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New generation dressings for wound healing: combined antibacterial activity and boosted regeneration process

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Motivation and Aim: Type 2 diabetes mellitus has been awarded the status of a 21st-century non-infectious pandemic. Complications of this disease lead to a significant decrease in the quality of life, disability of a fairly young, capable population. One of the complications is chronic non-healing wounds, leading to amputations in 50 %. The therapy of chronic wounds is difficult since this pathology is characterized by multifactorial homeostatic disorders at the systemic and local levels.

The low efficiency of therapy for complications of type 2 diabetes (diabetic foot syndrome, DFS) is an urgent problem and standard treatment protocols do not lead to its solution, which is manifested by a high frequency of amputations in this category of patients. The low efficiency of therapy for complications of type 2 diabetes (diabetic foot syndrome, DFS) is an urgent problem and standard treatment protocols do not lead to its solution, which is manifested by a high frequency of amputations in this category of patients.

The result of active scientific research and technological solutions is the creation of effective tissue-engineered structures for the treatment of chronic wounds [1, 2]. Foreign clinical trials have shown the high efficiency of using bioengineered skin substitutes for the treatment of non-healing wounds: cell-free human skin matrices – AlloDerm® (LifeCell, USA), GraftJacket® (Wright Medical Technology, USA), pig skin – Permacol® (Covidien, USA), Oasis® (Cook Biotech, USA).

Excessive degradation of the extracellular matrix, proteins, growth factors leads to impaired adhesion and functional activity of cells, to a decrease in the proliferative activity of fibroblasts and their susceptibility to growth factors.

The extracellular matrix (ECM) provides structural support, intercellular contact, serves as a reservoir for signaling molecules, thereby regulating cell migration, proliferation and angiogenesis. ECM failure is a key link in the pathogenesis of chronic ulcers in DFS, and it is ECM that is the goal of innovative approaches to the treatment of chronic wounds [3].

Thus, the development of tissue-engineered structures that replace defective ECM is an effective way to accelerate wound healing. Today, analogues of human skin dermal equivalents are polymer matrices, which are represented by both biopolymers (polypeptides, hydroxyapatites, glycosaminoglycans, fibronectin, collagen, chitosan, and alginates) and synthetic, completely degradable polymers (polyglycolides, polylactides, polytetrafluoroethylenes), polycaprolactone) [4–6]. Synthetic polymeric materials have less expensive and more reliable sources of raw materials [7].

Methods and Algorithms: We utilized the plasma functionalized nanofiber prepared by electrospinning of polycaprolactone modified by low temperature plasma and grafting of Platelet-rich plasma species and curdlan/chitosan foams in immobilized Ag nanoparticles to test *in vivo* the efficiency of new wound dressings.
Results: Herein we present the innovative two-component system for wound care that contains: 1. plasma treated poly(ε-caprolactone) nanofiber layer bonded with platelet-rich plasma (PRP) proteins (PRP PCL NFs – covering directly on the wounds) to enhance regeneration rate and to prevent scar tissue formation; 2. antibacterial superabsorbent foam layer (outer layer) which provides good oxygenation, prevents bacterial infection, and absorbs exudate, forming a soft gel (moist environment). These foams were prepared from a mixture of hydrolyzed curdlan and chitosan by lyophilization process. To enhance antibacterial properties $AgNO_3$ solution was added to curdlan/chitosan mixture during the polymerization process and then reduced by UV irradiation. The membranes were further investigated for their structure and composition using optical microscopy, scanning electron microscopy, EDX-analysis, FT-IR spectroscopy and XPS modelling. The influence of using obtained dressings on the regeneration process was studied *in vivo* and compared with commercial dressings.
Conclusion: The results obtained in this research proves high potential of nanofibers and news superabsorbing foams as wound dressing for type 2 diabetes DFS.
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