3D Printing in Aortic Surgery: The link from diagnosis to Surgical planning and Treatment

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MILANO
Rendering or Printing?
Strategy to teach:

Technical Skills
Procedures
Operations
New Devices

Recreate similarity to reality
SIMULATION MODELS

- Animals and Cadavers reproduce a real anatomical scenario (not always available and difficult to reach)

- Virtual Reality is in an ongoing R&D phase

- 3D Printing opens a new scenario
IMAGING

• Integral part of surgical and transcatheter intervention

• Plays an increasingly important role for preoperative surgical planning and for peri-procedural evaluation imaging guidance

• In minimally invasive and transcatheter procedures, preoperative findings cannot be confirmed by direct visualization of the structures
Imaging

Three-dimensional imaging in the context of minimally invasive and transcatheter cardiovascular interventions using multi-detector computed tomography: from pre-operative planning to intra-operative guidance

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IMAGING ANALYSIS

Open source softwares (ie Osyrix, VTK, 3D slicer, MITK

- Multi Planar reconstruction (MPR):
  Data obtained from axial CT scan are reconstructed in any desired plan

- Maximum-intensity projection (MIP)
  Create an image similar to conventional angiography
  Calcification will dominate the image appearance

- Volume rendered technique
  Reconstruction of 3D images (better with contrast!)
3D Volume Rendering
OUR EXPERIENCE
OUR EXPERIENCE
OUR EXPERIENCE
OUR EXPERIENCE
CASE 1

75 yrs Severe symptomatic AS

PREVIOUS CABG:

LIMA LAD; RIMA-Ygraft-OM, safen vein-RInt

Uncontrolled Diabetes – COPD – Euroscore: 14.5

High risk for resternotomy

Operation: AVR via RT
MIMICS 19 di Materialise
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CASE 2

45 yrs

Normal Bicuspid Aortic valve

Ascending Aortic aneurism (50 mm)

Familiar hystory of dissection

Ascending aortic replacement via MS
Pre operative Images
Pre operative Images (simulation)
CASE 3
70 yrs

Previous AAA Endovascular graft for aorto-iliac aneurysm

Chest pain: Penetrating atherosclerotic ulcers and aneurysm in Aortic Arch and Proximal Thoracic Descending Aorta

Operation:
FET and total arch replacement via MS
C.D., female, 23 y.
Coarctation

- Reduced exercise tolerance during the last 2 years
- Recent diagnosis of Aortic Coarctation
- Admitted to another Institution for surgery
- Surgery declined due to “high risk”, taking into account the unusual anatomy (CT scan)
CT scan: tight coarctation just distal to left carotid (left subclavian hypoplasia)
STL reconstruction (Mimics)

3D model (Materialise) (Heartflex material)
Planning Catheter Intervention

* Use covered stent to reduce the risk of dissection/rupture in a tight stenosis

* Avoid occlusion of the carotid
Planning the strategy of the procedure

Single covered stent (39 mm CP) mounted on 2 balloons (BALT 10x40 mm)
2 wires into right subclavian and left carotid
Distal part of stent deployment
Full stent deployment
Hemodynamics: 60 mmHg gradient

Conventional angio

3DR angio
3D model simulation

Patient procedure
3D model simulation

Patient procedure
Distal part of stent over dilation (BALT 18x40 mm)
Final result: no residual gradient

Conventional angio

3DR angio
Final result
Conclusions

• Simulation on 3D model proved to be extremely helpful for planning surgical and transcatheter intervention in complex aortic surgery.
Thank you!