# DESIGN OF A MICROFLUIDIC CHIPS WITH A DETERMINED CONFIGURATION OF THE MICROFLUIDIC NETWORKS

Alexandra Litvinova[1], Maxim Silkin[1], Vladislav Fomin[1], Alexey Shanturov[1], Andrey Demidov[1], Viktor Zhilkin[1], Vladimir Glotov[1]

[1]Department of Human Anatomy, Smolensk State Medical University, Russia
anatom@smolgmu.ru

**Introduction.** Modeling of hydrodynamic parameters of blood microflow and their distribution in real microvascular networks is one of the main tasks of Biomicrofluidics. It can be solved in experiments on artificial microfluidic (microvascular) networks. Model microfluidic chips (MMCs) were developed in our study and their suitability to be used in experimental platforms designed for the cultivation of self-developing functioning endothelial networks in vitro was evaluated.

The aim of the study was to develop a line of technological procedures for creation of simulation MMCs, suitable for further work as a part of the experimental platform to control and automation data processing of microcirculation modeling.

**Material and methods**. The study was carried out with the interaction of biotechnologists and engineering specialists in modern production. It made possible to produce variants of experimental samples of MMC directly in the course of the study and testing as a part of the experimental platform to control, automated analysis, evaluation and processing of microcirculation data and their completion. We designed biotechnical requirements for the structure of the MMCs. An electronic model was developed in the SolidWorks computer-aided design environment. The model was used for loading into one of the types of processing complexes with software control.

**Results.** The first technology (procedure) involved manufacturing topology with a milling cutter diameter 0.1-0.5 mm to a depth of 0.01-0.5 mm on a substrate of plasticized organic glass. The study was performed on precision automated processing centers "HAAS". Then the same solid organic glass was put on the substrate and the ports of the working fluid were formed.

The second technology (procedure) involved matrix topology MMCs with a method of laser cutting on the fiber machine of laser cutting ML-35 made of stainless steel 12X18H10T of thickness 0.01-0.5 mm. Then the matrix was placed on the flat surface of the cuvette and was filled with neutral silicone compound. After solidification of the compound, the silicone substrate with the printed topology was closed with solid organic glass and ports were formed.

The third technology (procedure) involved application of topology directly on the surface of organic glass on a laser plotter with an organic laser. The substrate was stacked with solid organic glass and ports working fluid were formed.

Each of the technologies has its own characteristics, which allow making the best choice for specific tasks.

Pilot control units of the generator of micro nutrient medium (micropump) using the microcontroller Arduino Due based on the processor Atmel SAM3X8E ARM Cortex-M3 based 32-bit microprocessor ARM core were designed using the demonstration microcomputer STM32F469N1 with micro-computer Raspberry Pi 3 Model B. Proper software was developed for each unit [1].

**Conclusion.** MMCs formed with any of the above mentioned technologies (procedures) have a unified port of the working fluid, installation dimensions and a transparent top. It allows them being installed in an experimental platform for control and automation of microcirculation modeling data processing. Flow of fluid is created with micropumps, working on gravitational, electromagnetic and micropulsation principles, and regulated with valve platform through software. Observation, analysis and registration of the experiment are carried out with an electronic USB microscope and a computer with software. Measurements and registration of primary parameters are performed: flow rate, volume and temperature of various working fluids. The software calculates and analyzes hemodynamic factors of microcirculation and structural parameters of artificial microfluidic (microvascular) networks, which ultimately allow forming the structure of the MMCs as much as possible corresponding to the required parameters of the initial biological object and studying its functioning under different microcirculation modes [2].

[1] Демидов А. Л., Жилкин В. В. Экспериментальная исследовательская платформа для управления и автоматизации обработки данных моделирования микроциркуляций // Смоленский медицинский альманах.– 2018. - №1. – С. 85-87.
[2] Глотов В. А. Структурный анализ микрососудистых бифуркаций (Микрососудистый узел и гемодинамический фактор). - Смоленск: Амипресс, 1995. – 255 с.