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Hydrophobic Nanofibrous Materials for Prevention of Postoperative Tissue Adhesions

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Extended Abstract

Undesirable tissue adhesions remain one of the severe and dreadful postoperative complications. The postoperative adhesions in abdominal cavity may often occur after the colorectal resection in case of colorectal cancer, Crohn disease or intestinal blockage. These postoperative complications may lead to chronic pain, female infertility, reoperation, decreased life quality and other serious complications [1], [2]. There are several attempts to understand the mechanism of formation of peritoneal adhesions. Moreover, significant effort was also put into development of a functional and safe material to prevent these complications. Despite the significant efforts, there is a lack of knowledge and available methods in this area [3]. The novel approach is to use a biocompatible barrier material, e.g. nanofibers, to the injured intestinal tissue and thus reduce the formation of peritoneal adhesions [1].

The planar nanofibrous materials can be applied around the surgical connection (gastrointestinal anastomoses) after the colorectal resection. To the best of our knowledge, the first application of nanofibers around the intestinal anastomoses in large animal models was presented by our team [3]. It was shown, the usage of nanofibers for this indication is safe and easy. Moreover, this procedure does not prolong the surgery time and does not require any special equipment. Since the first application, we are trying to improve the properties of the nanofibrous materials to both fortify the gastrointestinal anastomoses and prevent the life-threatening tissue adhesions. The inner fibrous layer of the material should be hydrophilic and thus adhesive to the intestinal tissue in order to secure the intestine and promote healing. While the outer side of nanofibers should prevent the formation of tissue adhesions. The antiadhesive behaviour could be supported by decreasing the wettability and by creating the hydrophobic material.

We introduced a functionalized nanofibrous material based on polycaprolactone (PCL). Biodegradable PCL is a well-described polymer used for many applications in medicine and tissue engineering. The nanofibrous layer was fabricated via needleless electrospinning via Nanospider to support the further transfer of the research to the industrial scale production. Based on the homogeneity of the final layer and also the electrospinnability of the polymeric solution, the best solvent system was established, namely chloroform:ethanol:acetid acid v ratio 8:1:1 v/v. The final concentration of PCL in the solution was 16% w/w. The outer side of the nanofibrous layer was further treated with hexamethyldisiloxane (HMDSO) via plasma assisted chemical vapour deposition with the following parameters: 50 V; 30 Pa; gas flow Ar 30 sccm; 10 min. The HMDSO was selected in respect to its biocompatibility and previously described applications in medicine [4]. The morphology of the treatment was observed via the scanning electron microscope, the plasma treatment was homogenous without any significant defect or preferential patterns. Most importantly, the increase in contact angles was observed during the sessile drop technique method. The untreated layer was hydrophilic, the droplet of distilled water was absorbed into the material and distributed over the fibrous surface, while the HMDSO treated side revealed a hydrophobic behaviour. The measured contact angle of the HMDSO treated surface was $(134 \pm 3)°$. Based on the final application of the materials, the cytotoxicity was evaluated *in vitro* according to ISO 10993:5 by using the 3T3 mouse

fibroblast. All tested fibrous materials (before and after HMDSO treatment) were cytocompatible and thus suitable for medical applications.

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