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Tensile Testing of Surgical Sutures | Using Straight-Pull and Knot-Pull Tests

Sutures are used in a variety of different surgical procedures to close wounds and aid in tissue healing. They are manufactured from a variety of different absorbable and nonabsorbable materials, and may be a single filament or braided with or without a coating. Tensile strength is a critical measure of performance during and after surgical procedures. The strength of different knotting techniques must also be evaluated. The test method must determine breaking strength and corresponding elongation and adhere to Food and Drug Administration (FDA) guidelines. Precise, consistent and reliable measures of strength and strain are essential for product development and quality control.

Test Configuration and Sample Preparation

The Instron 3345 frame with a 1 kN load cell and 1 kN capacity pneumatic cord and yarn grips were used to perform this test. These cord and yarn grips are instrumental to successfully conducting tensile tests on suture material for the following reasons:

- Ensure perfect alignment of the specimen in the grips
- Reduce stress concentration at grip faces
- Prevent slipping with increased gripping force
- Simplify method for loading specimen in grips (as compared with standard capstan grips)

In order to accurately set a specific gauge length, a thin rope with the gauge length marked is placed in the bottom grip such that the lower gauge mark is in line with the grip face. The rope is wrapped around the mandrel and fed around the upper mandrel. The crosshead is moved in order to align the upper gauge mark on the rope with the upper grip face. In this test, a gauge length of 150 mm was used.

Evaluation of the material was conducted in two different tests, a straight-pull test and a knot-Pull test. The suture was cut to a length that extends through both grip faces and the grips were closed with a clamping pressure of 85 psi. A close-up view of the suture in the grips is shown in Figure 1.

For the knot-Pull test, the suture material was tied into a square not around a 6 mm diameter rod. The rod was removed and the ends of the suture were positioned around the grip mandrels such that the knot was at the center of the gauge area, as shown in Figures 2 and 3.

In both tests, the rate of grip separation was 200 mm/min and values for break load and extension at break load were reported.

Figure 1:
Suture material loaded into the pneumatic cord and yarn grips for a straight-pull test.

Figure 2:
Suture material with a knot tied at the center of the specimen and loaded into the pneumatic cord and yarn grips for a knot-pull test.

Products for Materials Testing

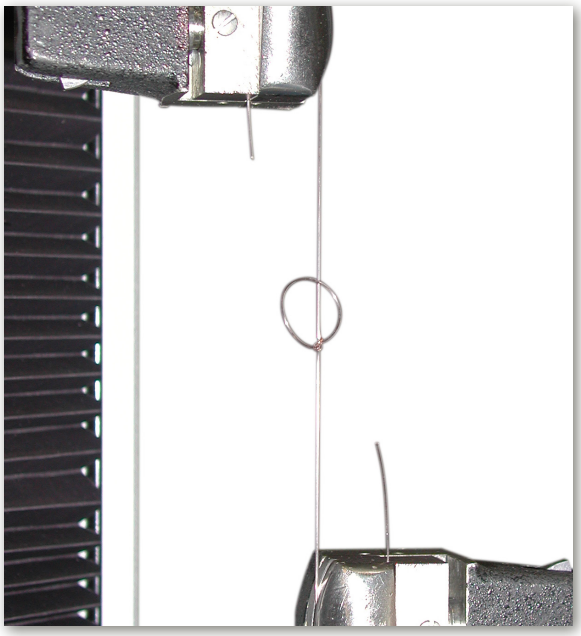

Figure 3:
Close up of knotted suture specimen

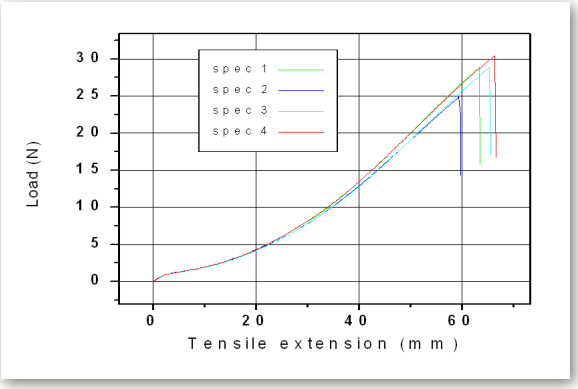

Figure 4:
Results from straight-pull test to failure of four suture specimens.

Sample Number	Break Load	Extension at Break
	N	mm
1	28.93	63.33
2	9.01917	59.67
3	8.46985	65.33
4	9.86817	66.33
Mean	9.63607	63.67
S.D	0.87168	2.94

Table 1:
Load and extension at break results from straight-pull test to failure of four suture specimens.

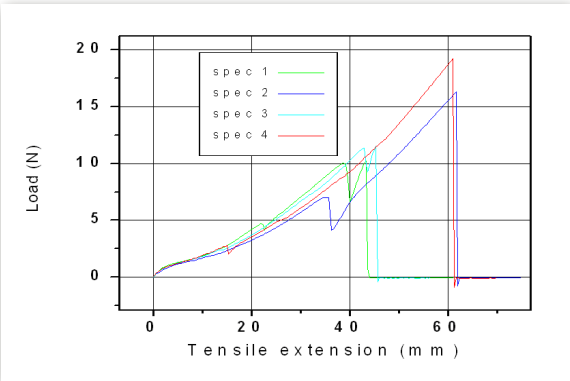

Figure 5:
Results from knot-pull test to failure of four suture specimens.

Sample Number	Maximum Load	Extension at Maximum Load
	N	mm
1	10.19	43.33
2	16.29	61.67
3	11.54	45.33
4	19.21	61.00
Mean	14.31	52.83
S.D	4.19	9.85

Table 2:
Maximum load and extension results from knot-pull test to failure of four suture specimens.

Conclusions

The test configuration described was successfully able to test the suture specimens to failure without slipping or premature failure of the material in the grip faces, providing reliable and consistent load and extension results.

It can be seen from these results that the load at break values for all specimens in both tests was significantly lower than the load capacity of the cord and yarn grips recommended. It should be noted that the higher load capacity grips have a greater gripping force as compared with lower capacity grips. This extra gripping pressure on the specimen prevented slipping that would normally occur in other grips.

A video extensometer is a supplementary accessory with this test configuration that would be useful in cases were precise strain measurements were required. The test method would followed exactly as described above except that small black flags would be placed on the specimen to mark the gauge area.

Catalog Number	Configuration Options	Description
	N	mm
3345	Frame	Single column frame
2519-105	Load cell	1 kN capacity
2714-004	Fixtures	1 kN capacity pneumatic cord and yarn grips
2410-257K1	Software	MerlinTM software
2410-258C1	-	Tension application

Table 2:
Maximum load and extension results from knot-pull test to failure of four suture specimens.

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