Patient Specific Adaptions of Imaging Techniques: MRI

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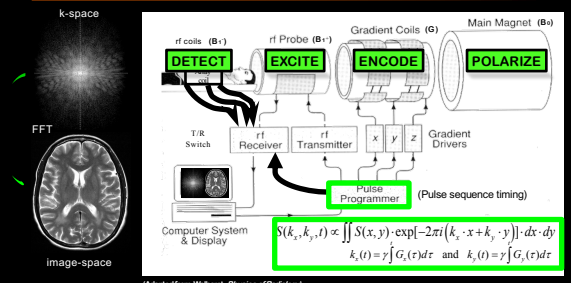
MRI Acquisition in a Nutshell

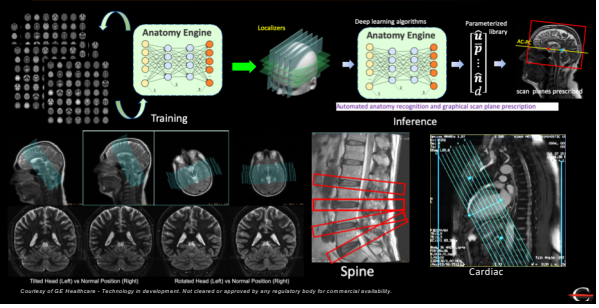


(Adapted from Wolbarst, *Physics of Radiology*)

Patient specific adaptation in MRI: A few interesting examples

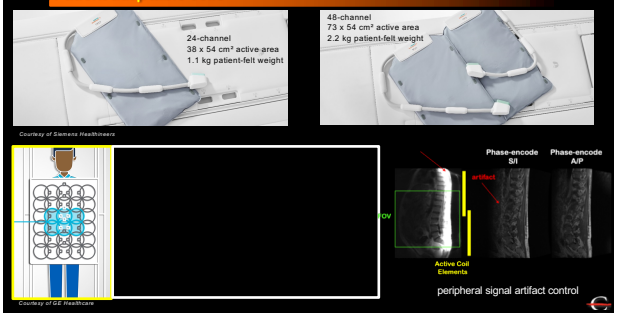
- MR Scan Prescription
- RF Coils
- Image reconstruction
- MR Scanner Tuning
- Patient Motion Management
- MR Safety

Toward artificial intelligence assistance in scan prescription



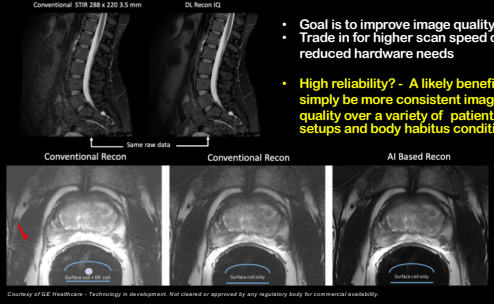
Courtesy of GE Healthcare - Technology in development. Not cleared or approved by any regulatory body for commercial availability.

Patient adaptable coils



peripheral signal artifact control

Artificial intelligence assisted reconstruction using deep learning



- Goal is to improve image quality
- Trade in for higher scan speed or reduced hardware needs
- High reliability? - A likely benefit will simply be more consistent image quality over a variety of patient setups and body habitus conditions

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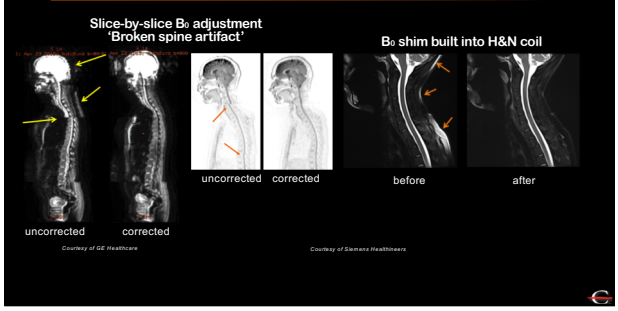
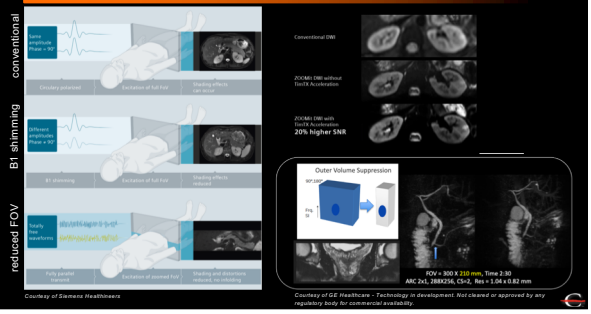
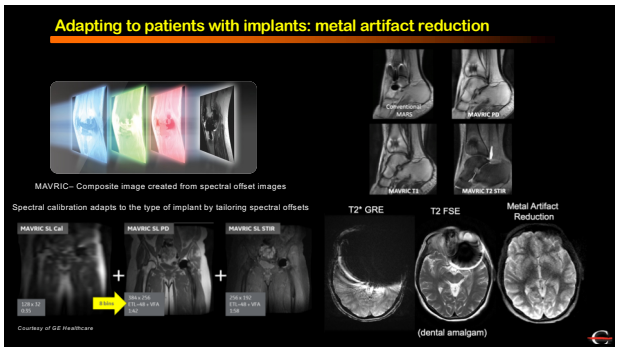
Patient specific system tuning: B_0 shimming



Patient specific system tuning: B_1^+ & multi-transmit

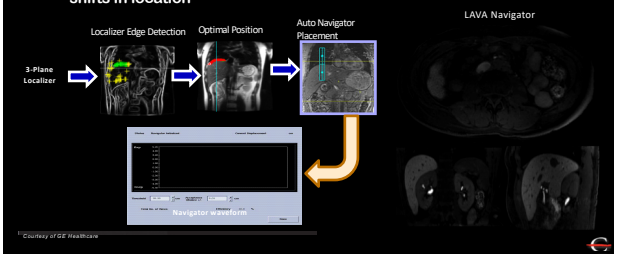


Adapting to patients with implants: metal artifact reduction



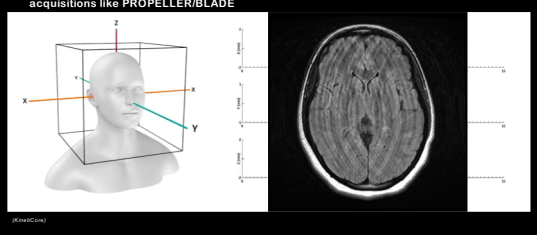
Adapting to patient motion: 'Navigators'

- Advances in adaptive navigators include automated navigator placement and moving navigator acceptance to adapt to slight shifts in location

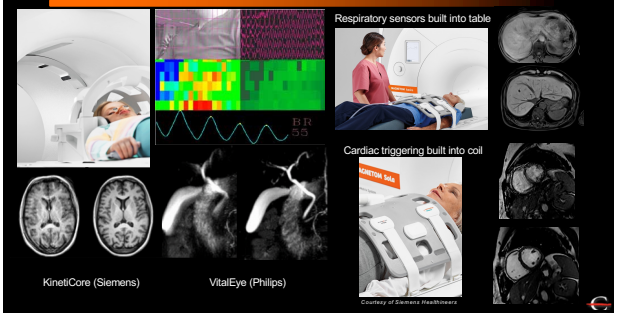


Adapting to patient motion

- To achieve desired contrast and coverage, MR acquisitions can be long compared to physiological motion (respiratory, cardiac, involuntary, etc) making susceptible to motion
- Navigators technology has been applied to brain as well in addition to non-Cartesian acquisitions like PROPELLER/BLADE



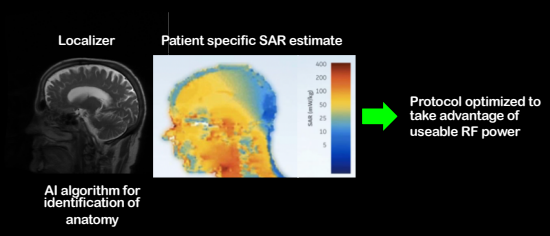
Adapting to patient motion: Hardware improvements



MR Safety Considerations

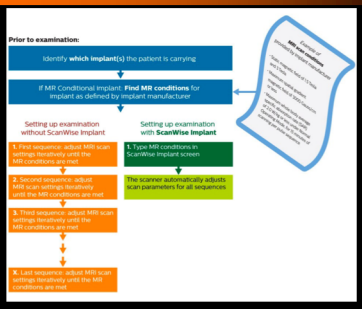
- MR systems have traditionally used body weight and sometimes height, sex, age or orientation in magnet to estimate whole body and local SAR
- More recently systems utilized real-time feedback to update SAR in real-time
- Now, to accommodate more restrictive heating conditions associated with implants vendors are moving toward a models that predict, estimate and/or help control either SAR (conservative) or B1+rms
- Vendors are now starting to use localizer scans to help estimate the amount of tissue exposed for even more refined calculations

Adapting to patient: SAR model



Courtesy of GE Healthcare

Adapting to patient: Implants



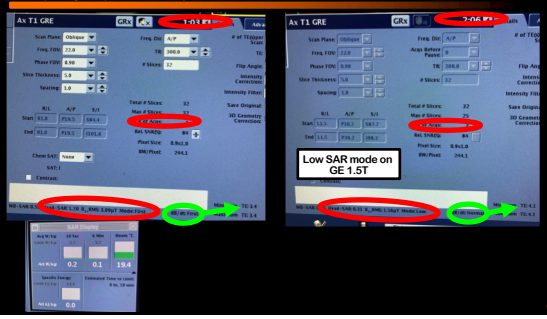
Philips ScanWise Implant

Managing SAR in the patient via the pulse sequence

- Concerns: Fast spin echo and fast imaging sequences (high density of refocusing pulses) and fast sequences utilizing large flip angle pulses (balanced steady state free precession, magnetization transfer angiography, etc)
- Use of emerging $B_1^+{}_{rms}$ limits instead of SAR more accommodating

Examples of Modifications	Potential Tradeoff
Reduce number of k-space views	
reduced phase encodes	resolution loss
rectangular field of view	not amenable to all anatomy
parallel imaging acquisition	SNR loss and potential artifacts; reduced ETL benefits
Modify RF pulse shape or flip angle	
reduced flip excitation pulses	SNR loss and contrast changes
reduced flip 180° refocusing pulses	SNR loss and contrast changes
pulse amplitude/width modulation	SNR loss versus sequence timing
Scan less efficiently	
increase concatenations	longer acquisition times
reduce ETL or increase ESP	longer acquisition times
increase TR	longer acquisition times
less or thicker slices	loss of volume coverage or slice resolution
Gradient-echo instead of SE, FSE or bSSFP	contrast and SNR considerations
Avoid saturation/suppression/preparation pulses	contrast changes; artifacts
Coil Selection	
Local transmit/receive coils	coverage, uniformity, availability

Adapting to patient: Implants



Summary

- MR has a long history of needing to adapt to a specific patient or anatomical region via tuning of the pulse sequence.
- Artificial intelligence in combination with fast calibration sequences or new hardware are facilitating a more patient adaptive MR environment
  - Patient scan prescription
  - Patient specific acquisition tuning
  - Patient specific safety management
- Potential for increased workflow, increased patient safety management potentially with more robust and consistent image quality

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Thank you for your time!

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