The project addresses issues of hernia, which is nowadays common medical problem e.g., as a postoperative complication. Despite high advancement in laparoscopic repair, recurrences of hernia or postoperative pain and discomfort after repair are still issues to be solved. In order to help surgeons, mechanics and engineering tools has been involved. However, one of the issue in modelling and designing appropriate solutions is high variability in abdominal wall mechanical properties. Another source of uncertainties in this topic are imperfections in hernia repair execution (e.g. in fixation). The aim of the project is to investigate:
• how changes of properties of the abdominal wall influence mechanics of the abdominal wall with implant system?
• how imperfections during hernia repair influence mechanics of the abdominal wall with implant system (e.g., putting joint by surgeon in different position)?

Mathematical models based on Finite Element Method will be defined and geometrically and physically nonlinear mechanical analysis will be performed. The illness relapses are usually caused by connection failure, so a sensitivity analysis telling about level of influence of different parameters to forces in joints will be conducted. Nonintrusive stochastic method will be used to include mentioned uncertainties in the modelling. Sensitivity analysis with stochastic elements will be done with use of two models. First local model of implant created of membrane elements will be used to draw initial conclusions. On this smaller model we will compare methods for stochastic analysis. Optimal way of conducting nonintrusive stochastic methods e.g., choosing sampling points, which is crucial in nonintrusive methods, is not known. Part of the project will be focus on studies on different approaches to choose effective and computationally affordable method. Then global abdominal wall model will be created. Chosen in previous step, stochastic method will be applied in sensitivity analysis. Uncertainties will be introduced in parameters of material law, thickness of layers and implants fixation to the human tissues.

Pioneering elements of the project are:
-investigation of influence of variability of people abdominal wall properties to forces in fasteners,
-investigation of influence of imperfections in hernia repair to forces in fasteners.

Outcomes of the project will enlarge knowledge about mechanics of abdominal wall with hernia and implant, which will lead to decrease of number of recurrences., which will also have social and economic impact.

Outcomes will say how variability in material properties influence the system of abdominal wall with hernia and implant. It will show how far patient-specific design of implants and its fixation is needed and knowledge of which parameters is the most crucial to be properly identified to obtain sufficient results. Moreover, results will enable to establish the aspect of hernia repair to which surgeons should pay the biggest attention. This will be achieved by knowing the sensitivity of the system to imperfections. The outcomes in the further future can be used in optimal design of implants and its fixation for general average cases, group of patients with properties in distinguished scopes or patient specific optimization. What is more, the methodology of using stochastic sensitivity analysis established within project will be ready to transform it to other similar biomechanical application e.g., pelvic floor reconstruction.