MEDICAL PRODUCTS FOR CARDIOLOGY OBTAINED BY ELECTROSPINNING

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Introduction. Adhesions are a serious postoperative complication in cardiac surgery which increase the risk of reoperations. Polymer materials are widely used in modern reconstructive cardiovascular surgery. The developed methods of production and modification of polymers and products based on them will be used to solve the important problems of theoretical and practical cardiology [1].

Electrospinning is a promising method of producing antiadhesive membranes. The electrospinning method allows obtaining thin polymer nanofibers, which may contain live cells or special drugs for changing biological properties [2].

Nanofibers are of interest due to the fact that the mechanical properties of materials, such as tensile strength, Young's modulus, elongation are increased, when the diameter of the fiber is lowered. The size effect may occur in the volume properties as a result of the additional interaction between the polymer molecules caused by their orientation when the fiber diameter becomes comparable to the length of the molecule. Therefore, reducing the fiber diameter to the submicron level can improve their strength.

The aim of the research was to study the surface morphology and physical-mechanical properties of antiadgesive membranes.

Materials and methods. The membranes are produced using 8% polymer solutions in an electrospinning apparatus Nanon 01A with addition of drugs and without it. Such polymers were used as polyhydroxibutirate/oxivalerate (PGBV) and copolymer polylactic-polyglicolic acid (PLGA). The drug such as dipyridamole (DP) was applied. The fibers structure was studied with the scanning electron microscope Hitachi S-3400. The physical-mechanical tests are carried out with the universal testing machine «Zwick/roell»-2.5N (Zwick GmbH & Co. KG, Germany).

Results and discussion. The membrane structure is essential for assessing the functional properties of the product. Morphology of the membranes made under identical parameters is distinctly different for coaxial

fibers and for usual fibers. As shown in Fig., coaxial fibers have a high degree of orientation and larger thickness. Addition of the drug through all thickness of the fiber does not influence the fiber size.

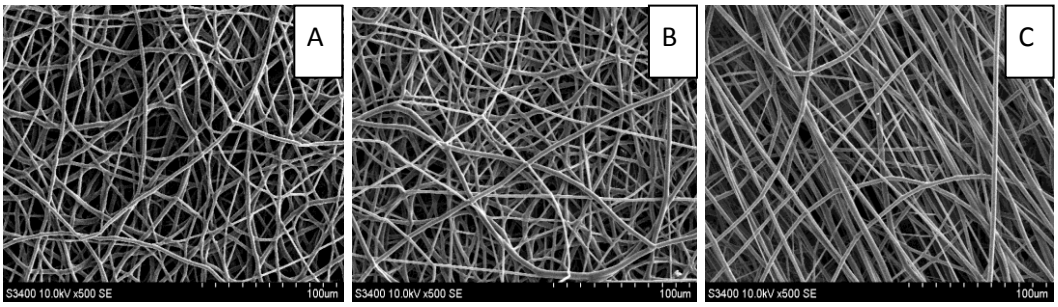

Fig.1. Image of the surface structure of antiadgesive membranes without drugs (A) and with addition of DP through all thickness of the fiber (B) and inside the fiber (C).

In cardiac surgery,it is very important that antiadgesive membranes could withstand the thrust of moving organs. According to the table, addition of DP allows to reduce the stiffness of the membranes. In coaxial fibers, it decreases by 1,9 times, and in usual fibers, it decreases by 4,24 times. However, the tensile strength is 1.52 times less in conventional fibers.

Table. Physical-mechanical properties of antiadgesive membranes

Membranes composition and structure	Tensile strength, MPa	Elongation, %	Young's modulus, MPa
PGBV+PLGA	3.63	3.025	289
PGBV+PLGA+DP (usual fibers)	2.39	28.32	68.1
PGBV+PLGA+DP (coaxial fibers)	3.69	10.01	152

Thus, addition of the dipyridamole inside the fiber can improve the properties of biodegradable membranes.

Experiments to assess the biocompatibility and hemocompatibility were carried out by internal implantation to laboratory rats. Antiadgesive membranes were implanted after aortic replacement to 10 rats for 60 days. As a result, one rat had adhesions formed and inflammatory process cultivated. On the contrary, the other rats did not have inflammations and the healing process was successful.

Conclusion. Wide opportunities of the electrospinning process make possible to receive fibrous materials with the desired physical properties.

Despite the complexity of the study and understanding of physical processes of the electrospinning method, it is characterized by instrumental simplicity, high energy efficiency of nanofiber production, versatility of the formable material and flexibility of the control over the process parameters. All this makes the process of electrospinning attractive for industrial production of nanofibers.

Nanofibers and materials obtained by electrospinning are used in a variety of areas. Using different nozzle allows changing the properties in the necessary side and getting different morphology structure. The ability of drug addition to polymeric composition can facilitate rapid healing.

References

1. G.A. Volozhin, Basic types of biocompatible materials, MSMSU Press, Moscow, 2010.

2. S.V. Sheremetev, E.M. Shteynberg, Application of functional polymers in medicine, SibAK Press, Kazan, 2012.

ULTRASONIC DISTANCE MEASUREMENT

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Ultrasonic distance measurement is a very effective non-contact method of measurement. It has been widely applied in navigation, probing, engineering design, construction and other fields due to its precise, fast, stable and easy operating characteristics.

Therefore, in-depth study of the ultrasonic distance measurement method is of practical significance. In order to further improve the precision of the ultrasonic distance measurement, the research focuses on the type of the ultrasonic distance measurement device based on temperature compensation of the microcontroller.

The ultrasound is a sound with the frequency greater than the upper limit of human hearing, this limit being approximately 20.000 Hz. The ultrasound is widely applied to measure distance and ultrasonic cleaning because of the ultrasound characteristics such as short wavelength, high frequency, strong penetrability, cavitation and atomization effect, and so on.