Needle Penetration Force and Suture Strength Comparison

Objective

The purpose of testing was to compare penetration force required to pass two surgical needles through a standard test material (Porvair®) and porcine tendon. Suture ultimate strength was also compared from manufacturer data.

Test Groups

A baseline comparison was conducted between the EasyWhip® needle from Winter Innovations (a novel two-part suture needle designed to improve ease of use, speed, and accuracy of stitching in soft tissue surgeries) and a conventional Loop Suture Needle typically used for whip stitching (Arthrex, FiberLoop®). Illustrations of the two products are depicted in Figure 1.

EasyWhip® **Loop Suture Needle**

Figure 1: The two suture needle designs tested: EasyWhip® two-part needle (left) conventional Loop Suture Needle (right)

Suture needle performance can be evaluated by two key metrics: needle penetration force and suture strength. First, lower needle penetration force is associated not only with improved usability from the surgeon perspective, but also lower tissue damage.[1] Needle samples were tested on two materials, Porvair® and porcine tendon. Porvair® is a homogenous leather-like material commonly used in needle testing for its consistency across samples. Porcine tendon is a less consistent, but more realistic material commonly used to simulate suturing in human tendons.

Next, higher suture tensile strength values signify superior performance and less likelihood to rupture under tension. This is especially critical in orthopedic procedures where the sutures provide mechanical strength to a repaired ligament or tendon. The EasyWhip® suture is made of 100% ultra-high molecular weight polyethylene (UHMWPE). In contrast, the loop suture material consists of a polyester core with a UHMWPE jacket.

Methods

A materials testing machine was used to penetrate needles through the material, Porvair® or porcine tendon (Figure 2).

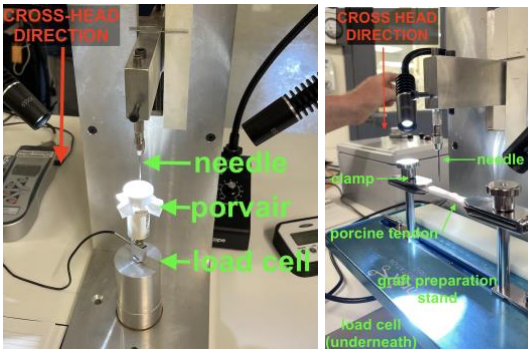

Figure 2: Test setup for needle penetration testing through Porvair® material (left) and porcine tendon (right)

A needle sample was fixed to the crosshead and perpendicularly pierced through the material at a constant rate of 1.7mm/sec. It was then withdrawn and passed through a new location ~5mm away from the previous hole, which was repeated for five replicates per needle. Force data was recorded throughout the penetration sequence, and the peak value was identified as the penetration force.

Suture tensile strength testing was conducted using sterile, size 2 suture and obtained from the manufacturer.

Results[2]

Needle penetration force for Porvair® and porcine tendon are shown below in Figure 3. Penetration force was significantly lower for EasyWhip® than the Loop Suture Needle in both Porvair® (p=0.002) and porcine tendon (p<0.0001).

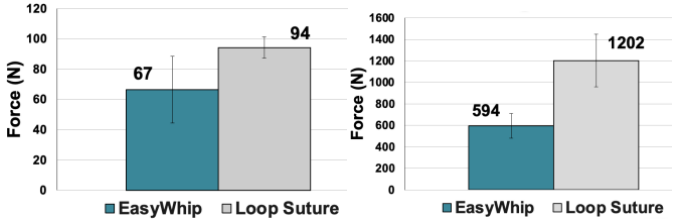

Figure 3: Average force (N) required for EasyWhip® and Loop Suture Needle to penetrate through Porvair® (left) and porcine tendon (right).[2]

In addition, suture tensile strength data is highlighted in Table 1 and demonstrates EasyWhip® suture is 17lbs stronger, on average, than the Loop Suture Needle.

Table 1: Avg. tensile strength for EasyWhip® and Loop Suture Needle[3]

	Average Tensile Strength (lbs)
EasyWhip® Suture (UHMWPE)	72
Loop Suture (UHMWPE/Polyester)	55

Discussion

For both Porvair® and porcine tendon, EasyWhip® required significantly lower force to penetrate the materials as shown in Figure 3. In porcine tendon, EasyWhip® required only ½ the force to penetrate porcine tendon compared to the Loop Suture Needle. Using less force to penetrate tissue in an operating room not only signifies a better user experience, but also lowers the chance of needle tip breakage[4] and the possibility of tissue damage.[5]

Additionally, EasyWhip® suture material has higher tensile strength than the conventional Loop Suture Needle tested. This suggests that EasyWhip® sutures can withstand higher force before breaking, which is critical in orthopedic procedures where the sutures provide mechanical strength.

Conclusion

EasyWhip® provides a promising alternative to the conventional Loop Suture Needle, as it requires lower force to penetrate tissue and offers higher tensile strength suture. Correlation to clinical results in humans is unknown.

References

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