An Investigation on *In Vivo* Degradation of Polydioxanone Films in a Rat Model

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INTRODUCTION

Polydioxanone (PDO) is a synthetic absorbable polymeric biomaterial that is used to manufacture monofilament surgical sutures. Melt-extruded PDO films also find uses in other fields of medical implantations such as plastic and reconstructive surgeries [1]. Since the PDO-based medical devices are designed to degrade in a biological environment, it is necessary to understand the degradation behaviors and factors affecting the degradation mechanisms in vitro and in vivo for the polymer. This study reports on the *in vivo* degradation behaviors of three PDO films in a rat model.

MATERIALS AND METHODS

The materials were three experimental PDO film samples with nominal thicknesses of 0.15, 0.25 and 0.5 mm, respectively. The film samples were made in-house from extruded dyed PDO films. The 0.15-mm thick film had evenly distributed perforations (diameter 2 mm), while the 0.25- and 0.5-mm thick films were solid. The initial tensile properties of the three samples are given in Table 1. For the purpose of this study, the film samples were cut with a pair of surgical scissors into tensile specimens with nominal dimension of 50×4 mm, and then subcutaneously implanted over the thorax on the dorsum of rats. Each rat received two implants, one on either side of the midline. All implantation was done under sterile condition. All animals were handled and maintained in accordance with the requirements of the Animal Welfare Act, with adherence to the Animal Welfare regulations (9 CFR) and conformance to the standards promulgated in the Guide for the Care and Use of Laboratory Animals. Animals were euthanized at pre-determined time periods of 1, 2, 4, 6, 8 and 10 weeks. The implants were immediately removed and tensile-tested at room temperature on an Instron mechanical tester with a gage length of 10 mm and a crosshead speed of 250 mm/min. The morphological changes of the explanted samples were grossly examined using a Nikon image system (SMZ1500 optical microscope, DXM1200C digital camera and NIS-Element imaging software).

RESULTS AND DISCUSSION

Fig 1 shows the change of tensile breaking strength retention (BSR) as a function of implantation time for the three samples. It is clear from this graph that after 6 weeks of implantation, 0.25-mm and 0.5-mm samples had more than 60% BSR, while 0.15-mm samples retained about 40% of initial strength. At Week 8, the materials still had approximately 30 to 50% BSR. Tissue encapsulation of all samples was grossly observed after 1 week. At 10 weeks, it became extremely difficult to separate tissues from the samples and in fact the tissues could not be removed from the 0.15-mm samples without breaking them, suggesting that the perforation promotes tissue ingrowth. It is interesting to note that all samples had a sharp drop in BSR initially, then from Week 1 to 6 there was almost no reduction in BSR, and after 6 weeks the BSR again decreased quickly. It is believed that the faster drop in BSR for the 0.15-mm samples was a result of a stress concentration effect, which can be considered as a constant throughout the degradation of this film with a 2-mm circular hole design. From this study, it is unclear how the sample thickness affects the material's *in vivo* degradation. Fig 2 illustrates the change of tensile modulus with implantation time. These results indicate that the changes in modulus were similar to those seen for the strength. Representative morphology changes of the materials are illustrated in Fig 3, which shows that the materials still kept their integrity in spite of the strength reduction. The samples did quickly lose their coloration due to the fact that the dye dissipated from the polymer films during the implantation period.

SUMMARY

The *in vivo* degradation behaviors of three PDO films were investigated. The results show that the tensile strength of PDO films decreased with implantation time. Substantial gross tissue encapsulation was observed after implantation. Polymer morphology changed during degradation. The sample structure may affect the material strength degradation profile.

REFERENCES

1. Plast. Reconstr. Surg. Vol. 122, p254 (2008).

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Table 1. PDO sample initial tensile properties

Property	0.15 mm perforated	0.25 mm solid	0.5 mm solid
Strength (MPa)	32.7±3.8	50.2±6.4	47.4±6.1
Modulus (MPa)	425.2±60.7	622.5±25.9	503.2±40.8

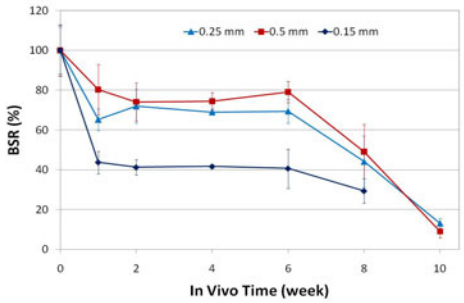

Fig 1. Change of BSR with in vivo degradation time

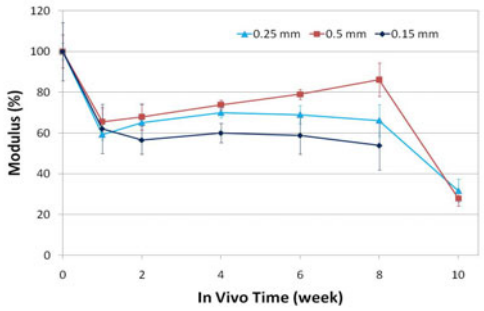

Fig 2. Change of modulus with in vitro degradation time

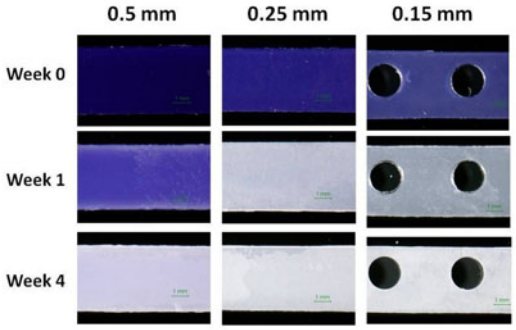

Fig 3. Morphology change of the samples