CEREBRAL ANEURYSM AND SPINAL DISK BIOMODELING

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1. Introduction

The main goal of the research cooperation between the Institute of Polymer Product Engineering, Johannes Kepler University Linz (JKU) and Neurosurgical Department of Landes-Nervenklinik, Linz is the development and implementation of novel biomodels for practical medical applications.

Neurosurgical procedures have diminished due to emerging endovascular strategies. Moreover, opportunities for developing appropriate procedural skills among junior neurosurgeons in a safe environment are progressively rare. Therefore, especially in cerebral aneurysm and spinal column surgery, modern educational programs are highly warranted [1].

We are working out a method for simulating cerebral aneurysm and spinal column surgery using three-dimensional (3D) biomodels reconstructed from 3D rotational angiography (RA), computer tomography (CT) and magnetic resonance (MR) images.

Subject-specific models of cerebral aneurysms have been reconstructed by Mimics (Materialise, Leuven, B) from 2D image data RA or CT (Fig.1) to construct 3D models (Fig.2).

![Fig.1: MR image (Siemens Verio 3T MR) (a) and a single layer image (Mimics) (b) of the cerebral vessels.](image-url)
We use this technique to create the solid skull, the cerebral vessels in different gray scale, and the aneurysm complex in a material with less rigid, flexible properties to simulate the real aneurysm when clipped. Analogy we can configure the spinal column consisting of spinal segments, flexible intervertebral discs and spinal cord.

3. Results

The feasibility of converting anatomical data into precise plastic replicas corresponding to complex anatomical structures was demonstrated in this preliminary study. We are going to use these models for accurate prediction of vascular anatomy, for optimization of teaching surgical skills, as well as for advanced procedural competency training. The advantages of these models are that they provide intuitive tactile views that can be scrutinized from any perspective. Our models then can be used for surgical education, for maintenance of established skills, for surgical planning (including emergency situations) and for patient counselling.

Furthermore, efforts were done for modelling the formation of aneurysms using computational fluid mechanics tools [2]. The second generation of biomodels should be used for validating these models. In addition to the tactile feeling, the new models can carry loads (at least in a selected range) and reveal stable mechanical performance and their material model parameters can be implemented in simulation tools.

4. References
