

The improvement of road safety is an important social problem. It is implemented, e.g., by equipping the roads with road safety barriers. Their main purpose is to prevent the errant vehicles from hitting the obstacle and to minimize injuries of the passengers. However, regardless of whether the barrier is steel, wire-rope or concrete and the parameters of the road accident (velocity and hitting angle), the collision may result in injuries. The most frequent, and the most dangerous, are those concerning the cervical spine. Knowledge on the influence of the barrier type and the conditions of a road incident on spinal injuries may be valuable. Especially, for the units and offices responsible for the design and maintenance guidelines of safety barriers. Information on possible injuries and associated costs may be taken into their consideration. The project is devoted to modelling and simulations of vehicle collisions with various types of road safety barriers, with particular emphasis on the mathematical description and understanding of the mechanisms of human spinal injury occurring during an impact. The project is focused on the influence of sudden loads, in particular on the soft tissues of the spine, whose modeling is not yet fully understood. The original aspect of the project will be the development of a detailed material model which will consider the various spatial properties and the strain-rate effects of soft tissues in order to accurately describe the behavior of the spine's ligaments. This process will be followed by the numerical implementation of this model. The work will be completed using proprietary Finite Element Method software along with LS-DYNA system. The research team has already developed numerical models of road safety barriers and has an access to various types of car models. Moreover the team also possesses the numerical model of human called ViVA, which can be supplemented with spine's soft tissue models. Researchers has wide competences and considerable experience in performing complex calculations using High Performance Computing in the Gdansk University of Technology TASK IT center. During the project, experimental studies on the human cervical spines will be carried out to get insight into their mechanical response under the sudden loads. Special attention will be paid on the behavior of soft tissues. That will help to determine new material parameters and develop a reliable mathematical and numerical description of the spine's soft tissues. Afterwards, it will permit the preparation of the cervical spine's numerical model and ultimately the whole person involved in the car against the barrier collision. The obtained results will throw new light on understanding spine behavior, including ligaments, during collision. This is an original attempt on the world scale. The results of crash tests of passenger's vehicles against various barriers allow proper government authorities making recommendations to design, application and usage of road safety barriers in Poland. The research is the joint endeavor of scientists from Gdańsk University of Technology (GUT) and Medical University of Gdańsk (MUG). The modeling and simulations are the domain of the scientists and engineers from GUT, the experimental part of research is the combined effort of all the teams whereas medical analysis of injuries belongs to the specialists from MUG. Completion of the project will yield the development of the interdisciplinary research that will broaden the knowledge and experience of the scientists from both universities.