International Journal of Applied Pharmaceutics

ISSN - 0975 - 7058 Vol 11, Special Issue 5, 2019

Research Article

COMPARISON TENSILE STRENGTH OF NATURAL AND SYNTHETIC ABSORBABLE SUTURES

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Received: 19 July 2019, Revised and Accepted: 21 July 2019

ABSTRACT

Objective: The aim of the investigation is to evaluate and to compare the tensile strength of commercial natural and synthetic absorbable suture materials currently used in surgery. The natural absorbable sutures of chromic catgut are prepared for this purpose as well as commercial synthetic absorbable sutures made from polyglycolide.

Methods: The analysis has been carried out following the standard test method for tensile strength and Young's modulus of fiber ASTM C1557-03. Measuring the diameter of each suture has been carried out with an optical microscope to determine the accuracy of manufacturers' data. Tensile testing has been performed to evaluate the tensile strength of each type of sutures. The modulus elasticity and strain (ϵ) obtained are also presented.

Results: The results show that sutures made from braided synthetic material of polyglycolide (violet coated) present a tensile strength remarkably superior (1070.292 MPa) to that of natural absorbable sutures of chromic catgut (392.276 MPa). Using optical macro microscope analysis, monofilament sutures present less surface irregularities than multifilament polyglycolide sutures. Chromic catgut monofilament sutures present less surface irregularities than multifilament polyglycolide.

Conclusion: Tensile test of absorbable sutures was conducted in this research. Two types of absorbable sutures were investigated and compared. It is found that sutures made from braided synthetic material of polyglycolide (violet coated) having much better tensile strength comparing with sutures made from natural material (chromic catgut monofilament).

Keywords: Comparison, Tensile strength, Natural, Synthetic, Absorbable, Sutures.

 DOI: http://dx.doi.org/10.22159/ijap.2019.v11s5.T1011

INTRODUCTION

Suture materials have various important applications in surgery ranging from repair of tension band of certain fractures, fascia, closure of surgical wounds, tendons, muscles, ligaments, and joint capsules. The quality of repair is dependent on variables including material properties of the surgical technique, suture, and tissue characteristics. The types of suture material have important implications in tissue repair. For appropriate indication, adverse surgical outcomes can be avoided by the selection of the suitable suture materials. Surgical complications associated with failure of tissue repair include wound dehiscence, re-rupture of muscle, tendon and ligaments, failure of repair of capsulolabral structures, incisional hernia structures, and loss of reduction of fractures, [1].

Sutures can be made from nylon [2], polyethylene, polyester, copolymerized lactide and glycolide [1], Thermoplastic poly urethane (TPU) [3], polydioxanone, polyglycolic acid [4], polypropylene [3,4], silk [5-8], and catgut [9].

Two important properties are non-reactivity to provoke the least inflammatory response and failure load, to provide adequate tension for wound closure [10]. The commission of group purchasing organisation providing market research from operating room and material managers at member hospital to survey regarding their rating of clinical acceptability and their vendor preference of the product. Evaluations of suture have typically been conducted by group purchasing organizations [11]. The data will assist the orthopedic surgeon in the selection and application of appropriate suture materials and calibers to specific tasks [1].

The purpose of this study is to compare the tensile strength of two types of absorbable sutures. The first type is absorbable sutures made from natural material and the second type is absorbable sutures made from synthetic material. The data of modulus elasticity and maximum strain are also provided.

EXPERIMENTAL

Two types of absorbable sutures are provided in this research for tensile strength investigation. The first type is absorbable sutures made from natural material (chromic catgut monofilament) from brand of T-CRHOMIC and the second type is absorbable sutures made from synthetic material of polyglycolide (violet braided coated) from the brand T-VIO. Both of these products were manufactured by company of Triton, Indonesia.

The sutures' diameter of each tested material was measured after extraction from sterile packaging and was immersed in alcohol for 24 h to follow instruction from previous publication. Using an optical microscope, the diameter measurements were performed on samples of each kind of material at three different equidistant points of the sutures. The average of the diameter sample measurements represented the mean diameter value for each material investigated as explained in previous publication [10].

The tensile strength test analysis has been carried out following standard test method for tensile strength and Young's modulus of fiber. Tensile testing has been performed to evaluate the tensile strength of each type of sutures. The modulus elasticity and strain (ϵ) are also presented. 5-time repetition of valid tensile tests was conducted for both types of sutures, and the average value of tensile test will be provided. A mounting tab (Fig. 1) is used for specimen mounting. Small amount adhesive is placed on the mounting tab that defines gage

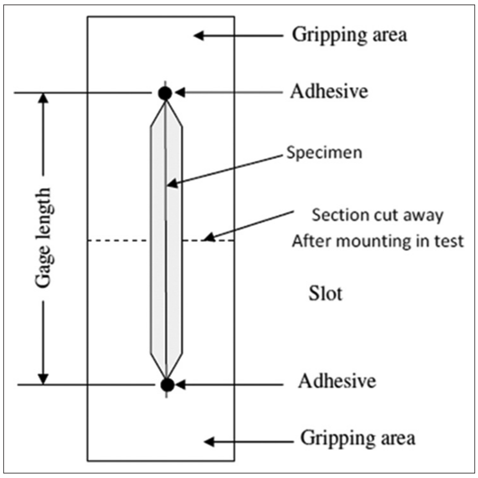

Fig. 1: Specimen mounting tab

length. The fiber is bonded to the mounting tab [12]. The gauge length in this research is 50 mm.

The tensile strength (*T*) was calculated using Equation 1, where *F* is force to failure (N), *A* is a cross-sectional area fracture plane normal to fiber axis (m^2). The tensile strain (ϵ) was measured using Equation 2 [12].

$$T = \frac{F}{A} \quad (1)$$

The tensile strain (ϵ) was measured using equation 2, where Δl is elongation of the gage length (mm) and l_0 is the gage length (mm) [12].

$$\in = \frac{\Delta l}{l_0} \quad (2)$$

Fiber Young's modulus was calculated using equation 3 [12].

$$E = \frac{\sigma}{\in} \quad (3)$$

RESULTS AND DISCUSSION

The appearance of the samples under macro microscope can be seen at Figs. 2 and 3 . The monofilament of absorbable suture made from natural material (chromic catgut monofilament (Fig. 2) presents less surface irregularity comparing the sutures made from braided synthetic material of polyglycolide (Fig. 3). More throws are required when using a monofilament suture. Braided sutures have greater strength and pliability making a knot less likely to slip, meaning fewer throws could result in a secure knot [13].

The graph of stress versus strain from the sutures made from natural material (chromic catgut monofilament) can be analyzed from Fig. 4 and for the sutures made from braided synthetic material of polyglycolide (violet coated) can be observed in Fig. 5. For easy comparison, the result is presented in Table 1.

The tensile strength of synthetic braided violet-coated polyglycolide is found superior (1070.292 MPa) to the natural sutures made from chromic catgut monofilament (392.276 Mpa). Tensile strength data assist the orthopedic surgeon in selection and application of appropriate suture materials to specific tasks [1].

The tensile strain synthetic braided violet coated polyglycolide is found very much higher (0.362) comparing to the natural sutures made from chromic catgut monofilament (0.143). Related to strain, it is also informed that polyglycolide exhibits stress relaxation [4].

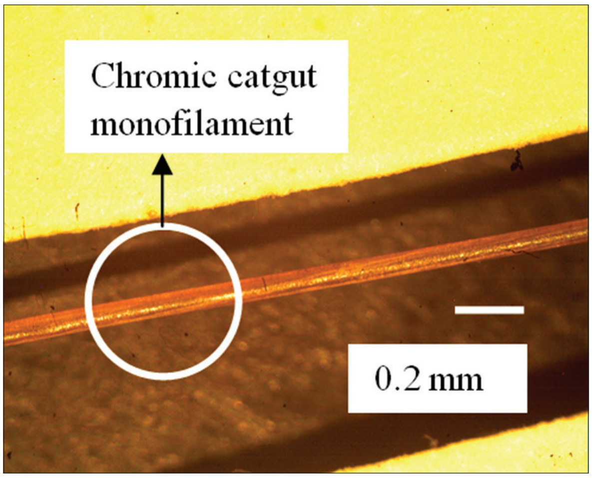

Fig. 2: Macrograph of the monofilament of absorbable suture made from natural material (chromic catgut monofilament)

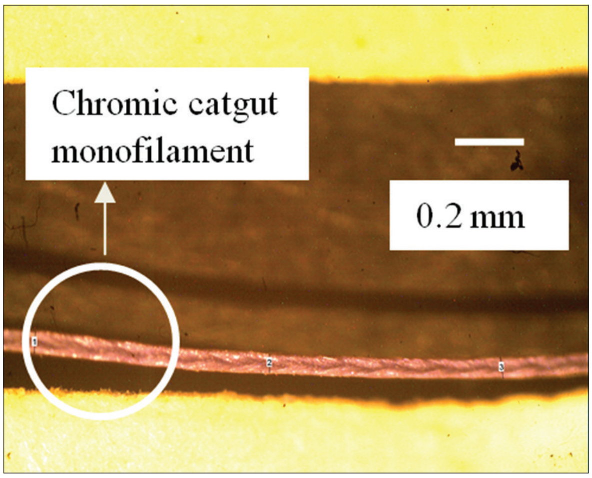

Fig. 3: Macrograph of the suture made from braided synthetic material of polyglycolide (violet coated)

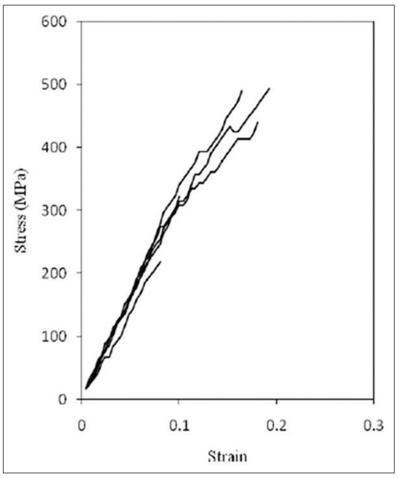

Fig. 4: The graph of stress versus strain of the sutures made from natural material (chromic catgut monofilament)

Synthetic braided violet-coated polyglycolide has Young's modulus higher (5321.328 MPa) than natural sutures made from chromic catgut monofilament (2786.484 MPa) which means that sutures made from synthetic braided violet-coated polyglycolide is more stiff than chromic catgut monofilament.

Table 1: The averages of tensile strength, tensile strain, and Young's modulus of absorbable sutures

Type of absorbable sutures	Material	Average tensile strength (MPa)	Average maximum tensile strain	Average Young's modulus (MPa)
Natural	Chromic catgut monofilament	392.276	0.143	2786.484
Synthetic	Braided violet coated polyglycolide	1070.292	0.362	5321.328

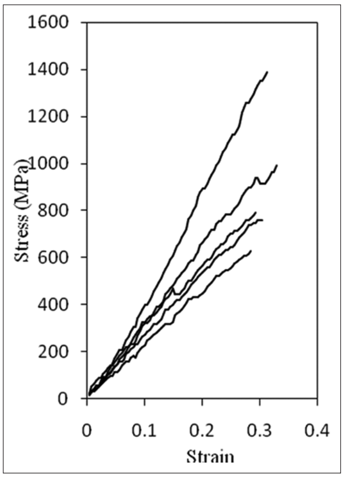

Fig. 5: The graph of stress versus strain of the sutures made from braided synthetic material of polyglycolide (violet coated)

Instead of synthetic braided violet-coated polyglycolide having better tensile strength than natural chromic catgut monofilament, previous publication also informed that polyglactin would be the best suture material with regard to tissue security and reaction scores. Chromic guts were problems with suture security over time [14].

This research promotes the application of absorbable sutures because previous publication reports that non-absorbable surgical sutures, including manufactured silk sutures, due to their antigenicity and/or the presence of bacterial infection, can cause granuloma formation after surgery [5].

Synthetic and natural absorbable sutures from other vendors than in this research may have different results because they do not have equivalent performance profiles. Specific brand seems to be the most important determinant of physician evaluations of the different vendors' products. It is importance of conducting comparisons of multiple vendors of the same product [11].

The difficulty about this research was found during tensile test. A skillful and experienced researcher is required to perform the tensile test. A size of specimen for single fiber tensile test is small; therefore, more concentration is needed during the test comparing to general tensile test with bigger size. For this reason, the technique can be improved by the utilization of magnifying lens during the test.

Future work will be addressed to compare the tensile strength between absorbable and nonabsorable sutures.

CONCLUSION

Tensile test of absorbable sutures was conducted in this research. Two types of absorbable sutures were investigated and compared. It is found that sutures made from braided synthetic material of polyglycolide (violet coated) have much better tensile strength comparing with sutures made from natural material (chromic catgut monofilament).

ACKNOWLEDGMENTS

This research was supported by the Ministry of Research Technology and Higher Education of the Republic of Indonesia through Udayana University, Jimbaran, Bali, Indonesia.

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