Section: **Visualisierung**

ID: 100

Abstract-Title:
COMPARISON OF TWO METHODS FOR PREOPERATIVE VISUALIZATION OF STENT GRAFTS IN CT-DATAVERGLEICH ZWEIER METHODEN ZUR PRÄOPERATIVEN VISUALISIERUNG VON STENT GRAFTS IN CT-DATEN

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Abstract-Text:
Purpose
An important area of medical image processing is the support of therapy planning for endovascular treatment of aneurysms. When an aneurysm reaches a critical diameter, the risk of rupture increases. Deploying a stent, splints and eliminates the aneurysm. Since 1991 – besides open surgery – it is possible to splint certain aneurysms endovascularly. This form of therapy is less stressful on the patient but requires a precise determination of the aneurysm dimensions for planning the operation. Randomized multicenter studies of abdominal aortic aneurysms (EVAR, DREAM) have shown that the mortality rate of endovascular surgery is lower within the first 24 months after surgery. After 2 years, the mortality rate is similar to open surgery, e.g. caused by occurring endoleaks (Fig. 1). Improved support of patient selection, planning and follow-up, based on improved imaging and image processing, will hopefully reduce the increasing mortality rate.

Methods
For stent simulation, the affected artery is segmented with a region growing method that starts at a user-defined seed point. Then, a skeleton algorithm determines the vessel centerline by iterative erosion of the segmentation mask. Rays, sent out radially from the centerline, intersect with the vessel wall. These intersections represent the nodes of the triangulated stent surface (Fig. 2). Setting the maximum length of the ray to the maximum stent radius ensures that the stent does not extend to the vessel wall in an aneurysm area. In addition to this pure geometrical method, the stent is deformed by using an active contours (ACM) method. The physical attributes of the virtual stent are simulated by internal forces in horizontal, vertical and diagonal directions. External forces press on respectively pull on the stent in the direction of the vessel wall. One external force is called the balloon force which simulates the balloon that is used to expand the stent. Another external force, is derived from the distance image of the segmented artery, simulates the resistance of the vessel wall. Voxels within the artery have the distance value zero. Outlying voxels have a distance value according to the minimum Euclidean distance from the vessel wall.

Results
Both methods were implemented in C++ in the MeVisLab environment and tested on CT data acquired during clinical routine as well as artificially generated CT aneurysm data.

The ACM method provided better results. In particular, the material properties of the stent grafts were simulated suitably and the fit to the vessel wall was more realistic (Fig. 3 and 4). A drawback of ACM is the increased computation time. Using a CT dataset with 512*512*387 voxels and a stent graft consisting of 170 surface vertices, the calculation of the inverse stiffness matrix took about one minute on an Intel Xeon CPU, 3 GHz, 3 GB RAM, Windows XP Professional 2002. (the geometrical method does not need an inverse matrix). Based on the geometrical method, the stent expanded in real-time. An iterative expansion step within the ACM method took less than one second.

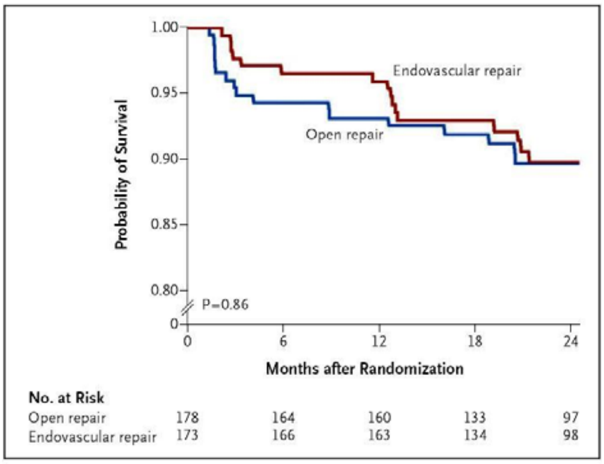
Conclusion

We visualized stent grafts in arteries with aneurysms (AAA, TAA, iliac). We implemented and tested a pure geometrical and an ACM method. The ACM method provides more realistic results. Before an operation, physicians are supported in choosing a stent by visualizing it in the CT data. This is very important because a stent which has not the exact dimensions could shift or cover an artery branch. The presented methods were specifically developed for aneurysm therapy planning, but the use in other applications is also possible, e.g. stenosis therapy planning.

References

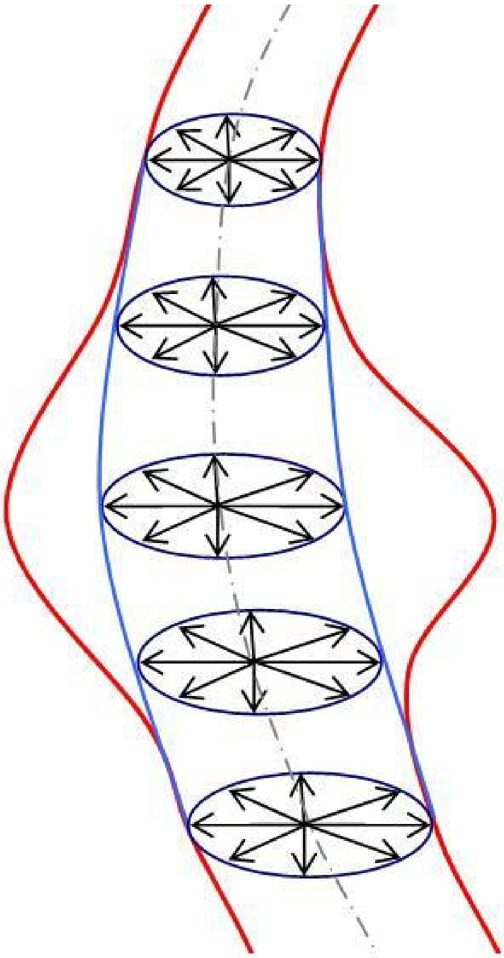
[1] Blankensteijn JD et al., “Two-Year Outcomes after Conventional or Endovascular Repair of Abdominal Aortic Aneurysms“, N Engl J Med June 9, 2005; 352:2398-2405

Bild 1/JPG



Mortality rate after open- and endovascular surgery [1]

Bild 2/JPG



Principle of geometrical stent construction

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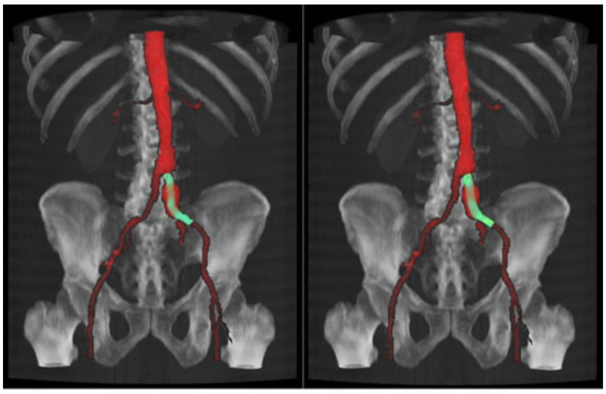

Iliac aneurysm: Results of the simulation of a stent graft with the pure geometrical (left) and the ACM method (right)