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Research paper

Investigation of the material properties of alginate for the development of hydrogel repair of dura mater

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ABSTRACT

The collagenous dura mater isolates the brain from the external environment and requires a secure closure following invasive neurosurgery. This is typically accomplished by approximation of the dura mater via sutures and adhesives. In selected cases, however, large portions of dura mater require excision, necessitating a tissue replacement patch. The mild reaction conditions and long-term biocompatibility of alginate evince strong candidacy for these applications. This study investigates the potential of diffusion and internally gelled alginates for these applications. Specifically, we quantified the viscosity, gel rate, syneresis level, compressive strength, compressive modulus, complex modulus and loss angle in the context of dura mater repair. The ideal sealant would have a rapid cross-link speed, while the ideal dura mater replacement would have a low level of syneresis. Both applications require a compressive modulus of 20–100 kPa and a complex modulus of 1–24 kPa. The data collected in this study suggests that the use of 1.95 wt% 43 mPa s alginate with 200 mM CaCl₂ is sufficient for approximating the dural membrane for closure alone or in conjunction with suture. Alternatively, the use of 1.95 wt% 43 mPa s alginate with 100 mM CaCO₃ is sufficient for tissue replacement in large dural defects.

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1. Introduction

Invasive neurosurgery often requires a method to close the collagenous meninges that functionally isolate the brain from the external environment. Typically, adhesive materials can be used as sealants for minor dural defects, while large dural defects require patches. Several different materials have been

evaluated for both sized dural defects; however, sufficient drawbacks exist limiting the efficacy of the state-of-the-art approaches.

In the case of minor dural defects, sutures or adhesives are used as dural sealants. Even for minor defect closure, there are sufficient drawbacks to these approaches. Sutures alone are quick but do not provide adequate sealing of

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