# Tissue Anchoring Performance of Barbed Surgical Sutures for Tendon Repair

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**Introduction:** Barbed surgical sutures are approved by the US Food & Drug Administration for use in plastic and cosmetic surgical procedures [1-3]. The main advantage of the barbed surgical suture is that the barbs project out, penetrate, and anchor with surrounding tissue along the entire suture's length, thus eliminating the need for tying a knot. While this barbed suture technology is widely accepted clinically for skin wound closure, its suitability in other applications, such as tendon repair, has not been accepted [4]. Increasing the tissue anchoring performance generated from the protruding barbs is a key factor to expanding the application of barbed surgical sutures into other fields. The initial objective of the current study was to develop a novel *in vitro* tendon/suture model for measuring the anchoring performance of barbed sutures in porcine tendon tissue. The second objective was to compare the tendon anchoring performance of nylon 6 with polypropylene (PP) barbed sutures.

*Figure 1. Repair-site profile using 4-core unbarbed cruciate technique (top) and 6-core barbed technique (middle), compared with uninjured tendon (bottom)[4]*

**Methods:** Nylon 6 and PP size "0" (diameter = 0.38 mm) monofilament sutures (Ethicon Inc.) were fabricated into barbed sutures using a special barb cutting instrument designed and assembled in our laboratory. The barb geometry followed Ingle's optimized values for tendon tissue of 170° cut angle and 50% cut depth [5]. The largest needle length, 4 cm, was taken as the length of the barbed section, in which 10 barbs were inserted. So the density of barbs was 2.5 barbs/cm. The barb geometry was measured using a Nikon H550S optical microscope at 40x magnification. The tissue anchoring performance of the prepared nylon 6 and PP barbed sutures was measured in tendon tissue using the *in vitro* pullout test illustrated in Figure 2. Fresh porcine superficial distal flexor tendons were harvested from the NCSU School of Veterinary Medicine and used within 12 hours. The distance between the needle insertion point and the needle exit point, Dt, was kept constant as 1.5 cm. The maximum pullout force (F) in Newton was regarded as the anchoring performance. Five repeat specimens were tested for each sample. A pairwise student t-test was performed to determine whether there was a significant difference in anchoring performance between the nylon 6 and PP barbed sutures.

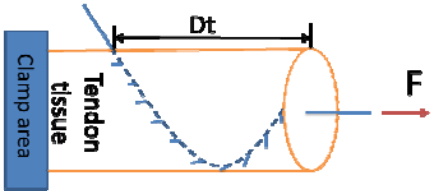


*Figure 2. Tendon/suture pullout test model.*

**Results:** Table 1 shows the average results of barb geometry and tensile pullout force measured on the nylon 6 and PP barbed sutures. Based on the t-test result, the PP barbed sutures had a significantly higher anchoring performance compared to the nylon 6 sutures (p=0.03).

*Table 1. Cut angle, cut depth and pullout force measured for both nylon 6 and PP barbed sutures. (n =5)*

| | Cut angle (°) | Cut depth (%) | Pullout force (N) |
|---|---|---|---|
| Nylon 6 | 164.87±1.53 | 51.1±4.8 | 4.22±3.40 |
| PP | 167.49±1.00 | 46.4±3.2 | 8.58±1.41 |

The significant difference in anchoring performance between the nylon 6 and PP barbed sutures may be explained by the difference in barb openness at the suture surface (Figure 3). Barbs on the nylon 6 suture have a tendency of collapse back onto the surface, whereas the polypropylene barbs appear to stand out more readily. This may be due to differences in the crystalline micro-structure and physical properties of the two suture materials.

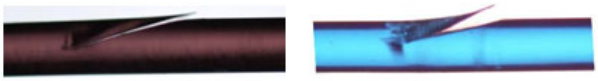

*Figure3. Optical microscopic images of nylon 6 (left) and PP (right) barbed sutures showing typical barb openness (Magnification 40x).*

**Conclusions:** The study was successful in developing an *in vitro* tendon/suture pullout test model to distinguish the tendon anchoring ability of nylon 6 and PP barbed sutures. Statistical analysis showed that PP barbed sutures have a significantly higher anchoring performance than nylon 6 sutures. Work is continuing to establish more appropriate *in vivo* animal test procedures that will facilitate the clinical evaluation of barbed sutures for tendon repair.

**References:**

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