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Evaluation of drug release from electrospun nanofibers by modification of material morphology

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The possibility of controlling drug release from nanofibrous scaffolds has attracted many researchers around the world. Recently, we showed that nanostructured material acts as an anti-liaisons barrier positively influencing glial scar formation and caused decreasing neurodegeneration [Sulejczak *Folia Neuropathol*, 2014 (in press)]. The next step is to compose nanofibers with antioxidant drug (α-tocopherol) to further limit neurodegeneration of brain tissue. Embedment of lipophilic drug in nanofibrous materials of different: porosity, material structure or fiber arrangement results in different release kinetics. In this paper we present experimental and numerical study of the influence of fiber arrangement on the drug release from nanofibrous materials. Construction of such system is a tedious experimental task. Hence, we proposed 3D finite element model prepared in COMSOL Muliphysics® which can give insight of geometrical structure impact on the drug release from the nanofibrous mat.

Two materials electrospun from 9% wt. of poly(L-lactice-*co*-caprolactone) containing model drug Rhodamine B (2 % wt. with respect to polymer) were prepared from solvent mixture of N,N-dimethyloformamide and chloroform (1:9 wt./wt.). Electrospinning parameters and material characterization method can be found in paper [Andrychowski, *Folia Neuropathol,* 2013, 51,147-157]. Obtained nanofibers were collected on a rotating drum (13 cm in diameter) with different rotational speed to attain random and highly oriented nanofibers.

Results obtained from experimental study showed faster release of model drug from materials with random nanofibers comparing to oriented material. Both materials has reached release saturation at 80% of initial drug loading and the time necessary to reach release plateau was 4 and 6 days for random and aligned nanofibers, respectively. Numerical studies in representative unit volume of materials with aligned and random fibers structure showed similar behavior. Release of drug from materials in random fiber structure was prolonged comparing to aligned fiber structure.

In this paper we showed that change of fiber orientation and porosity can influence drug transport. Prolonged release can be obtained for materials with high order of fiber arrangement since the short distances between fibers and lower porosity of material can alter diffusion transport in the pores. Our results suggest that inhibition of a drug release from material can be attained by a higher fiber orientation in thin membrane near material surface.

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