Tensile Mechanical Property Evaluation of Two Absorbable Sutures: Effects of Size and Types

Nelle D'Aversa, Daniel Burkley, Elizabeth Vailhe, and Meng Deng
R&D, Ethicon, a Johnson & Johnson Company, P.O. Box 151, Somerville, New Jersey 08876, USA

INTRODUCTION

Sutures have been used as far back as 2000 BC and are still the most important device in closing a wound. The physical and biological properties of a suture are specific to each suture type and are important factors for a surgeon when selecting a suture for surgery. Sutures are load-bearing medical devices and routinely tensile-tested for performance. Resulting tensile properties are dependent, among other factors, on types of sutures as well as their size. When discussing tensile strength, industry professionals and surgeons normally refer to a suture's absolute strength in pounds or newtons (N), which in some cases may not be enough to understand fully a suture or fiber's performance. In this study we performed tensile testing on six suture samples and compared various tensile properties in both absolute and normalized values, and investigated their interrelationship for both monofilament and braided sutures.

MATERIALS AND METHODS

The experimental materials used were two synthetic absorbable sutures, made from polydioxanone (PDO) and poly(glycolide-*co*-L-lactide) 90/10 (PLGA). The former is a monofilament and the latter is a braided suture. To study effects of size on properties, three suture sizes were tested (Table 1). Eight specimens of each size and suture type were cut to 101.6 mm specimens and tensile tested at room temperature to break using an Instron 5544 tester with a 500-N load cell at a gauge length 25.4 mm and a crosshead speed 25.4 mm/min. The tests and calculations (strength, modulus, elongation and stiffness) were accomplished using Instron Bluehill 3 software. To study the failure mechanism, the fracture ends of suture samples were examined using a Keyence digital optical microscope. ANOVA and Fishers LSD tests were performed using Minitab 16 to determine if there are statistical differences among various tensile properties.

RESULTS AND DISCUSSION

The results show that tensile properties were largely dependent on the suture type and size. While the absolute tensile strengths (N) increased significantly with the increased suture size, the normalized strengths (MPa) decreased with the suture size (Figs 1 and 3). A smaller sized suture tended to be subjected to higher drawing in manufacturing and therefore have higher orientation, which could be understood also by analyzing the tensile elongation (Fig 3). Although there were larger differences in absolute strength (N) than normalized strength (MPa) between sizes of the same suture type, both values were statistically different among samples. Fig 2 shows the modulus of the suture decreased with the increased size, and therefore this property cannot be used as an indication for suture's flexibility because obviously smaller size sutures are much more flexible than larger size sutures. Instead the stiffness (slope of load-displacement curve) is much more appropriate to describe the flexibility of a suture made of the same polymer in this case (Fig 2). Braided PLGA suture samples had higher modulus and stiffness values for all sizes than PDO sutures and such results may also be due to lower glass transition temperature of the latter. Fig 3 shows that percent elongation increased with size for both PDO and PLGA suture samples, and PDO suture samples had a higher % elongation. Finally, Fig 4 shows that the fractured ends of PLGA and PDO sutures are significantly different in morphology.

SUMMARY

Polymer type, suture configuration, and size had significant effects on tensile properties of two experimental sutures. While a large suture can bear more load, small sutures will have higher normalized tensile strength and modulus. Tensile modulus cannot be used to describe the flexibility of sutures of different configuration. PDO and PLGA sutures in this study showed significantly different failure mechanisms.

Table 1. Measured Diameters (mm) of Suture Samples

Sample	Size 1	Size 2-0	Size 4-0
PDO	0.53 ± 0.01	0.36 ± 0.01	0.21 ± 0.00
PLGA	0.50 ± 0.02	0.32 ± 0.02	0.21 ± 0.01

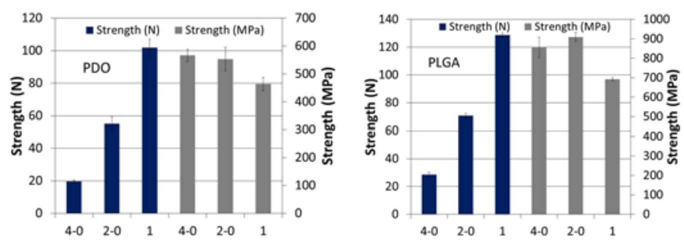

Fig 1. Comparison of Tensile Breaking Strengths for Two Sutures.

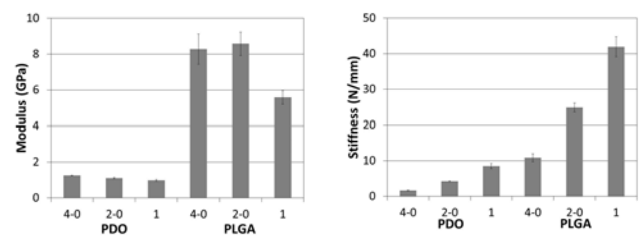

Fig 2. Modulus and Stiffness Comparison for Two Sutures.

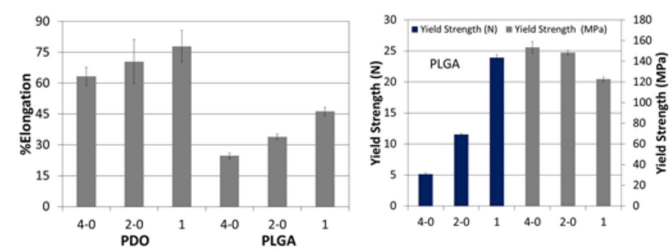

Fig 3. Elongation and Yield Strength Comparison of Two Sutures.

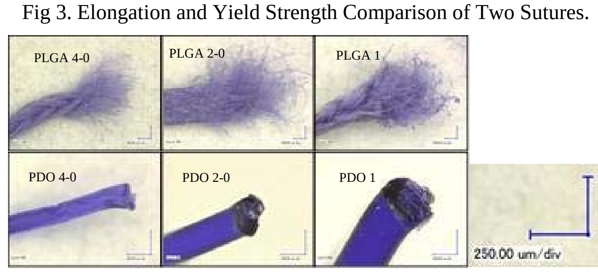

Fig 4. Morphology of Fractured Ends of Tensile-Tested Suture Samples

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