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АДДИТИВНОЕ ПРОИЗВОДСТВО (3D-ПЕЧАТЬ) В МЕДИЦИНЕ

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В научной статье рассмотрены основные направления 3д-печати в медицине, а также характеристика методов 3д-биопечати.

Ключевые слова: 3D-печать, направления применения 3D-печати, методы 3D-биопечати.

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ADDITIVE MANUFACTURING (3D-PRINTING) IN MEDICINE

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The scientific article discusses the main directions of 3D printing in medicine, as well as the characteristics of 3D-bioprinting methods.

Key words: 3D-printing, applications of 3D-printing, 3D-bioprinting methods.

Additive technology, or as it is often called – three-dimensional printing, is the process of creating entire objects in three dimensions by step-by-step layering of various materials. In the arsenal of such technology are plastic, metal, ceramics, powder mixtures, liquid compositions and even biomaterials. In addition, 3D printing opens up many promising opportunities for us. One of the exciting and perhaps key applications of 3D printing devices is the manufacture of medical devices. The origins of this technology go back to 1983, when American scientist Charles Hall invented a new technology. In the process of creating small plastic parts for a future prototype, instead of using ultraviolet radiation to glue layers of photosensitive polymers, Charles superimposed many layers of plastic on each other, on each of which he applied epoxy resin, previously used for coating, and fixed the resulting structure with ultraviolet light. The experiment showed that the method of layer-by-layer gluing of the material with subsequent gluing opens up opportunities for the production of objects of any complexity. The experiment showed that the method of layering the material with subsequent gluing opens up opportunities for the manufacture of objects of any complexity. Since the early 2000s, 3D printing has been used in medicine, and since then it has gone through a significant development path. The main medical applications of 3D printing include:

1. The use of 3D printing technology to repair tissues and create organs directly on the patient is an innovative approach in medicine.

2. Printing large models of organs that can be used in transplantation, scientific research and surgical intervention planning is one of the important directions in the development of medical 3D printing.

3. The production of medical products, such as masks and orthopedic corsets, using 3D technologies, contributes to the creation of customized solutions for patients.

4. The development of personal surgical instruments using 3D printing facilitates operations with maximum accuracy and minimal impact on tissues.

5. The production of medicines with the gradual release of the active substance is one of the directions of development of 3D printing in pharmaceuticals.

6. The use of 3D printing technology in prosthetics is due to the need for an accurate approach to each patient and increases the effectiveness of treatment.

Currently, there are several methods for creating organs and tissues using 3D printing, each of which has its advantages and disadvantages that determine the scope of their application.

1.Extrusion printing process

Extrusion printing is a method in which a biocinc is applied by continuously forming layers to create a three-dimensional structure. In this process, the bioink contains a hydrogel as an additional component. In addition, collagen, alginate, gelatin and other substances can be used as possible materials.

The hydrogel has a high viscosity, which allows it to flow smoothly through the printer nozzle, providing cells with some protection during passage through the nozzle. Various physical or chemical methods are used to solidify the printed organ. The main problem with this method is the lack of mechanical strength, which means that the resulting structures may be less stable or durable.

2. Laser bioprinting technology

This approach to bioprinting uses a low-power laser to control the movement of particles in a liquid. To implement this process, a laser, a quartz plate acting as a target and coated with biolin, as well as a substrate for fixing the material are needed. When the laser beam reaches a quartz plate with a biological instrument, it transfers a small portion of the material to the substrate, forming layers of an organ or tissue. Despite the fact that this method of creating biomaterials is relatively slow, studies have shown that cells printed using laser technology quickly lose their viability, limiting the application of the method to printing a limited set of tissues. . For these reasons, laser technology is one of the less developed methods of bioprinting.

3. Printing using microvalves

The principle of operation of microvalve printing is to apply bioinjections by drip method, while liquids move at constant pneumatic pressure. The ink is supplied through a nozzle with a valve that is controlled mechanically, electrically or by a magnet. Microvalve printing involves printing a collagen solution followed by a layer of cells. Collagen is applied first. Then, to form a gel, the pH is changed by spraying sodium bicarbonate. After that, a layer of cells is applied on top of the collagen layer. This method contributes to high cell survivability.

4. Inkjet printing

This method involves using microscopic drops of ink to apply the pattern. There are two types of such printing. Continuous printing, in which ink is fed through a nozzle in a constant flow, and on-demand printing, where ink is used only as needed. Inkjet printing was originally used for printing on fabric. Interestingly, this method was inspired by a regular HP inkjet printer. The difference is that the ink consumption for bioprinting through the nozzle is higher than that of a conventional HP inkjet printer. Products created by this method have a high degree of cell durability. Another important feature of inkjet printing is the possibility of simultaneous application of different types of cells using different nozzles. This feature allows scientists to create more complex structures containing a variety of cell types.

5. The process of printing fabric fragments

The process of printing tissue fragments combines bioprinting technologies and the ability of cells to self-assemble, which leads to the formation of tissue. This method gives nature the opportunity to develop consistently. Parts of tissue fragments saturated with embryonic cells form spheroids, which are located in relative proximity to each other. At the same time, the embryonic cells in the immediate vicinity merge into a single mass to eventually form a structure based on their natural characteristics. Этот процесс также отличается своей медлительностью и позволяет создавать лишь небольшие тканевые структуры.

3D printing of organs and tissues is undoubtedly popular and in demand at the moment in the field of medicine and, probably, its improvement will only grow, and in the near future it can potentially save many lives.

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