New Techniques to Decrease Radiation Exposure to Surgeons and Staff During Complex Aortic Procedures

Mark A. Farber, MD FACS
Chief, Division of Vascular Surgery
Director, Aortic Network
Professor of Surgery and Radiology
University of North Carolina
Chapel Hill, NC

Brain tumors among interventional cardiologists: a call for alarm?

What is our exposure? At What Risk?

Real-Time Dose Monitoring

- Use of real-time monitoring demonstrates that Dose Area Product (DAP) was the highest for EVAR procedures
- Result of procedural complexity, distance, use of shielding

Protection Strategies

- Protective Equipment
  - Protective Drapes
  - Shielding
- Procedural Details

Disclosures

- Cook Medical: Consultant, Research Support, Clinical Trials
- WL Gore: Consultant, Clinical Trials
- Endologix: Consultant, Clinical Trials
- GE: Clinical Trials

3D Visualization of Radiation Scatter in Hybrid Operating Rooms

Exposure: 17 minutes of DSA (yearly)
Amount of XRT: DSA > CBCT > FL
Scatter highest for non-AP positions on side of emitter

Chauhan et al. SCVS 2016
Operator’s Eyes

- International Council for Radiation Protection: 20 mSv/y (lens)
- Estimated that a fluoroscopy time of 23.4 hours result in critical lens dose of 20 mSv/y

Top 10 List for Procedural Details

1. Oblique Orientation of Tube
2. Eyes: Protect Them
3. Save Images
4. Optimize, Old Images
5. De-Mag
6. Exit the Room for DSA
7. Vary the Technique
8. Add Barriers
9. Slow the Frame Rate
10. Increase table height (table Up, top Down)

Modern Day Badges
Detection and Early Warning

Dose Aware Real Time Monitoring
- Dose monitoring during the procedure
- Gives immediate direct feedback to operator
Intra-Operative Guidance

- Identification of Vessel Origins
- 3D Aortic Overlay

Exposure Risk

- The majority of the exposure during the procedure comes from scatter radiation
- Degree of Exposure is not always under our control
- Complexity of the procedure
- Body habitus of the patient

Conclusions:
With adherence to the ALARA principle and routine application of fusion imaging guidance for EVAR, low radiation exposure compared with the published literature can be achieved in a real world setting.

Imaging Is Key to Endovascular Procedures

Current Paradigm - Fluoroscopy
- Ionizing radiation
- 2D Visualization

Future Paradigm - IOPS
- Intraoperative Positioning System (IOPS)
  - Interactive 3D Vascular Image
  - EM tracking of endovascular "tools" within the vascular tree

Utilizes Pre-Op CT Scan with computer algorithm to provide interactive patient specific models
Overlay Fusion of Interactive Mathematical Model

Electromagnetic Navigation
- IntraOperative Positioning System (IOPS)
- Integration:
  - Interactive 3D model
  - Vascular tools (catheters, wires, devices)
- Allows for real-time tracking and positional feedback without the use of ionizing radiation

Navigation System Development
- Sensors on Sheaths, Wires, Catheters

Display System Development

Concept Validation in Rigid Vascular Model

Integration of Overlay and EM Navigation
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In Vivo Testing

Interactive Model
Vector Prediction

Interactive Model
Ostial Indicator

Assess ability to cannulate porcine visceral vessels using IOPS

Verify with angiography
Next Steps

Potential Advantages of IOPS
- Reduced XRT exposure to patient and proceduralists
- Reduced use of XRT
- Potential for reduced catheterization times
- Reduced overall procedure time

Conclusions
- Current advancements in vascular therapy significantly increase the exposure of vascular specialist to the harmful effects of ionizing radiation
- Maximal efforts should be employed by proceduralists to protect themselves
- Leg and Head Protection
- Immediate intra-procedural feedback is important in developing proper technique
- Future research should identify non-ionizing methods for navigation and device implantation