loc (29/36; 80.6%) compared to polypropylene (18/36; 50.0%) (p = 0.006).

Suture breakage was significantly more frequent with V-Loc (35/36; 97.2%) than polypropylene (20/36; 55.6%); conversely, tissue pull-through was more common with polypropylene suture material than with V-Loc (p <0.001).

In regard to suture pattern, significantly more force was required for ultimate failure of 3LP (100.9 ± 36.6 N) than for BM (66.1 ± 25.6 N) (p <0.0001). Force to create a 1 mm gap was greater in 3LP (69.3 ± 31.0 N) than BM patterns (33.7 ± 19.4 N) (p <0.0001) and the incidence of 1 mm gap formation before failure was significantly greater with BM (34/36; 94.4%) compared to 3LP (19/36; 52.8%) (p <0.001). Similarly, the incidence of 3 mm gap formation before failure was significantly greater with BM (34/36; 94.4%) compared to 3LP (13/36; 36.1%) (p <0.001). Tenorrhaphy using the 3LP (94.7 ± 41.0 N) had significantly greater yield forces than BM (61.4 ± 29.9 N) (p <0.0001) (▶Figure 3). Suture breakage was significantly more frequent in the BM (34/36; 94.4%) than 3LP pattern (21/36; 58.3%) (p <0.001).

Gap distance at yield force was significantly less for 3LP (▶Figure 3) (median: 0.0 mm, range: 0.0–5.4 mm) than for BM patterns (median: 4.6 mm, range: 0–20.3 mm) (p <0.0001). Gap at peak force was significantly less for 3LP (median: 0.9 mm, range: 0.0–7.8 mm) than for BM (median: 10.6 mm, range: 0–30.9 mm) (p <0.0001). Gapping of tendon ends at peak force was significantly less for polypropylene suture (median: 2.8 mm, range: 0–19.1 mm) than for V-Loc (median: 6.9 mm, range: 0–30.9 mm) (p = 0.0036).

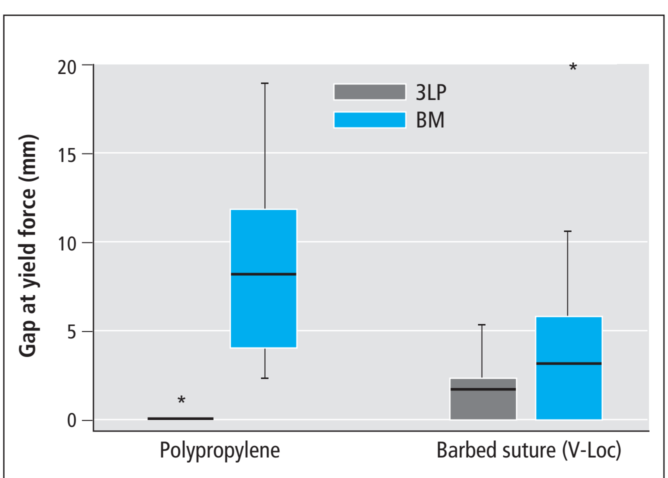

Figure 3 Results of electromechanical tensile testing for determination of gap formation (mm) between cut tendinous ends. Gap distance (mm) at yield force was significantly less for the three-loop pulley pattern than for the Bunnell-Mayer pattern (p <0.0001) in both suture types. *represent outliers (greater than 1.5x interquartile range)

Discussion

The results of this study show that the use of a 3LP suture pattern caused significantly less distraction between the tendon ends (gapping) when compared to the BM pattern in a canine cadaveric model, irrespective of the suture material used. Our results also indicate that the incidence of gap formation between tendon ends was significantly more likely in tenorrhaphies repaired with a barbed suture compared to those repaired with smooth polypropylene.

Resistance of the surgical repair to gap formation is an important attribute of the method used for realignment of tendinous ends after transection, irrespective of cause (12). Large gaps markedly impair the healing process in tendon repair, leading to an increased risk of rupture and failure in the early phases of healing (3, 5). Gap formation of greater than 3 mm has previously been shown to be detrimental to tendon healing affecting the ultimate force, repair-site rigidity and accrual of repair site strength and stiffness (3, 6). These "gapped" repairs are at greater risk of rerupture during the early periods of rehabilitation (3, 6). In our study the 3LP group, using both barbed and polypropylene suture, required significantly greater force to generate both 1 mm and 3 mm gaps compared with those repaired using the BM pattern. The 3LP also sustained a significantly greater peak force prior to failure compared to the BM pattern. The 3LP has previously been shown to be superior compared to locking loop patterns in biomechanical studies in canine cadaveric models, leading to increased tensile strength, and resistance to the development of gap formation (6, 9, 13). In one study, the force required to produce a 2 mm gap between tendon ends was significantly greater for both single and double-braided 3LP than locking loop patterns (9). The conclusion of that study was that the 3LP pattern provided more support, less tendon distraction, and less tendon matrix constriction and distortion to the tendon substance (9). When tension is applied to a tendon repaired with a 3LP pattern, suture glides through the tissue in a pulley-like fashion so that equal tensile load is supported by each loop (9). Redistribution of tension occurs more easily if each loop is tightened, and the ends of the tendon are approximated prior to completion of the suture pattern. Barbed suture allows this gliding motion in a single direction only and prevents slippage by the anchoring of barbs within tissue when tension is applied, potentially creating an unequal tensile load distribution between loops. We found that at peak force, gapping occurred much more commonly in tendons repaired with barbed suture in the BM pattern. This may support the reason for differences seen in the failure mode of the barbed suture compared to polypropylene in the 3LP pattern. Pilot studies performed prior to data accrual (unpublished) revealed it was challenging and time consuming to achieve apposition of tendon ends until after all suture material had been placed when using barbed suture. Subjectively, 3LP appeared to provide better apposition of tendon ends once tension was applied, however BM resulted in less distortion and deformation of the tendon substance. These findings are consistent with findings of previous studies comparing 3LP with a single locking-loop suture pattern (12).

In 97.2% of the tenorrhaphy constructs repaired with barbed suture, rupture of the suture material occurred as the primary mode of failure, documented visually at the time of testing and after assessment of high-speed camera data. Rupture occurred along the length of the material and not at the pre-constructed end loop. The exact location of suture rupture (barbed or non-barbed portions) was not directly evaluated and is an area for future study. In tendons anastomosed with polypropylene that failed, failure occurred at the level of the knot. None of our patterns were locking; therefore gapping can be attributed to slack within the construct and gliding of the suture material within the tissue, and by elongation of the suture itself. Suture breakage was more common with V-Loc, and was more common for tendons repaired with

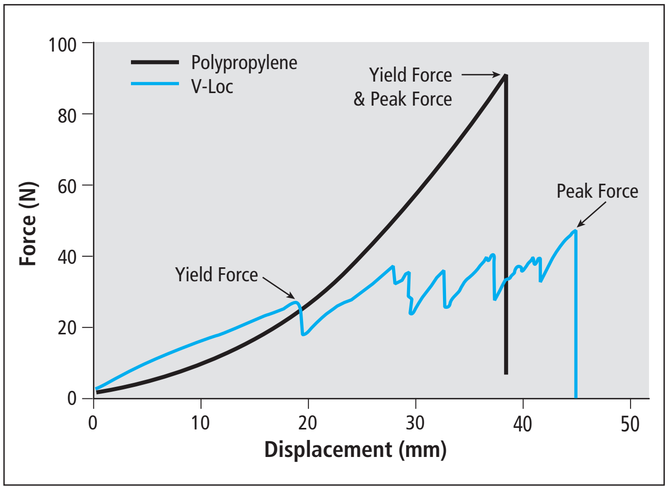

Figure 4 Graph depicting results for typical load-displacement curve of polypropylene and barbed suture in the Bunnell-Mayer pattern. The yield and peak force can be seen marked on the figure.

BM compared to the 3LP patterns. This was probably related to the fact that after gapping occurs, all applied load is borne by the material used for repair. In the same pattern, rupture of the barbed suture was observed while smooth suture remained intact, this finding suggests that V-Loc is indeed weaker than standard suture of the same size, despite claims made by the manufacturer. It should be noted that the yield force and peak force for the polypropylene repaired tendons generally coincided (▶Figure 4) compared to the barbed suture repairs where there was a greater discrepancy between yield and peak force.

Potential differences of failure mode may be related to suture placement, test conditions, differences in substance resistance to pull-out, or the suture itself. Due to the fact that all variables apart from suture were controlled, it is likely that the suture material is the main determinant for the observed results. V-Loc suture stock (4 metric synthetic non-absorbable polybutester material) is processed to create a barbed suture (3.5 metric barbed non-absorbable polybutester) equivalent in diameter to a non-barbed 3.5 metric suture. It should be noted that in the 3LP groups, six strands of suture span the level of tendinous transection, however in the BM groups only two strands cross the repair site. Each strand of suture placed in the BM pattern therefore carries a greater proportion of the force applied to the construct, and could reflect potential differences observed within our results between the 3LP and BM groups.

In the barbed suture groups, it was evident that upon gapping there was slippage and backing out of suture through the tendinous tissue, and then the barbs would regrasp and hold until further slippage occurred (▶Figure 4), as has been previously demonstrated in a biomechanical cadaveric canine gastrocnemius model (27). Previous studies using barbed suture have determined the primary mode of failure to be bending or reversal of the barbs, where a barb fails to anchor within tissue and facilitates pull-through by backwards bending of the barb (17). It is interesting to note that failure did not occur in any of the cases repaired with barbed suture by pull-out of the 1 cm suture tag. Pull-through was more common with polypropylene suture where elastic and plastic deformation prior to failure was appreciable, and our results agree with results of another cadaveric study (12).

A proposed advantage of self-anchoring barbs for use in tendon repair is the ability to prevent transected ends from gapping when tension is applied (29, 31, 32). Results of our study demonstrate the use of polypropylene for anastomotic repair of cadaveric tendons to be superior to barbed suture (V-Loc) of equivalent size. This finding may be due to barb realignment or barb reversal within the tendinous substance without damage to either the suture or tissue, consistent with the results of previous biomechanical studies (17, 27). Polypropylene suture required significantly greater force to produce 1 and 3 mm gaps compared to that of barbed suture, where gapping occurred when much lower forces were applied. We found the unidirectional V-Loc suture easy to handle, however care must be taken with each needle pass, as misalignment or misplacement of suture cannot be corrected by simply retracting the suture owing to the orientation of barbs. Bidirectional barbed suture have barbs orientated in a helical array, set in opposing directions from the sutures midpoint. This configuration allows the suture to be self-anchoring, permitting close approximation of the tissue while resisting tissue migration in both directions and may have advantages for suture tenorrhaphy (18, 19). With smooth polypropylene, the tenorrhaphy has to be retightened, or constant tension maintained to prevent separation of the apposed tissue edges when tying the knot. Incidence of gap formation was much more common, irrespective of pattern, when barbed suture was used. It would seem logical that the more barbs embedded within the tissue, the greater the strength of the construct and thus the more force required for separation of the tissue. We chose the BM pattern because this allowed the maximal amount of suture, and thus barbs, within tendinous tissue compared to other common patterns. The ultimate tensile strength of smooth polypropylene has been demonstrated to be significantly greater than barbed polypropylene in a canine cadaveric biomechanical study (27). This may be related to the creation of barbs by cutting into the core suture, which could potentially cause significant weakening of the suture itself, despite claims made by the manufacturer. To our knowledge, the force required to overcome the barb-tissue interaction with V-Loc against the direction of barb orientation is not known. It has previously been demonstrated in skin and tendinous tissues that increasing the cut angle of the barbs decreases the level of shear stress and decreases the amount of force required to peel a barb from its anchor point within the tissue (17).

This study has its inherent limitations. Firstly, the *ex vivo* nature of this biomechanical analysis was a single ramp to failure without evaluation of cyclical loading, as would more closely represent conditions in clinical situations. Cyclical testing at physiological loads rather than testing to failure has previously been shown to more accurately mimic the *in vivo* situation, and has been demonstrated to be more sensitive to gap formation in a human flexor tendon study (33). We did not evaluate glide function as part of our study. Glide function is an important concept in human flexor tendon repair in which surgical repairs must be devoid of protruding foreign material which may catch or impede surrounding soft tissue structures. This is less problematic in canine tenorrhaphy repair as fine motor function is less of a clinical concern.

Another limitation relates to the measurement of gapping after review of the video footage. A gap was easily identifiable by progressive separation of the tendon anastomoses, however, at times precise measurement was hampered by asymmetric openings as the cut ends were not always parallel and the length of the gap not always uniform. Variability was reduced by measurement of the smallest gap possible between tendon ends. We recognize that small errors in gap measurement may have led to improper classification of tendons, however we do not believe that the results and the conclusions drawn from them were affected in any way, and any variability in gap measurement was minimized by the measurement of the gap formation four times and the use of different video frames for gap selection. This testing model however remains superior to the use of reflective markers within biomechanical studies as it eliminates tendon elongation as a confounding variable (6). The cadaveric specimens in our study were obtained from relatively immature, healthy dogs. Although performing this study using mature patients is unlikely to have changed the performance of suture configurations and suture type utilized, it is possible the absolute values for peak and yield force may differ in the mature patient as a function of differing cross sectional morphology of the adult tendon. Age may also influence a change in the relative collagen composition and cross-linkage of the tendon over the tension holding capacity, and resistance of the tendon to suture pull-out. Pre-existing tendinous disease due to concurrent metabolic or endocrine co-morbidities may also influence the results presented here.

Lastly, the experimental sutures used for testing were produced by different manufacturers and composed of different materials. This was however deliberate, in order to most closely represent what is currently used for tendinous repair in clinical situations in our hospital. We used 3.5 metric monofilament polypropylene to anastomose tendon constructs because it is commonly used in clinical practice for canine tendon repair.

Conclusion

We conclude that the use of polypropylene suture is superior in canine cadaveric tenorrhaphy in preventing anastomotic gap formation when compared to a similar sized unidirectional barbed suture. We also demonstrate that a 3LP pattern for repair was more resistant than a BM pattern at preventing gap formation, thus confirming that suture technique is of primary importance in producing a strong and stiff repair throughout the early phases of healing.

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Conflict of interest

The authors declare no conflict of interest related to this study. No financial support was received to fund this study.

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