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MRI Image Reconstruction Artefacts

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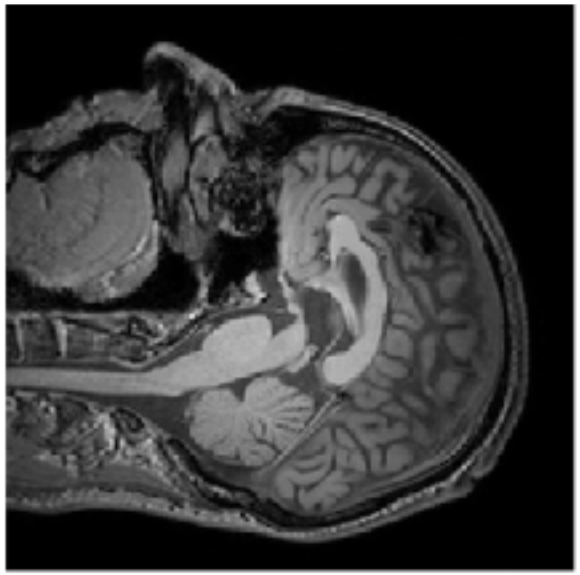
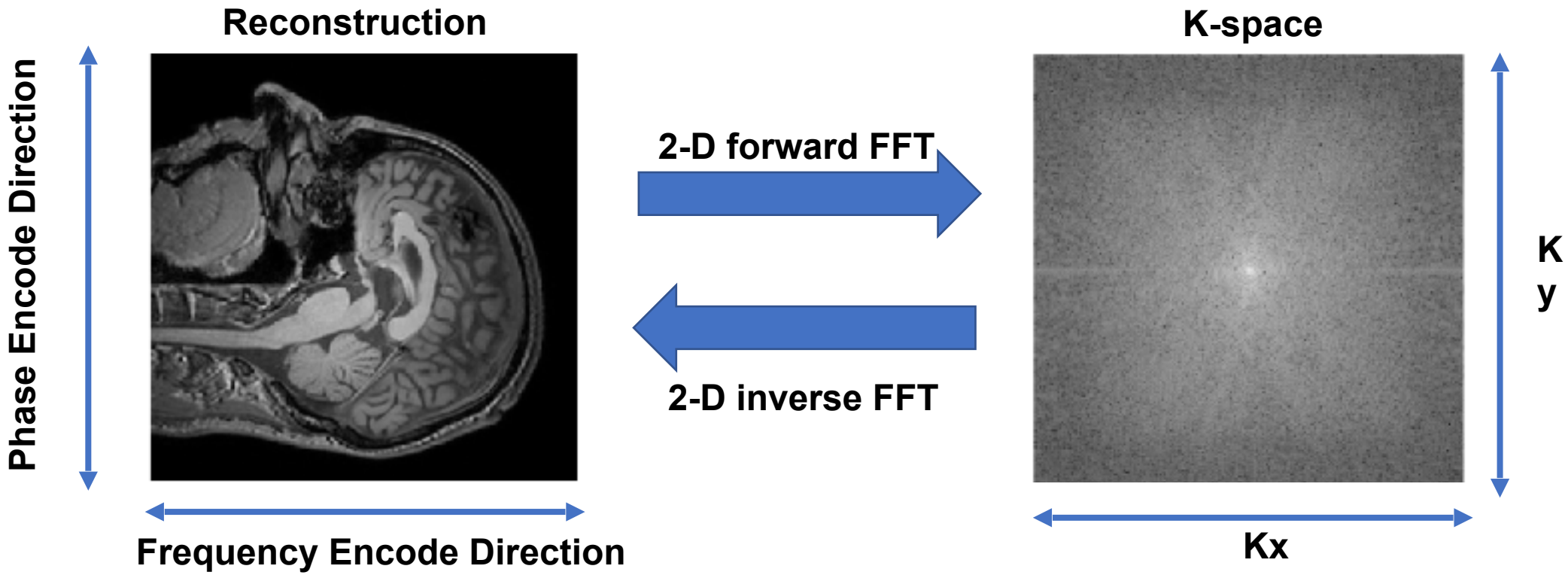
MRI data selection

Sagittal direction
T1 weighted
256x256 pixels



	Parameters
Data Source	IXI Dataset, Copyright by Imperial College London
MR Image type	Head-Neck image; T1 weighted
Scanner	Philips Medical Systems Intera 3T
Repetition Time (TR)	9.6
Number of Phase Encoding Steps	208

k-space Transformation



- High spatial frequency at the edge
- ΔKx, ΔKy = 1/FOV
- Filled row by row, one line per TR

Inadequate Sampling Artefacts

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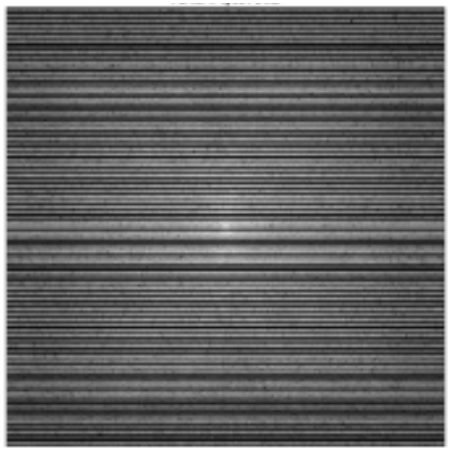
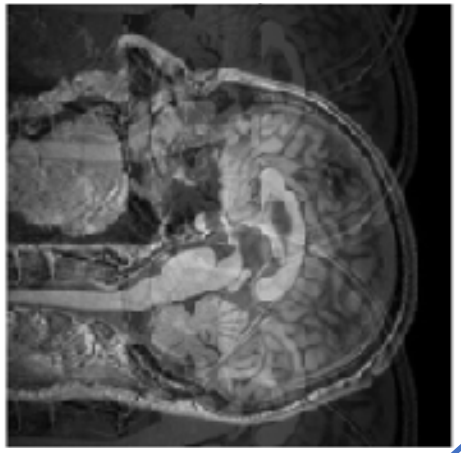
Ky:1,4,7,10,···=0
(ΔKy too large
Small FOV)



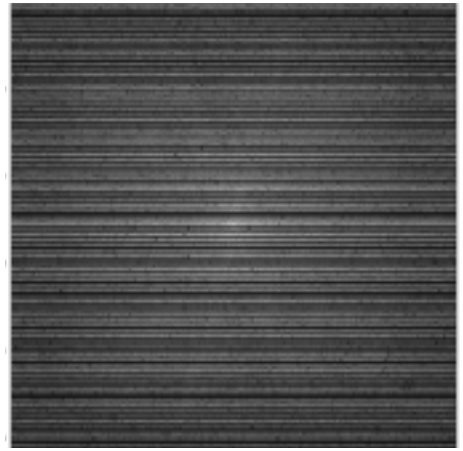
2-D inverse FFT



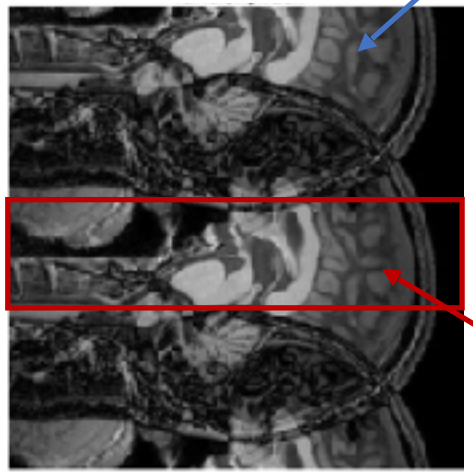
Aliasing Artefact
(wrap-around)

Out of FOV

Ky:1,3,5,7,···=0



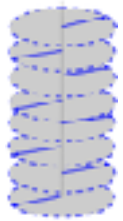
2-D inverse FFT



Structures outside FOV are
mapped at the opposite end

Small FOV

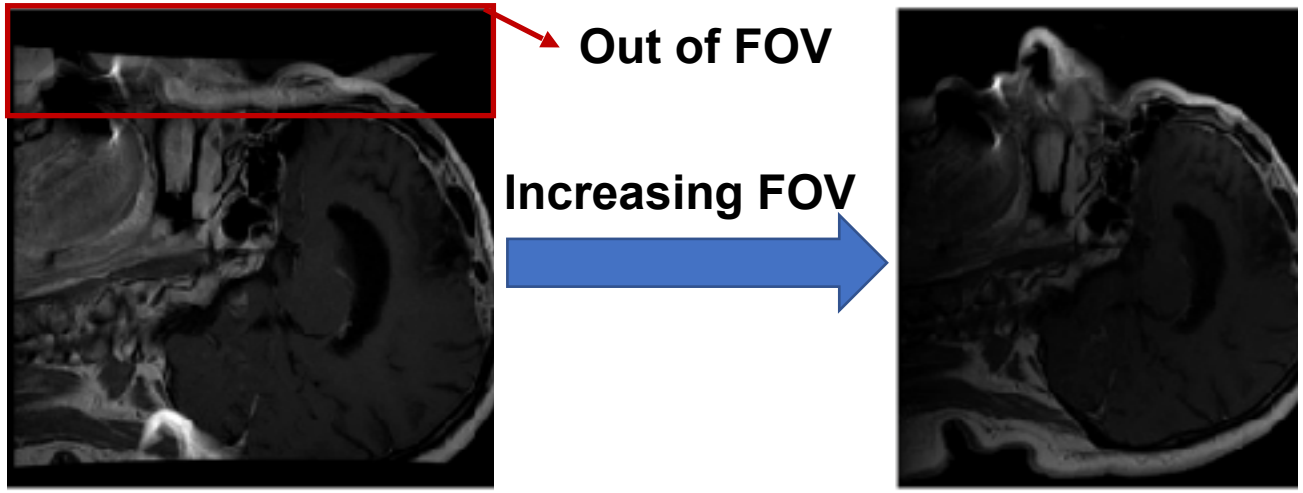
Inadequate Sampling Artefacts

Low sampling rate → **phase shift out of 0-360° are encoded with spins inside the FOV (365° mis-mapped to 5°)**  → **Wrong Spatial Localisation**

Strategies:

- Increase FOV
- Switch the PE and FE directions
- Oversampling in the PE direction
- Place pre-saturation bands (RF) outside FOV in PE direction
- Use a surface coil to reduce the signal outside FOV

Aliasing Artefact



Partial k-space sampling Artefacts

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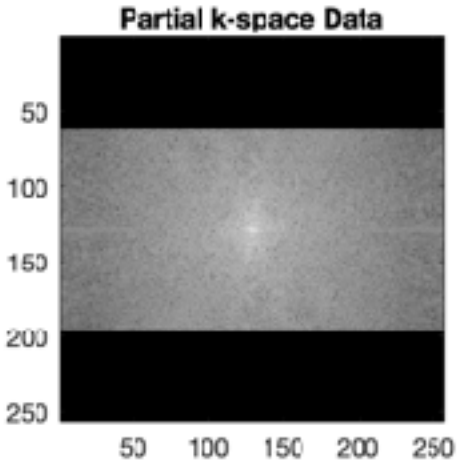
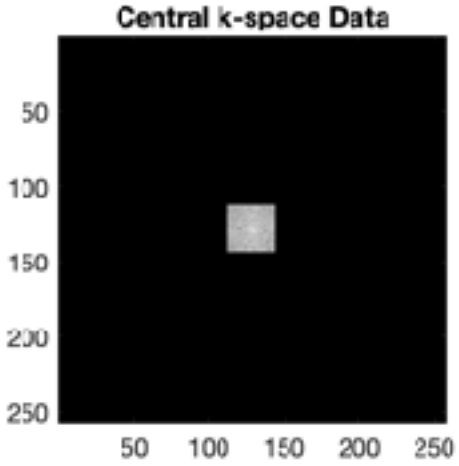
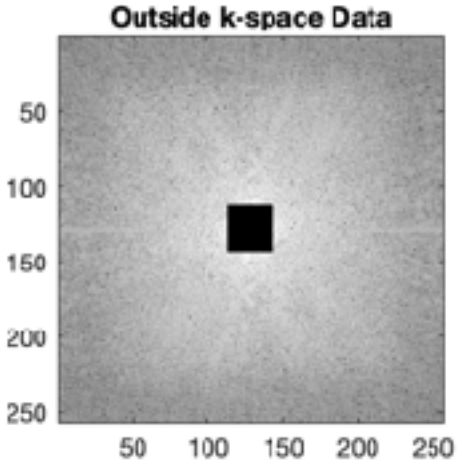
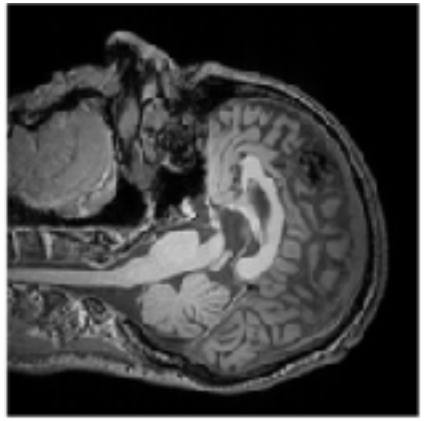
Gibbs Artefacts (Truncation/Ringing)

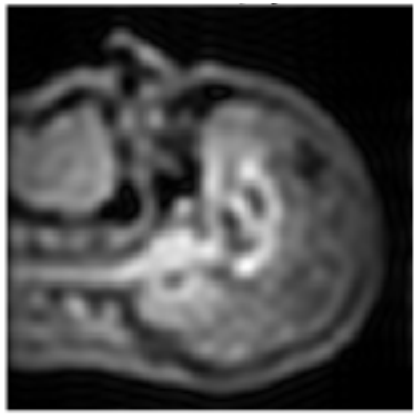




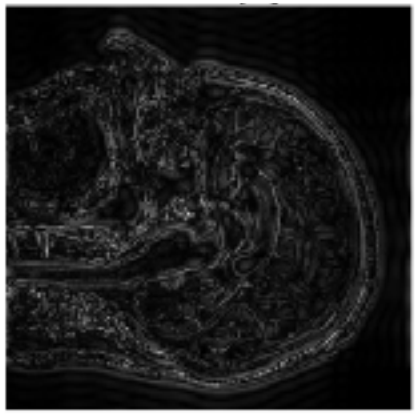


Oscillations or ripples near sharp edges





Contrast Information
But very blurred

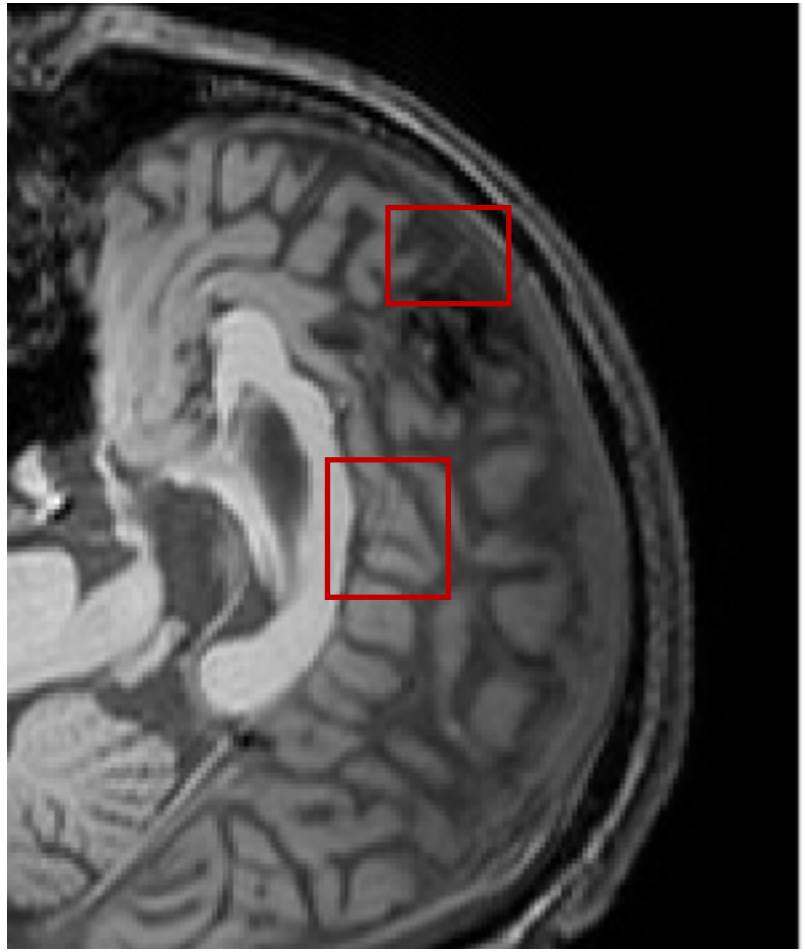


Tissue boundaries
But low SNR & contrast

Partial k-space sampling Artefacts

Strategies:

- Increasing the matrix size (sampling frequency for FE and number of PE steps, but lower SNR)
- smoothing filters (2-D exponential filtering, Gaussian filters, but blurred)
- Decrease pixel size by decreasing FOV (for better sampling of high-frequency information)
- Fat suppression if one boundary is fat



Gibbs Artefacts

Oscillations or ripples near sharp edges due to signal intensity difference

Patient movement Artefacts

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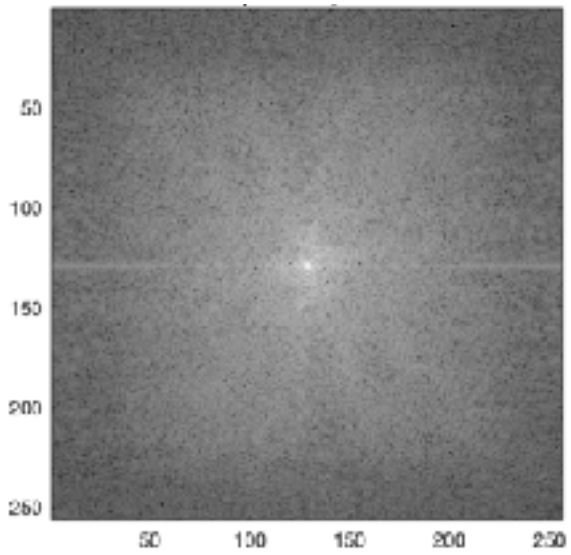
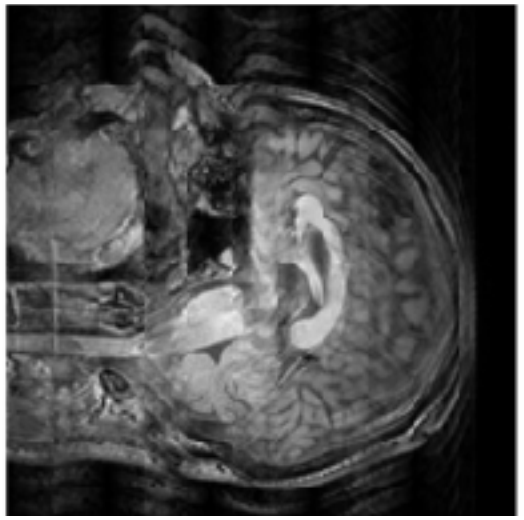
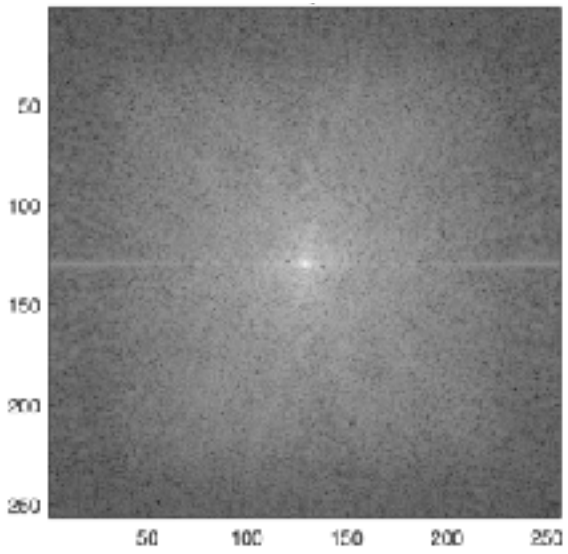
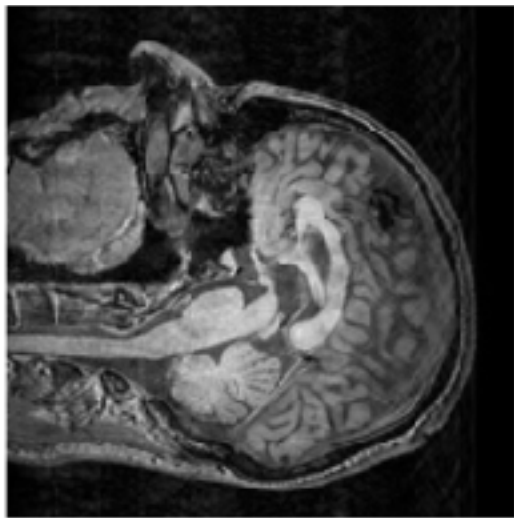
Shift = 5 pixels
Periodic movement every 20 rows





Shift = 5 pixels
Random movement with 10% probability





(Periodic Motion) Ghosting Artefacts

Discrete ghosts ↓ Cardiac beats, Respiration

Mainly in the PE direction

Smear ↑ Nodding

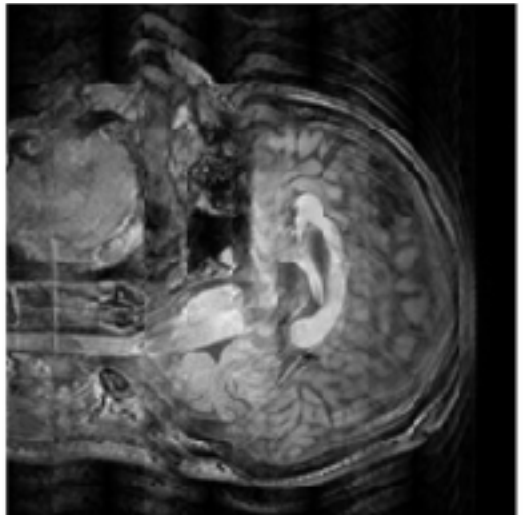
(Random Motion) Blurring Artefacts

Patient movement Artefacts

Strategies:

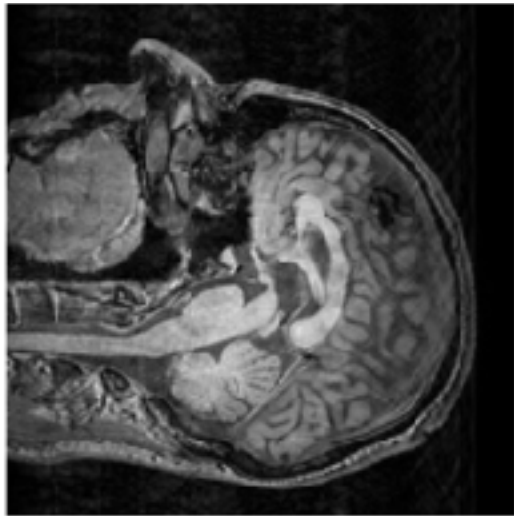
- Respiratory gated sequences (data acquisition is triggered during expiration)
- Switching phase and frequency encoding directions
- Increasing Number of signal averaging (NSA)
- Radial k-space sampling
- Spatial pre-saturation bands placed over moving tissues

- Instructing patients to stay still
- Fast sequences (Gradient echo sequence, Fast low angle shot sequence)
- Multiple slice imaging by multiple receiver coils



Ghosting Artefact
Discrete ghosts, related to TR and frequency of motion

Distinguished from Gibbs artefacts
Extend across the entire FOV



Blurring Artefacts
Smear in phase direction

References

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- Krupa, Katarzyna, and Monika Bekiesińska-Figatowska. “Artifacts in magnetic resonance imaging.” *Polish journal of radiology* vol. 80 93-106. 23 Feb. 2015, doi:10.12659/PJR.892628
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Questions

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Q&A session