A personalized approach to fracture therapy necessitates the integration of knowledge and techniques from mechanics, orthopedic trauma surgery and computer science. Merging the relevant knowledge of these disciplines can lead to the development of less invasive, individually tailored treatment approaches comprising the surgical technique and the implant used.

Focusing on the case of distal tibia fractures, a new setup for a more realistic experimental testing of osteosynthesis systems is presented. Therefore, the experimental workflow is organized as follows: (1) starting point is a testing device to produce predefined tibia fractures, (2) the fractured lower extremities will be treated by an orthopedic trauma surgeon and (3) tested in a second testing device simulating the forces acting during a normal step forward. The experiments are realized with fresh frozen human cadaveric specimen.

During the first step of the workflow, the main goal is the repeatability of the fractures with respect to the applied forces and moments. Before the procedure starts, computed tomography scans of the bones are performed and are used as basis for the simulations. After the fracture is produced, an orthopedic trauma surgeon treats the lower extremity with an osteosynthesis locking plate and a second computed tomography scan is executed to enhance the computational model. Thereafter, in the last step of the testing workflow, the treated tibia is clamped in the second testing device and a mechanical loading scenario is applied on the bone-implant-system. The loading scenario is based on the OrthoLoad database and is calibrated by the subject-specific data of the human cadaveric specimen. During the test, stresses and strains are gained via a high-speed camera system combined with digital image correlation and several pressure and force measurements. This workflow allows a more realistic testing of tibia implants and gives information about the mechanical behavior of the fracture gap, like the interfragmentary move.

The whole procedure can also simulated based on the performed tomograms combined with the CAD data of the implant and the screws. Therefore, the image stacks are segmented, the material parameters are assigned and passed to a meshing procedure. After that, finite element simulations are executed with respect to the testing parameters and protocols in order to validate and to verify the simulation process. Here, the investigation of the simulations is focused on the best possible match of the experiments and the achieved results.