DEVELOPMENT OF *IN-VITRO* ADHESION TEST FOR CHITOSAN BANDAGES

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Introduction

Chitosan, a hydrophilic biopolymer derived by N-deacetylation of chitin (Figure 1), is a major component of crustacean shells such as crab, shrimp, and crawfish (1). Chitosan is biocompatible, biodegradable, bio-adhesive non-toxic, and induces hemostasis, which makes it a desirable material for biomedical applications. Chitosan bandages are being developed as wound dressings for severely bleeding injuries. The bandages need to adhere to the wound site to effectively control hemorrhages. The objective of this study is to develop a simple and quick *in vitro* test to evaluate the adhesion property of chitosan bandages.

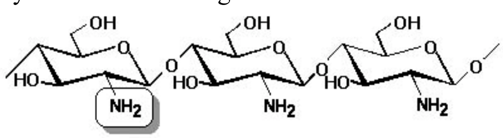

Figure 1: Structure of chitosan.

Materials and Methods

Chitosan Preparation

Chitosan bandages were made from pressing chitosan sponges made by freezing and freeze-drying suspensions under acidic conditions. Bandages were subjected to post processing steps of heat treatment and gamma sterilization.

In Vitro Adhesion Test Design and Development

The adhesion test was designed and developed from a standard tissue adhesion test (2). The chitosan bandages were tested with a MTS 858 Mini Bionix II. The adhesion test involved clamping a chitosan bandage sample between a cover plate and loading platform (figure 2). The bandage was wetted with 0.25 ml of porcine blood to coincide with *in vivo* porcine model. The 200 mm^2 PVC adhesion surface area was brought into contact with the bandage and loaded at a rate of 10 N/s to 10 N or 50 kPa and held for 3 minutes. The adhesion-testing surface was then pulled away from the bandage at a rate of 1 mm/s and the adhesion strength (kPa) was determined by the maximum force divided by the contact surface area.

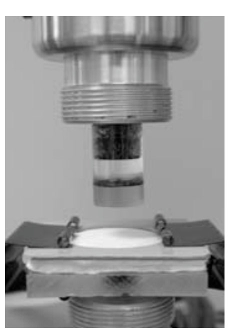

Figure 2: *In vitro* adhesion test setup.

Preliminary Experiments

Four batches of chitosan bandages were evaluated to determine the consistency of the adhesion test method and the effects of gamma sterilization. Each batch of bandages were separated into two groups, non-sterilized and gamma sterilized. Each group of bandages consisted of eight test pieces.

Statistical Analysis

Student's T-test and ANOVA were used to determine statistical significant differences between batches.

Results and Discussion

No significant differences were found between the batches (Figure 3). The sterilized bandages on average were two times more adherent than the non-sterilized bandages. Previous studies suggested that a lower-molecular-weight chitosan had better adhesion than higher-molecular-weight chitosan and γ irradiation decreased chitosan's viscosity molecular weight (3-4). Future work will involve investigating the effect of viscosity on adhesion properties.

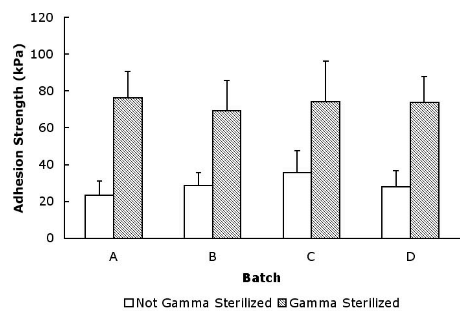

Figure 3: No significant differences between the batches. Adhesion significantly increased after gamma sterilization ($p<0.01$).

Conclusions

The *in vitro* adhesion test has demonstrated to be a useful and consistent tool to investigate the efficacy of chitosan bandages for severely bleeding injuries.

References

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(3) Lehr, C. *et al. In vitro* evaluation of mucoadhesive properties of chitosan and some other natural polymers. *Int. J. Pharm.*, 78: 43-48, 1992.
(4) Lim, L. *et al*. γ Irradiation of Chitosan. *J. Biomed Mater Res (Appl Biomater)* 43: 282-290, 1998.

Acknowledgements

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