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A Software System for Stent Planning, Stent Simulation and Follow-Up Examinations in the Vascular Domain

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Introduction

The focus of our work is the computer-aided treatment of artery diseases

- Artery enlargement (aneurysm)
- Artery narrowing (stenosis)

There are two different treatment alternatives for this kind of vascular diseases

- Open surgery
- Minimally invasive (endovascular) treatment

Open surgery is very stressful on the patient and not eligible for everyone, e.g. risk patients

Clinical studies compared open surgery with endovascular treatment

- Aneurysms [1], Figure 1
- Stenosis [2]

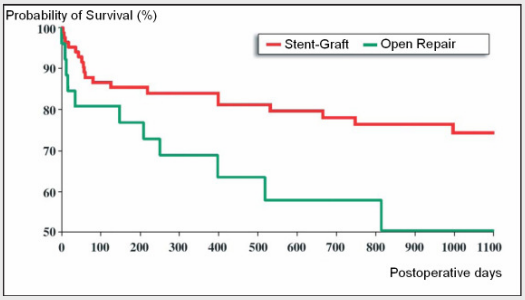

Fig. 1. Survival rate for high-risk patients after open- and endovascular surgery [1]

System

The architecture of our system is shown in Figure 2

Supports the physician during all treatment phases

- Diagnosis (preoperative)
- Intervention (intraoperative)
- Follow-up examinations (postoperative)

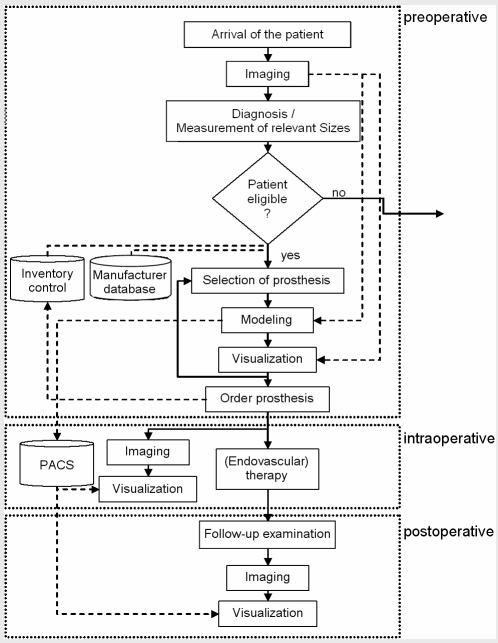

Fig. 2. Diagram of the developed system

Results

The methods were implemented in C++ in the MeVisLab and RadBuilder environment

Results were applied to CTA with variations in anatomy and location of the pathology

Aorta Segmentation [3, 4] (Figure 3)

- 50 clinical datasets were used – containing more than 3000 multiplanar reformatting (MPR) slices
- The average Dice Similarity Coefficient for all fifty datasets was 90.67%

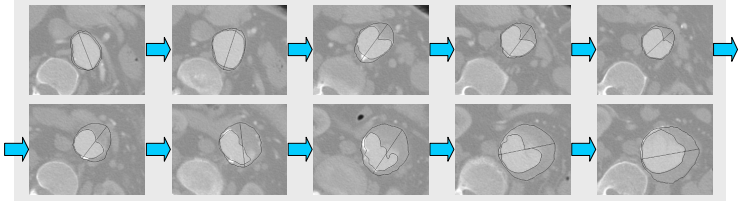

Fig. 3. Segmentation results for several MPR slices

Stent-Simulation [5, 6] (Figure 4)

- The Active Contours method for simulating (bifurcated) stents provided good results
- The material properties of the stents were simulated suitably and the fit to the vessel wall was realistic

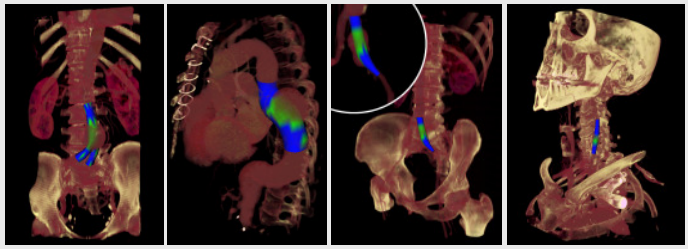

Fig. 4. Results of the stent simulation

Conclusion

In this work, a software system for supporting stenting in the vascular domain was presented. The system covers all treatment phases from diagnosis to follow-up examinations and supports the physician during the pre-, intra- and postoperative stages of the therapy. During the preoperative phase, the system helps suggesting the date and the kind of therapy based on segmenting the patient's CT data. Therapy planning is additionally supported by a computer-aided stent simulation. The intraoperative phase is supported by visualizing the selected stent from the planning phase at the requested position. After stenting, regular follow-up examinations are necessary to detect stent migration and endoleaks. These time-consuming procedures are also assisted by our system.

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