At some point of life it may bother as much as 15% of human population. It equals pain and limited mobility. In more dangerous cases it may cause strangulation and obstruction of bowel. Out of a hundred persons, one suffers from a chronic form of this disease. A considerable number of these serious cases requires surgical attention. Hernia - which is a matter discussed here - stands for abnormal exit of an internal organ or tissue outside the abdominal wall. It causes the organ to form a bulge under the skin of an affected person. Among the reasons of this disease are excessive intra-abdominal pressure, a weakening of connective tissue due to issues with collagen metabolism, and open surgeries on abdominal cavity in the past. Currently hernia is one of the most common reasons for performing a surgery.

Hernia treatment is based on implantation of a surgical mesh. The implant is usually made of a circular sheet of synthetic fabric, which is later connected to the abdominal wall using tacks, suture or glue. Although the method is widespread, there are no strict rules which would help a surgeon to choose and fix an implant in a given case. Recurrence rate of the disease is still high. Some of the recurrences are caused by insufficient load capacity of the connectors, others are a result of an inappropriate stiffness of the mesh, rendering it ineffective in holding back a hernia bulge. The team deriving from Gdansk University of Technology and Medical University of Gdansk is determined to improve hernia treatment in an optimal way, using up-to-date medical technology and computational methods.

Currently it is hard to achieve this goal because of little general knowledge concerning properties of abdominal wall. Most of the research performed to date was executed on animals or on dead, cut out human tissues. In order to pursue the research goal, the team will identify, i.e. recognise and quantify the mechanical parameters of abdominal wall on living humans. High-tech methods of non-invasive deformation tracking in real-time will be used for this task along with advanced numerical computations. To avoid any unnecessary interference with a subject's body, photogrammetrical measurements will be executed during routine peritoneal dialysis, regularly applied to people suffering from end-stage kidney disease. During the dialysis the abdominal cavity of a given person is filled with a particular fluid, which causes the abdominal wall to deform notably. In order to perform further analyses, this deformation will be recorded along with pressure change and volume of the fluid. Implants will be examined separately, using specialised test machines. After the collection of data and development of mathematical models is over, a complex personalised safety- and comfort-oriented optimisation process will be carried out. Individual traits of a given person will be taken into account, as well as a natural variety of biological tissues (probabilistic approach). An appropriate speed of computations will be assured by introducing machine learning algorithms (neural networks) or specialised meta-models. Natural randomness of tissues and lack of precision in real surgical mesh implantations will have their impact on the outcome as well.

The study will result in finding a personalised optimal solution concerning the choice of type, fixation and orientation of an implant for given patients. It will have a large impact on recognition and development of hernia treatment. What is more, the identification of abdominal wall mechanics will be useful in solving other medical problems. Examination of implants will be crucial for developing a new type of implant in the future. All of the study will be performed in a humanitarian way, without sacrificing animals and without additional interference in the human body, which underlines the innovative and modern character of the research.