The project is a result of cooperation between engineers from Gdańsk University of Technology and medical doctors from Medical University of Gdańsk towards understanding of the biomechanics of the intertrochanteric fractures. Fractures around the hip joint, such as intertrochanteric fractures, are one of the most common fractures sustained and operated on in humans. They occur most commonly in elderly people with developed osteoporosis. One of the most common treatment method for this fracture is to fix them with short intramedullary nail (gamma nail). Unfortunately, the after operation complication rate is still high and may lead to second fracture of the intertrochanteric region or the femur shaft close to the distal screw. Many biomechanical studies based on composite femurs are realized towards understanding of the mechanics regarding techniques of femur fracture implantation. Nevertheless, the consensus on the best methodology of femur fracture fixation has not been established yet. Computational medicine and mechanical approach can be used to understand behavior of bone-fixation system and propose improvement in the treatment. Therefore, the main goal of this study is to develop a methodology of construction a credible computational model for numerical (*in silico)* analysis of fracture fixation and performing associated biomechanical laboratory (*in vitro)* experiments. From the medical point of view the key target of the research is performance of a joint clinical, laboratory and numerical biomechanical analysis of the intertrochanteric unstable fractures implanted with the short intramedullary nail (gamma nail).

In the laboratory part of the project the composite femur will be used for creation of intertrochanteric fractures, which will be later stabilized with the use of a short nail. The application of the cerclage cable to strengthen the fixation will also be investigated in particular fracture cases. The load in mechanical tests of composite femurs are planned to resemble loads generated on the femur during basic movements of the patient after operation, like walking and standing up from a chair. The experimental results will be then used in validation step of the finite element model. Uncertainties in simulation of experiments will be included at validation step. The forces generated by muscles will also be introduced both in experimental and numerical models. Next, uncertainties related to e.g. variability of mechanical properties and some geometric parameters of human femur will be propagated and their influence on the stability of fixation will be checked. Finally, the laboratory and numerical results will be juxtaposed with the clinical findings regarding patients with intertrochanteric fractures. Preoperative, intraoperative, postoperative and control radiographs will be assessed towards the quality of fixation and position of its elements.

The realized coupled *in vivo*, *in vitro* and *in silico* methodology will contain proposed set of experiments, obtaining credible computational model of fixation including uncertainties related to e.g. natural variability of mechanical and geometrical properties of human femur and reliability analysis of fracture fixation, as well as clinical data for confirmation of findings from aforementioned parts.

The project is characterized by several innovative aspects. Firstly, the novel experimental stands will be created within the project to simulate muscle forces and complicated movements patters of human body. Secondly, the registration of displacements during loading will be based on the digital image correlation method resulting in high quality of the obtained results. Next, with the help of advanced software for analysis of computer tomography scans it will be possible to create very precise numerical models of intertrochanteric fracture fixations. Computational model will be proposed and its credibility in prediction of behavior of intertrochanteric fractures will be assessed. This model will be used in the next steps of the research to optimize treatment of intertrochanteric fractures.

Another important aspect of the project is its interdisciplinary nature that means close cooperation and data transfer between both universities involved in the project. The cooperation between mechanical engineers and medical doctor to extend the knowledge on femur fracture fixations will be beneficial for the efficiency of intertrochanteric fractures treatment. It is valuable that the phenomenon of gamma nail moving in the wide medullary canal will be investigated. The research findings will be the basis to some new guidelines for surgeons applying short nails and for engineers designing novel implants with the use of credible computational model.

Within the framework of the project preparation of basis for one doctoral dissertation and basis for at least one postdoctoral promotions are expected. The publication of the research results is planned in journals from the list of Web of Science. Presentation of the project results during scientific conferences on medicine, engineering and biomechanics are also planned.