Description for the general public

The aim of the project is to examine the material interaction under high deformation and with urine flow conditions and to define how the deformations in the urethral lumen influence the fibrosis of the epithelial tissue. The long term goal is to develop a materials system to healing of the genitourinary. It should be explained how the changes of the deformation field values in the physiological urethra and pathological urethral stricture, during voiding and erection, affect the resorption of the material proposed in this project, and the mechanical, histological and immunological characteristics of the surrounding tissues. It is still an open issue to fit the composition, physicochemical properties and deformation characteristics of the material, which are correlated with the crosslinking rate and components, to be proper for normal tissue remodeling and regeneration. Urethral stricture disease significantly affects the lives of the patients, preventing proper and free urination, which is often painful, and disrupts erection.

It the project numerical and experimental research will be carried, using animal models, to build a numerical model of the urethra. Numerical modeling of the urethra will be performed under simulated urine flow conditions corresponding to the boundary and initial conditions from experimental research results. An axisymetric model of the urethra will be used in the second stage of the numerical research, i.e. examination of the material resorption. The numerical modeling results will render it possible to define the optimal stiffness characteristics of bioresorbable materials, with high strain, proper for interaction with the tissue. Moreover, optimal material models based on sodium alginate (natural bioresorbable polymer) fitted for resorption in the urethra will be proposed.

Histological and immunological research results, analysis of the tissue response to the material, will lead to the conclusion whether or not the crosslinking level of the natural polymer and its chemical modification influences the healing process and characteristics of the growing fibrotic tissue. At the same time, a comparison of the results of experimental research and numerical modeling results will answer the question whether it is possible to adjust the material composition to the kind and type of the urethral stricture, and to regulate biochemically and mechanically the healing process, to obtain the most satisfactory results for the patient in the shortest time, thus reducing the total cost of the treatment.