REPLICAS OF HUMAN ABDOMINAL AORTIC ANEURYSMS AND ARTERIAL STENOSES

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Vascular diseases mimicked in the phantom

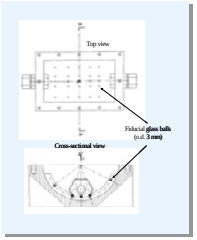
Stenosis : Reduction of the vessel lumen

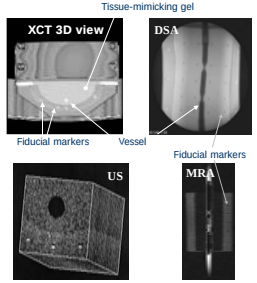
Abdominal Aortic Aneurysm

- There is a need for anthropomorphic flow phantoms to allow in vitro investigation of vascular disease such as stenoses and abdominal aortic aneurysms.

The multimodality vascular phantom

- Fiducial markers are very useful in the identification and orientation of plane views in DSA, CTA, MRA and US. They can also be used for calibration, rescaling and fusion of 3D images obtained from these different modalities, and 3D-image reconstruction from angiographic plane views.





- PCT patent pending.

Methods of fabrication

- Several approaches have been proposed to create realistic vascular phantoms, namely stereolithography, the casting of real vessels, and lost-material methods.
  - **Stereolithography** was used to build 3D replicas of coronary and cerebrovascular vessels with stenoses. Until recently, this method allowed only fabricating rigid-wall phantoms with an irregular lumen surface. However, with recent developments in technologies and materials, rapid prototyping technology and stereolithography now offer an increased geometric flexibility and a better accuracy in the production of realistic three dimensional flexible models.
  - Studies were also performed on phantoms derived from **real vessels harvested** on cadavers. However, the geometry of each artery is unique and unknown, and they cannot be duplicated if the vessel is damaged.
  - **Lost casting material techniques** using wax or cerrolow are interesting to reproduce realistic vessels with a smooth inner surface. The lost casting material is usually filled in a two-part mold and thermically removed to create the vessel lumen. Geometries of the human carotid bifurcation and cranial blood vessels were produced with this method.

Prototyping and fabrication based on the lost-casting material techniques

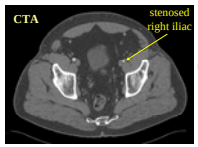
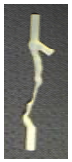


Image segmentation

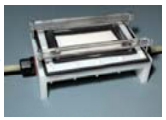
Geometry preparation



Prototyping

Moulding

Cerrolow rod



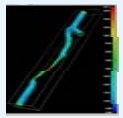
Lost casting technique

Geometrical validation

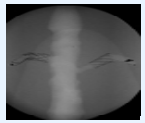
- The polyurethane membrane avoid the diffusion of gadolinium and other contrast agents through the vessel wall.
- The agreement between the lumen diameter of the phantom and the geometry of the CAD geometry is within -0.5 % (-0.04 ± 0.06 mm).
- A thin layer of polyurethane avoid degradation of the vessel wall and increase the long-term durability of the phantom.

Related work

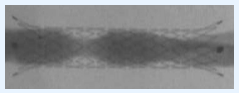
Provide a calibrating device for 3D imaging methods



Provide a calibrating device for image processing softwares



Study the influence of scan adjustment parameters on the visualization of restenosis

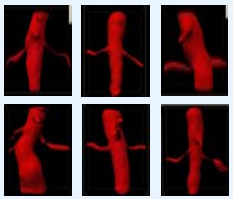


Evaluate imaging characteristics and artifacts of endovascular prostheses

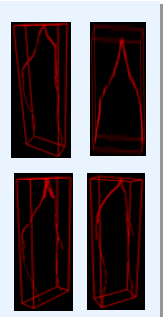
Geometries available

4 contiguous segments of known diameters

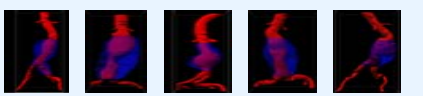
Simplified stenoses (12 models)



Renal stenoses



Iliac arteries with stenoses



Abdominal aortic aneurysms

- Other specific designs available
- Vascular phantoms can be built with or without stent

Key References

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Acknowledgments

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For information

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