Reducing Radiation Exposure During Endovascular Procedures

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Radiation in the Interventional Lab

- Image guided procedures are a leading source of radiation exposure
- As complex interventions and number of procedures increase, radiation exposure to medical staff is becoming a growing concern
- Radiation in the work environment can create significant radiation-related illnesses
- Radiation safety in the interventional suite, hybrid suite, and operating room is of critical importance to both operating physician and patient
- Requires a Team Approach to be truly effective

Recent Study  JACC 2015

Subclinical carotid atherosclerosis and early vascular aging from long-term low-dose ionizing radiation exposure: a genetic, telomere, and vascular ultrasound study in cardiac catheterization laboratory staff.


CONCLUSIONS: Long-term radiation exposure in a cath lab may be associated with increased subclinical CIMT and telomere length shortening, suggesting evidence of accelerated vascular aging and early atherosclerosis.

Goals

- Minimize radiation to the patient, physician, and staff without increasing risk of procedure
- Maintain image quality while utilizing techniques to decrease overall radiation exposure
- ALARA (As Low As Reasonable Achievable) principle should guide every procedure

How Does Operator Exposure Occur

Image Intensifier

Sources of Exposure

A. Scatter radiation from the patient
B. Primary beam radiation exposure
C. Leakage radiation from X-ray tube

Disclosures

- Advisory Boards:
  - Boston Scientific
  - WL Gore
  - Phillips Healthcare
Keys Principles to Reduce Radiation Exposure

- TRIAD: Time, Distance, Shielding

**Time**

- Less imaging = less exposure
- Ensure benefits of exposure outweigh risks

**Distance**

- As the distance doubles from the radiation source, exposure drops by 1/4th

**Shielding**

- Lead aprons and shields absorb 90% of radiation
- Protection of the eyes and thyroid is crucial and often overlooked

*ORSIF: Organization for Occupational Radiation safety in Interventional Fluoroscopy: 2015

Shielding

- Protection is critical:
  - Minimum 0.5 mm lead apron
  - Thyroid Shield
  - Lead glasses
- Make sure the apron is checked at least yearly for cracks in the lead

Practices That Decrease Radiation Exposure

- Collimation (reduce field of view)
- Minimize use of magnification
- Limit digital subtraction angiography (DSA)
  - When perform DSA, limit frame rate (i.e. 1 fps for tibial artery evaluation)
- Utilization of filters
- Decrease exposure when possible (don’t be a lead foot)

Limit Steep Angulations of Image Intensifier When Possible

LAO, RAO views may improve visualization

Note: 60 degree angulation has 3x the exposure of 30 degree angulation
Use Pulsed Fluoroscopy

Elminate Air Gap – Minimize distance between image intensifier and patient

Keep Hands Out of the Primary Beam

- However, do NOT use lead gloves (blocks x-rays from II and as a result the kVp and mA

Additional Practices

- Hang lead shield appropriately
- Use the shielding below the table as the radiation to the lower extremities is far greater than that to the torso
- Consider using shielding on the patient (mandatory for pregnant patients, children, etc)

NEWER TECHNOLOGY

Radiation monitoring equipment
Dose Aware

Real-time feedback on scattered x-ray dose so you can change behavior
Reminded to take secondary lead precautions
Idea of how distance, cine imaging, DSA, shielding etc affect radiation dose

Newer Technology: 3D Roadmapping/Fusion Technology

- 3D image fusion allows fusion of preoperative CTA or MRA and fluoroscopy to yield a live 3D roadmap that allow movement of the table and II while maintaining the roadmap
- There was 72% reduction of contrast use during EVAR in one study (Tacher V et al. JVIR 2013)
- Procedure time decreased from 6.3 hrs to 5.2 hours during FEVAR (Sailer et al. Eur J Vasc Endovasc Surg 2014)
- Ring markers can be added to segmented image to indicate renal ostia, landing zone, and plan angles

3D Roadmapping/Fusion During EVAR

During EVAR, 3D Fusion With Vessel Navigator:
- Decreased contrast use
- Decrease procedure length
- Reduced radiation

Typical Cath Lab Layout

Magellan Robotic System

Robotic Room Setup
74 y/o male presented with juxtarenal AAA, bilateral common iliac artery aneurysms, bilateral hypogastric artery aneurysms, and left common femoral artery aneurysm. 5 mm aortic neck length.

Cook Zenith Fenestrated Graft with SMA scallop

Renal arteries and SMA cannulated with Main Body deployed
Robotic cannulation of bilateral renal artery fenestrations

Main body cap unrestrained and PTA

Bilateral renal artery stents placed

Completion Aortogram

ROVER Registry: Materials & Methods

Procedure Types:
- Endovascular TACE Procedures, Carotid Interventions, EVAR, Peripheral Interventions

Methods:
- Intra-procedural radiation exposure at bedside (typical primary operator position) and actual primary operator using RaySafe.
- Follow-up data within 14 days.
- Adverse events
- Data recorded through the ROVER Registry*

Imaging Type:
- Siemens Flouro Manufacturer
- Zeego 3040 Image Intensifier
Radiation Exposure (Endovascular Procedures µSV)

Bedside Dose vs. Operator Dose

95% Radiation Reduction

Bedside Avg Dose - 168µSV
Operator Avg Dose - 23.3µSV

Medical Staff Comparison Graph Manual vs. Robot Two Comparable Cases

Radiation Hormesis

- What are potential benefits of radiation
  - Increased ability to handle free-radicals
  - Enhanced chromosomal injury repair
  - Stimulation of immune system

- Unpublished study of conventional versus nuclear ship builders showed a statistically lower death rate (24% less) in the nuclear group

- Cancer death rate lower in states with highest background radiation (i.e. Colorado)

Conclusions

- Fluoroscopy guided interventions can be done safely
- Small differences in daily can lead to significant accumulated dose over 30 year period
- There is a decades-long latency; therefore, consequences could develop when you are retired
- Radiation exposure can be reduced through a combination of techniques
- Follow ALARA (time, distance, shielding)
- New technology may help further reduce radiation

ISET 2016

- Dedicated session on radiation protection and newer developments