Cardiorhythm 2009

Radiation Physics and Safety Considerations in the EP Lab

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Cardiorhythm 2009 - Disclosure

- St Jude Medical Canada - travel support

History

- 8 November 1895 **Wilhelm Röntgen** discovered X-rays.
- 1898 Fluoroscope invented by Thomas Edison.
- 1913 Coolidge Tube (Vacuum Tube)
- 1950's Development of X-ray Image Intensifier and Television Camera.

Fluoroscopy for ablation: Then . . . and now.

- Kugler, NEJM 1994
- Pediatric EP Society
- LFW 59±43 min
- RFW 80±51
- RAS 61±34
- RPS 60±41
- AVNRT 46±34

- Tuzcu, PACE 2007
- Clark, PACE 2008
- LFW 0 min
- RFW 0
- RAS 0
- RPS 0
- AVNRT 0

Why? Is fluoroscopy bad?

- Effects of radiation
  - Deterministic (dose-related)
    - Caused by cell necrosis
    - Threshold dose, dose-response effect
  - Stochastic (chance-related)
    - Caused by cellular mutation
    - No threshold, dose-response likelihood

Measuring radiation

- Absorbed dose: Energy per unit mass
  - 1 Gray (Gy) = 1 J/kg
  - Material-specific
- Equivalent dose: Radiation-specific
  - 1 Sievert (Sv) = 1 Gy (for X and gamma rays)
- Effective dose : best correlates with effect
  - Sum of each equivalent dose multiplied by tissue weighting factors

Tissue Weighting Factors

Gonads	0.20
Marrow, colon, lung, stomach	0.12
Bladder, breast, liver, thyroid	0.05
Skin, bone surfaces	0.01

Typical effective doses

- Television (CRT) 5 uSv/hour
- Chest Xray 20 uSv
- Toronto - Hong Kong 63 uSv
- Abdominal Xray 1 mSv
- Natural exposure 3 mSv
- CT abdomen 10 mSv
- Angiography 20 mSv

Carcinogenic risks

- Patients:
  - Overall 0.01-0.1% risk per fluoro hour
- Operators:
  - May be as high as 0.3% for busy volume
- Difficult to discern given background rate of 10-20% lifetime risk of cancer

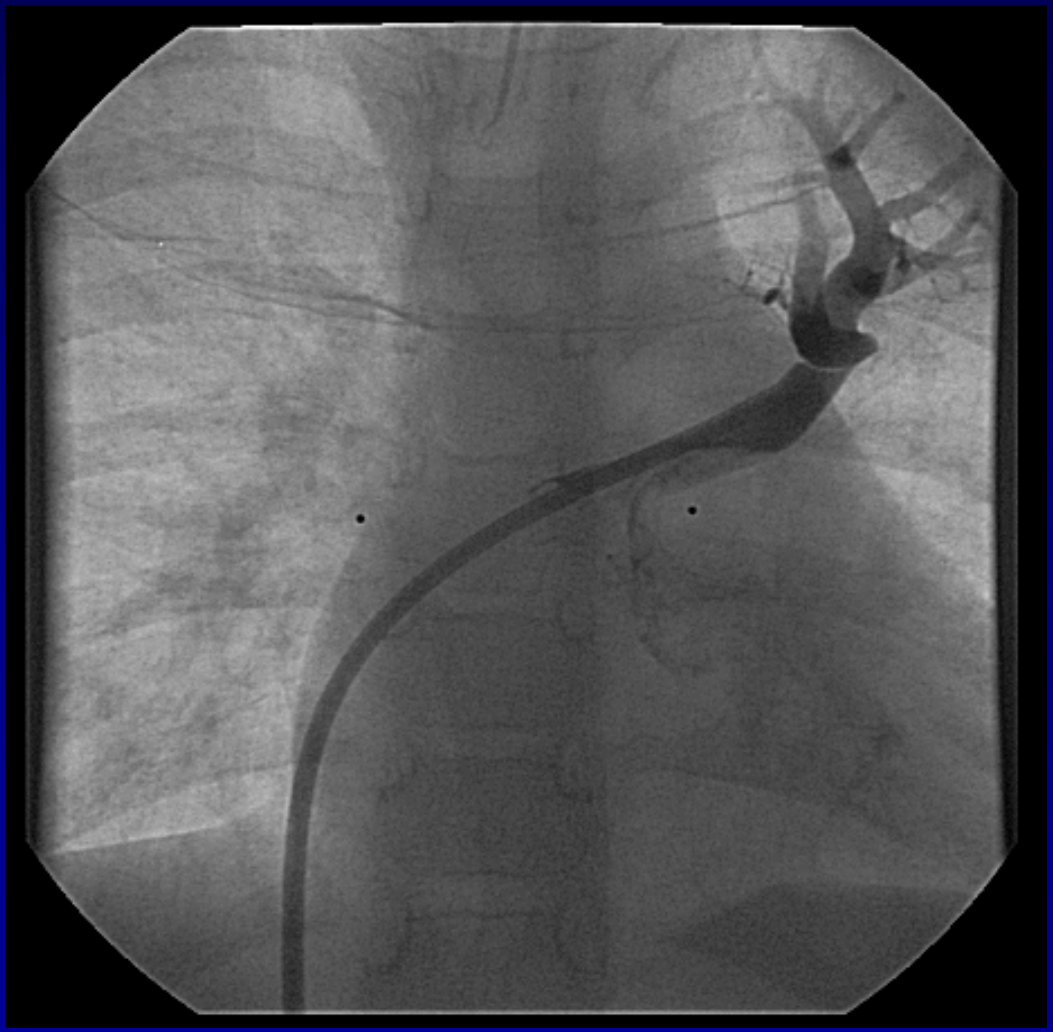
Strategies to reduce fluoroscopy

- Patient factors

Proper Patient Position

- Isocenter and Straight
- Facilitates change to oblique projections
- Allows for tighter collimation
- Do not fluoro while table is being moved or patient is being repositioned!

Poor centering…



Minimize patient's exposure to field

- Arms out of field:
  - Avoids irradiation of arms
  - Avoids increased exposure (Automatic Exposure Control)
- Gonad shielding
  - Highest weighting factor (0.20)

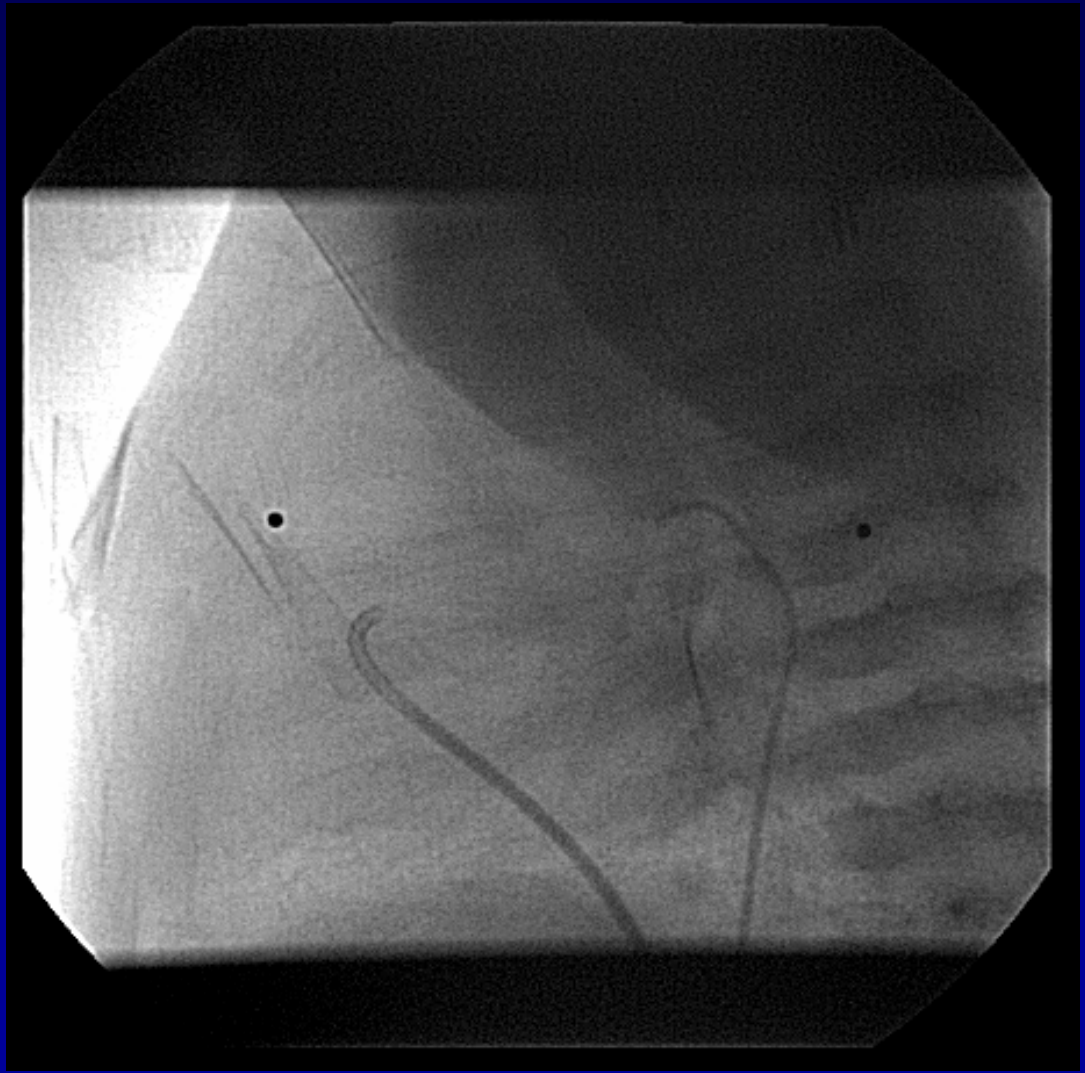
Strategies to reduce fluoroscopy

- Patient factors
- Operator & Equipment factors

Use Collimators and Cones

- Reduces volume of tissue exposed to radiation
- Reduces scatter exposure to staff
- Improves image quality
  - Elimination of air densities
  - Smaller field utilizes resolution of system better

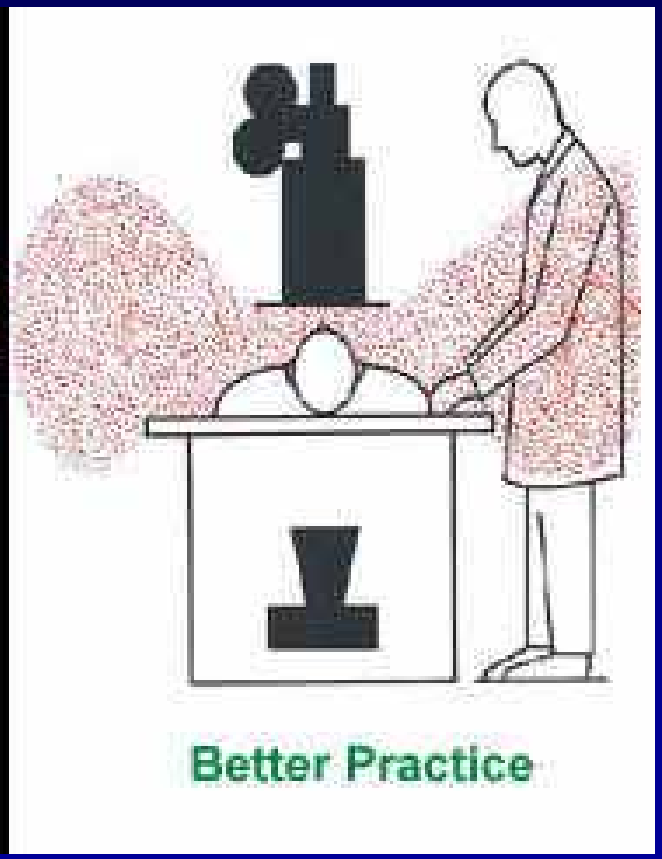
Poor collimation, with arms in field…



Keep II Close to Patient

- Higher II results in higher input doses
- Higher II results in more scatter to personnel
- Avoid “air gap” technique
- High II results in geometric magnification which requires higher dose with degradation of image quality

Keep II Close to Patient



Sorenson 2000

Decrease Beam On-Time

- Do not fluoro while positioning patient: move patient first, then screen briefly to verify position
- Use virtual markers to collimate & cone
- Develop the reflex: “if the eye is not on the screen, the foot is not on the pedal”
- Use lowest frame rates for fluoro/angio

Staff protection - basic concepts

- Anything that reduces patient exposure will reduce staff exposure
- Staff are repeatedly exposed; even small reductions in per-case exposure will have long-term benefit

Staff - Personal protection

- Lead vests and aprons
- Thyroid shields
- Lead goggles/glasses (helps with BSP)
- Overhead shields
- Underbed skirts

Shields and Skirts

Fluoro Rate	1.0 Gy/hr
Scatter	0.2 Gy/hr
With shields	.01 Gy/hr

Strategies to reduce fluoroscopy

- Patient factors
- Operator & Equipment factors
- Innovation

Innovation: TEE for TSP

QuickTime?and a
decompressor
are needed to see this picture.

From Clark et al, PACE 2008;31:283-9

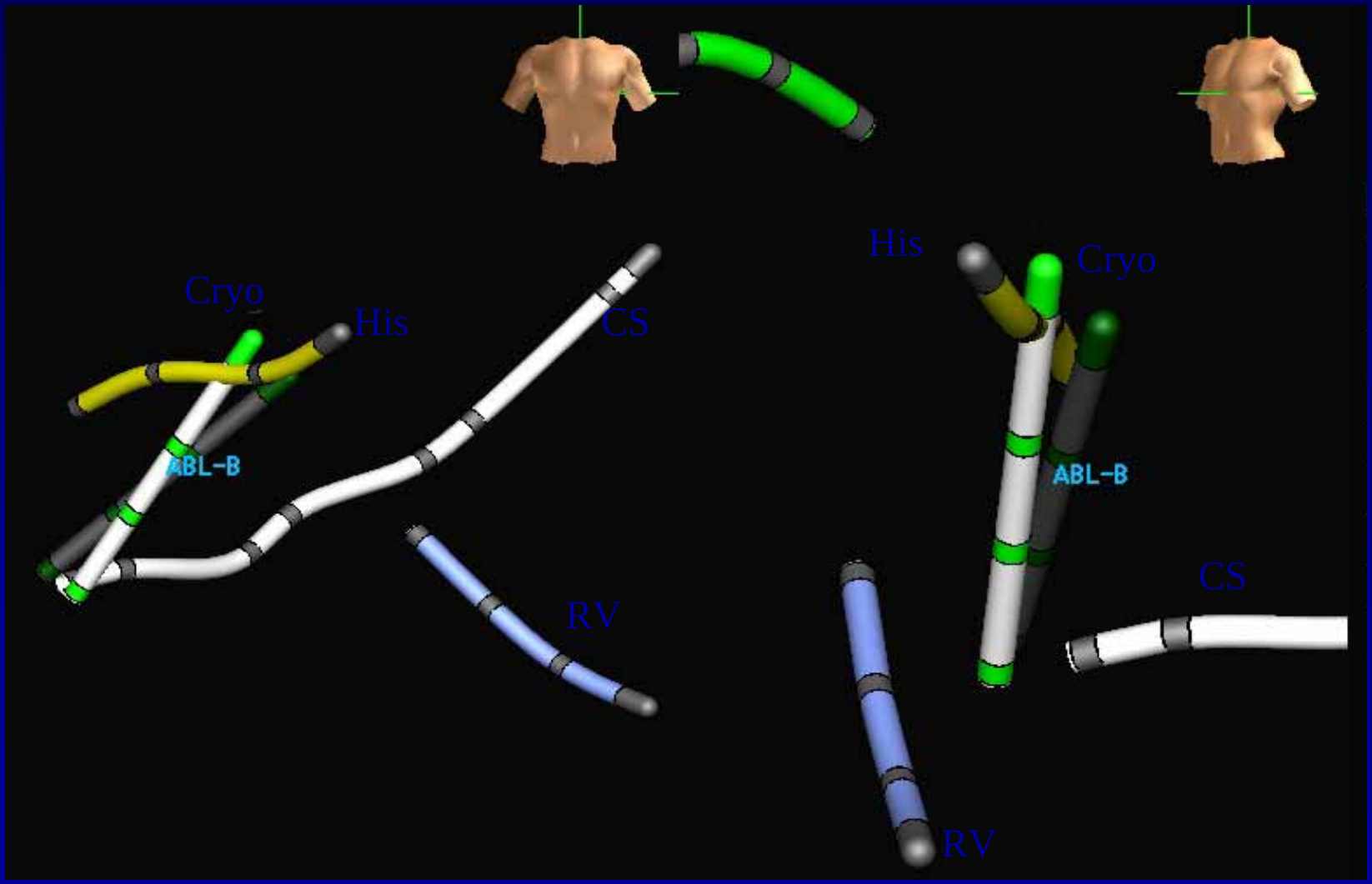
Flour-less chocolate cake.

Fluoro-less ablation tools.

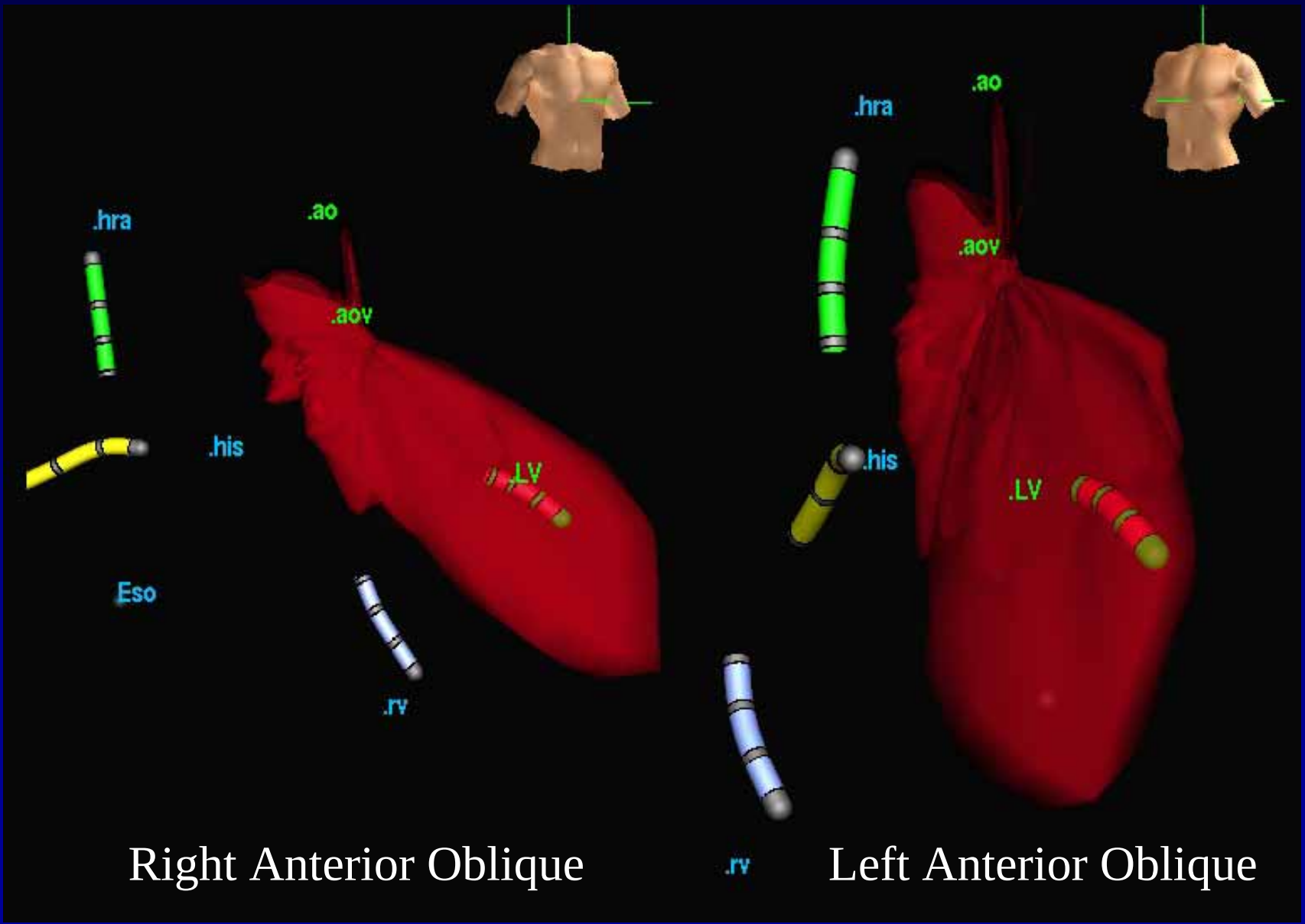
Innovation: ESI NavX™

- Nonfluoroscopic navigation
  - Impedance signals through standard catheters
  - Reference body electrodes in XYZ planes
- Realtime catheter positioning
  - Any electrically measurable catheter
- Signal acquisition and processing
  - Activation maps, voltage maps
- Routine use for all EPS/ablations

NavX™ for paraHisian ablation



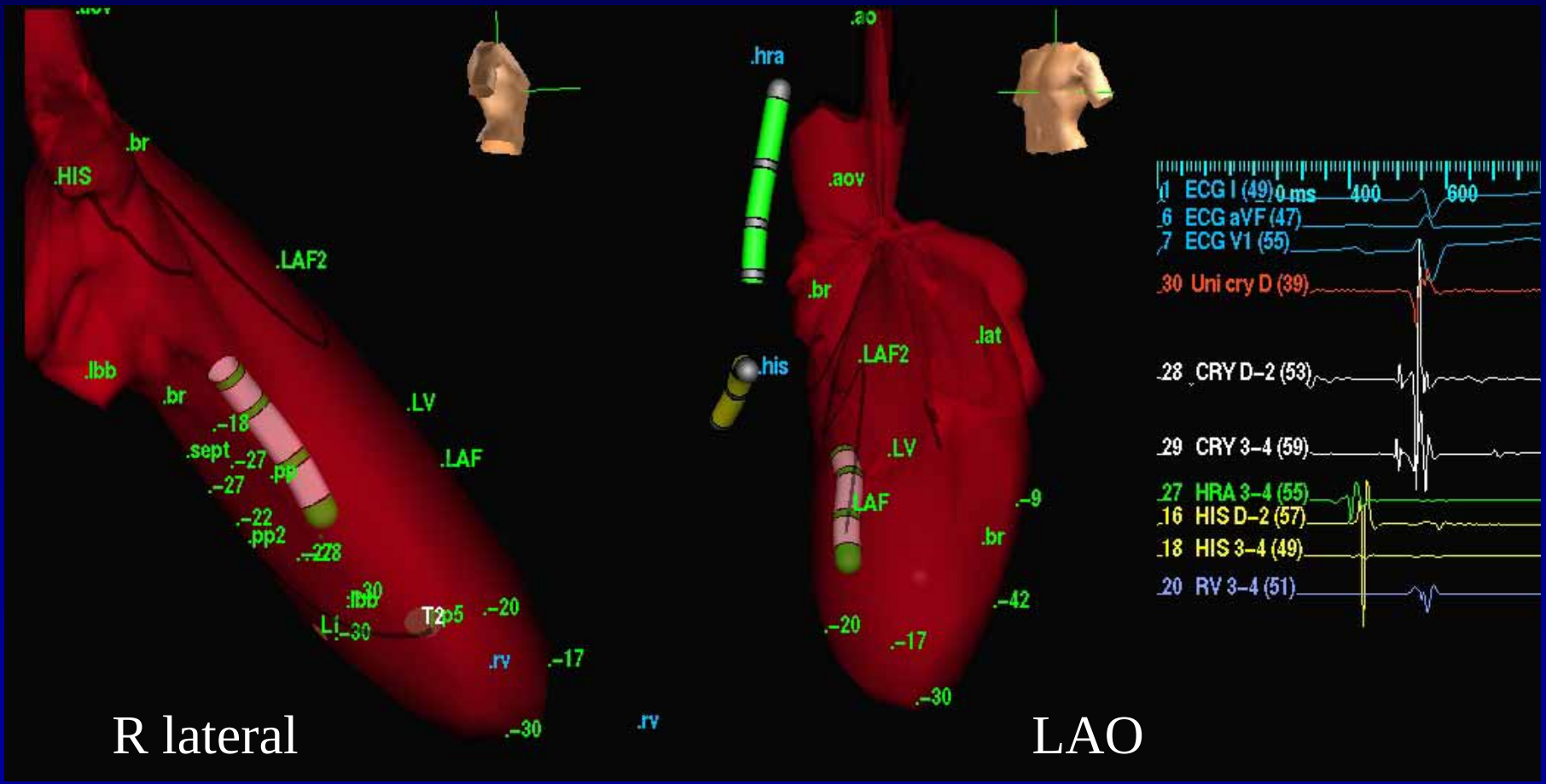
Cryoablation of ILVT using NavX™



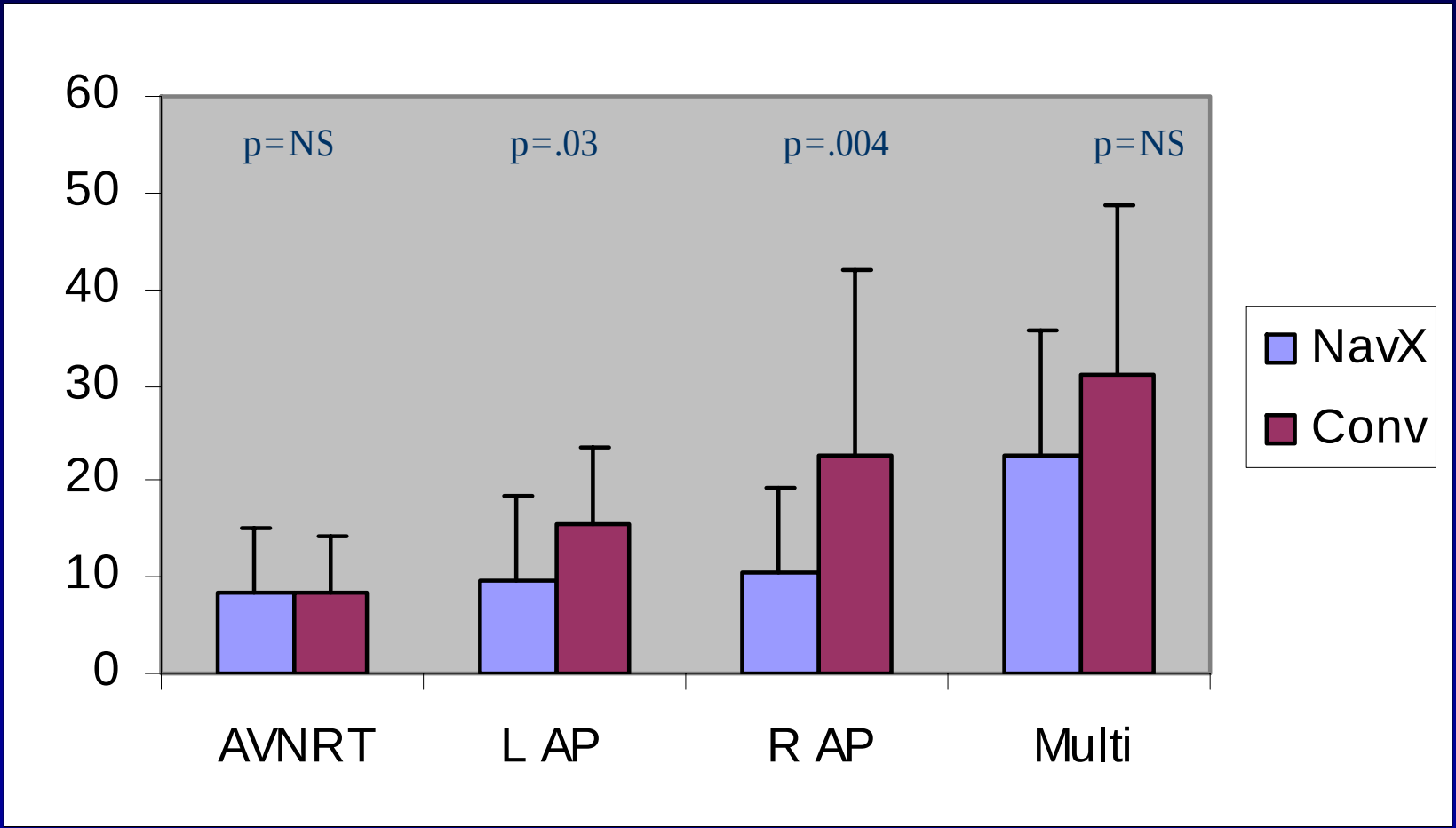
Right Anterior Oblique

Left Anterior Oblique

Cryoablation of ILVT (Belhassen) using NavX



Ablation fluoro time - Toronto
Neilson et al, AEPC 2006



NavX in Athens

Papagiannis et al, PACE 2006;29:971-8

QuickTime?and a
decompressor
are needed to see this picture.

Fluoro-free ablation of two APs

Clark et al, PACE 2008;31:283-9

QuickTime?and a
decompressor
are needed to see this picture.

Summary

- Fluoroscopy effective imaging tool for EPS
  - Risks of ionizing radiation
- Effective means for reducing exposure
  - Patients and staff
- TEE and non-fluoroscopic systems
  - Reduce or eliminate radiation in the cath lab

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