Update on MR in Patients with Implanted Devices

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FINANCIAL DISCLOSURE:
None relevant to this presentation

UNLABELED/UNAPPROVED USES DISCLOSURE:
Performing MRI of patients with most pacemakers and ICDs in an unapproved use of both the MRI system and the ICD

Some of the MR pulse sequences discussed are not clinically available products

Use of gadolinium-containing contrast agents for cardiac MRI is an off-label application
Outline

• New devices and procedures
• Update on CMR in device patients
MR Conditional Pacemaker(s)

- Medtronic Revo SureScan
- "MRI conditional" 1.5T only, no T/R coils over generator
- FDA approved 3/2010
- Only generator/lead pair
- Isocenter can’t be from C1-T12 - no hearts
- Update 6/13, anatomic restriction removed
- Normal SAR mode scanning only (<2 W/kg)
- Electrical isolation mode for generator
- Leads better insulated
- Replace Reed switch with Hall sensor
MR Conditional Pacemaker(s)

- Medtronic Advisa MRI SureScan
  - FDA approved Feb 2013
  - New MR compatible leads
    - Passive fixation vs. active fixation
- Biotronik Entovis pacemaker
  - FDA approved May 2014
  - Anatomic restrictions
  - Isocenter above eyes or below hips
- Biotronik Iperia ProMRI - includes ICD
  - Head SAR 3.2 W/kg, body 2.0 W/kg
  - New devices with no anatomic restrictions
MR Conditional Pacemaker(s)

- St. Jude Accent, Assurity, Assura, Endurity MRI pacemakers (CE approval)
- No anatomic exclusions
- Up to 4 W/kg whole body (first-level)
- Hand-held “actuator” device for MRI mode
- Don’t need EP involvement

- Boston Scientific Accolade and Essentio
  - Backward compatible lead system - Fineline II
- Approved April 2016
Latest Approved Devices

• Medtronic Evera ICD
  • 1.5T only, only normal SAR (2 W/kg)
  • No anatomic restrictions
• Boston Scientific and St. Jude ICDs pending
• Subcutaneous ICD
  • Boston Scientific Emblem MRI S-ICD
  • MR conditional 1.5 and 3T
  • Tachy detection and therapy turned off
  • Beep function may be permanently turned off after MRI
  • Audible warnings to patient
Latest Approved Devices

• Leadless pacemakers  
  • Medtronic Micra  
  • 1.5 and 3T  
  • No restrictions  
  • First level SAR ok  
• St. Jude Nanostim  
  • CE approved  
  • FDA pending
Pacemakers and CT

- Pacemakers can sense time varying x-ray intensity as cardiac activity (oversensing)
- Can lead to transient inhibition of output
  - Only when beam is directly over device
  - A few seconds at most
  - No permanent changes in programming
Frequent PVCs
Delayed Enhancement - TI Scout
Artifacts in CMR of Device Patients

• SSFP sequences (cine and TI scout)
  • Balanced gradients require field homogeneity

• Late enhancement
  • Inversion pulse requires field homogeneity to properly null myocardial signal

• Dark zone immediately adjacent to generator

• More remote hyperintensity from incomplete inversion
What Can We Do About It?

- Reduce inhomogeneity in region of heart
- Move generator - push up in pocket and tape
- Right sided generator
- Use or make sequences less affected by inhomogeneity
  - Spin echo instead of gradient echo (localizers)
- Non balanced gradient echo cine
- Reduce TE as much as possible
- Adjust inversion pulse for LGE
Late enhancement artifacts
Wideband LGE Sequence


Wideband Sequences

• UCLA (Peng Hu, et al.), Utah (Kim, et al.)

• 2D LGE sequence

• 3D LGE sequence

• T1 mapping

• T1 scout
2D Wideband LGE Sequence
Wideband T1 Mapping Sequence
HCM with NSVT

- GRE cine, less artifact than SSFP
- GRE perfusion
HCM with NSVT
HCM with NSVT
HCM with NSVT
21 yo M, witnessed arrest

1st MRI
Epicardial LGE

2nd MRI, S-ICD
Spin echo DB

2nd MRI, S-ICD
nl LGE sequence
Conclusions

• New devices are making things complicated
• Different conditions
• Someone in your practice needs to know this
• S-ICD causes more artifact over apex
• New pulse sequences make CMR possible in device patients
• But still limitations for cine imaging