3D navigational tools: Of help or just another useless tool?

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Development of 3D navigation

- 3D rotational angiography (3D-RA)
- Dynamic 3D roadmap
- Cone-beam CT
- Image fusion (merging)
3D-RA

- Accurate measurements (length/diameter) no calibration catheter needed
- Choose optimal angulation of X-ray tube during intervention
- Reduction of contrast volume
- Reduction of radiation dose

J.C. van den Berg et al, AJR 2002;178:149-152
J.C. van den Berg et al, JET 2003;10:595-600
Dynamic 3D roadmap

- Real-time monitoring from any angle
- Allows for change of magnification without need to perform new run
- ‘split screen’ of live fluoroscopy and 3D roadmap
Dynamic 3D roadmap

FOV 32 cm
Dynamic 3D roadmap

FOV 15 cm
3D overlay (fusion/merging)

• Combines real-time feedback of fluoroscopy with optimal soft-tissue contrast of CT/MR
Image fusion

• 4 steps
  – Segmentation
  – Planning
  – Registration
    • CTA and MRA: 3D-3D (cone-beam CT)
    • CTA: 2D-3D (fluoroscopy)
  – Live
Segmentation (CTA)
Registration (3D-3D)

Optimizing ‘overlay’
Optimizing overlay
Registration (2D-3D)

Optimizing overlay
Segmentation (MRA)
Planning
Registration (3D-3D)
Registration (3D-3D)

Optimizing overlay
‘Live’
Control angiography
Embolization false aneurysm hepatic artery
Embolization false aneurysm hepatic artery
Embolization false aneurysm hepatic artery
Embolization false aneurysm hepatic artery
Type 2 endoleak treatment
Type 2 endoleak treatment

Canulation right hypogastric artery
Type 2 endoleak treatment
Type 2 endoleak treatment
Type 2 endoleak treatment
Type 2 endoleak treatment
Advantages

• Re-use of diagnostic CT/MR data saves contrast, time and radiation to the patient and to the staff

• Availability of continuous 3D

Bargellini I et al, CVIR 2012 (epub ahead of print)
Gupta A, et al, JVR;24:1690-1697
Advantages

• Selective catheterization can be performed without using any contrast

• Merging techniques can improve technical success rates in complex recanalization procedures, while reducing fluoroscopy time as well (animal model)

Bargellini I et al, CVIR 2012 (epub ahead of print)
Gupta A, et al, JVIR;24:1690-1697
Advantages

- Significant reduction in contrast dose
- Shorter procedure time
- Trend toward lower fluoroscopy time
- Trend toward reduction of DAP (P=.18)
  - 2D angiography: 1,188 Gy.cm² +/- 1,067
  - 3D RA: 984 Gy.cm² +/- 581
  - 3D-3D image fusion: 655 Gy.cm² +/- 457

Dijkstra ML et al  JVS 2011;53:583-590
Sailer AM et al EJVES 2014;47:349-356
Tacher V et al JVIR 2013;24:1698-1706
3D-3D vs. 2D-3D

- Effective dose
  - Cone-beam CT 1.53 - 1.66 mSv
  - Two oblique fluoroscopy projections 0.14 - 0.20 mSv
  - 6-second DSA run with 3 frames per second 0.91-1.46 mSv

J.C. van den Berg et al, AORTA 2015, in press
Conclusion

• 3D image fusion has matured into a technique that can easily be implemented in daily practice and helps in reducing contrast and radiation exposure

• 3D navigational tools are here to stay and should not be considered another useless tool
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