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FORSCHUNGSLABOR FÜR BIOMECHANIK UND IMPLANTATTECHNOLOGIE
ORTHOPÄDISCHE KLINIK & POLIKLINIK UNIVERSITÄT ROSTOCK

Position for a Student Research Project or a Master thesis

Finite element analysis of the mechanical loading of total shoulder endoprostheses under consideration of physiological boundary conditions

As life expectancy increases, degenerative wear in the human shoulder joint also rises. The replacement of the shoulder joint with a endoprosthesis is a common surgical procedure but continues to face several unresolved challenges. Biomechanical analyses of prosthetically treated shoulder joints can be used to identify potential failure mechanisms. Numerical approaches (Finite Element Analysis and Multibody Simulation) are increasingly being used to systematically study and improve the performance and durability of shoulder endoprostheses.

The aim of this work is to develop a Finite Element (FE) model that represents an endoprosthetic shoulder joint, using boundary conditions based on validated musculoskeletal simulation. This FE model will be employed to analyze the mechanical stress and contact pressure on the articulating implant components. The study will consider both anatomical and reverse shoulder endoprostheses during the load case of arm abduction. To account for physiological boundary conditions, data (e.g., forces) from an existing musculoskeletal multibody model at various time points during arm abduction will be extracted and applied to the FE model. The FE results will be validated through a mesh convergence analysis and by comparing them with data from existing robot-based studies of the same designs and existing literature.

As part of the study, the following work packages will be addressed:

- Conduct a literature review and familiarize yourself with the biomechanics of the human shoulder joint and the design of shoulder endoprostheses.
- Perform a literature review on Musculoskeletal Multibody and Finite Element Simulation.
- Compile a literature overview of available FE studies on the shoulder joint.
- Learn to use the software programs Abaqus, Simpack, and Geomagic.
- Develop Finite Element models, incorporating boundary conditions generated by musculoskeletal multibody simulation, and conduct convergence studies.
- Comparison and verification of the results from the Finite Element modeling using relevant literature data.
- Evaluation, summarization, and documentation of the generated results.

Depending on the progress of the work, individual steps may be shortened.

Keywords: Finite Element Analysis, Musculoskeletal Multibody Simulation, Numerical Simulation, Computational, Biomechanics.

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