

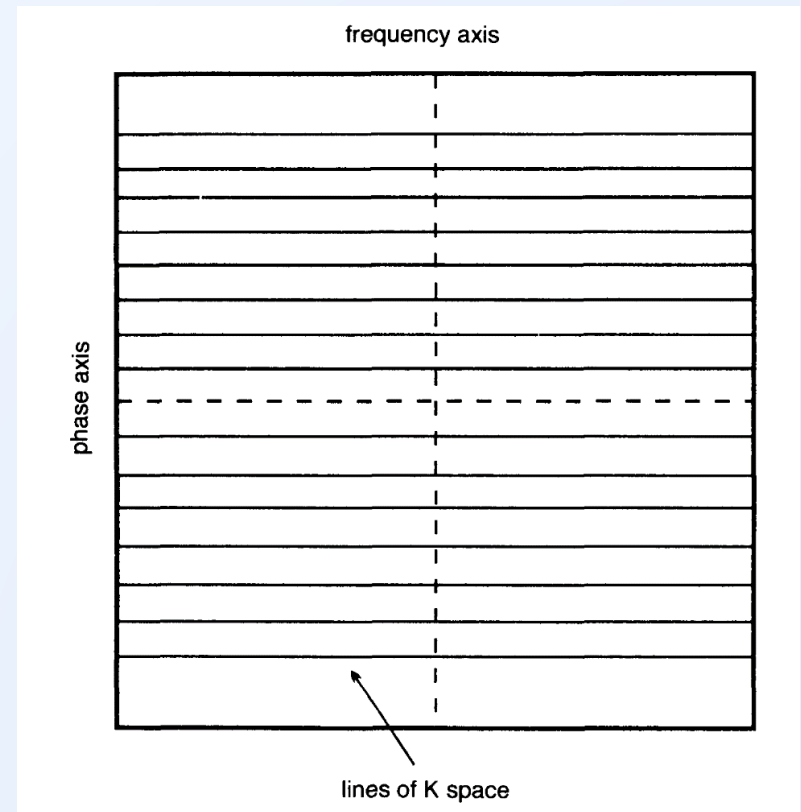
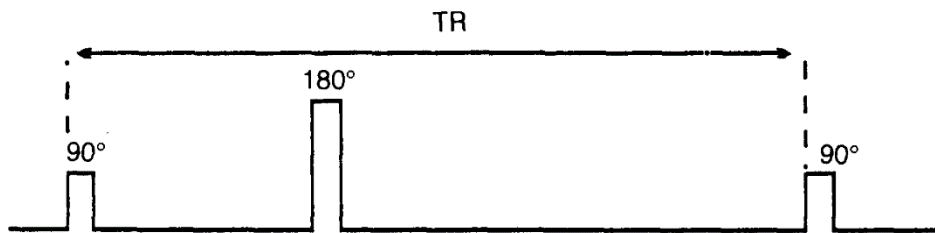
Lesson 11 (A): Fast pulse sequences (1)

Aims

- Learning the following topics about fast pulse sequences:
- Fast spin echo
- Echo planar imaging (EPI)

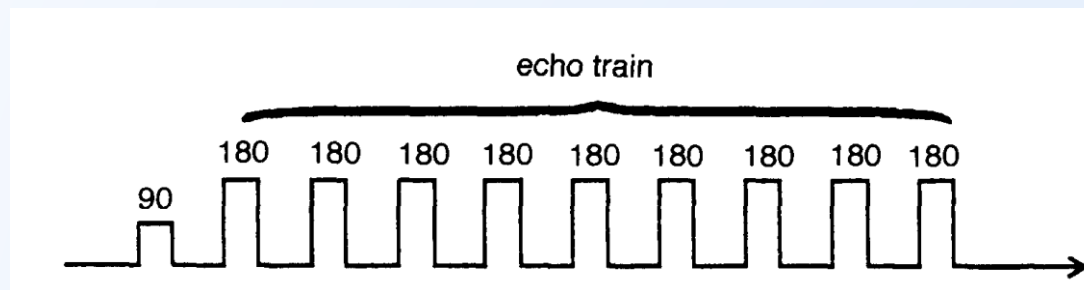
SE and K space

- One line of K space is filled per TR
- Produce optimum SNR and CNR



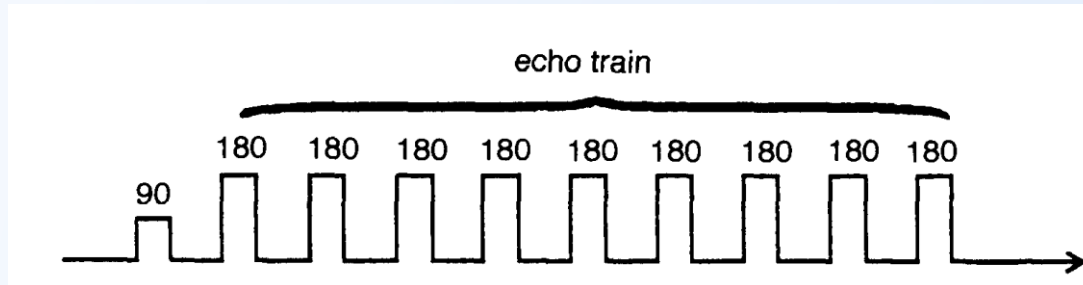
Fast spin echo (FSE) or turbo spin echo (TSE)

- Reduction of scan time
- The echo train length (ETL):
- Refers to the number of 180° rephasing pulses that correspond to the number of lines of K space filled per TR.



FSE or TSE

- Longer the ETL \rightarrow shorter the scan time
- ?
- More lines of K space are filled per TR



ETL and k-space filling

- If a phase encoding matrix of 256 is selected, rather than requiring 256 repetitions of SE pulse sequence to fill all the lines of k space, only 16 repetitions would be required ($256/16 = 16$) using ETL=16.
- Increasing the ETL to 32 would require only repetitions to fill all 256 lines of k space.

eight

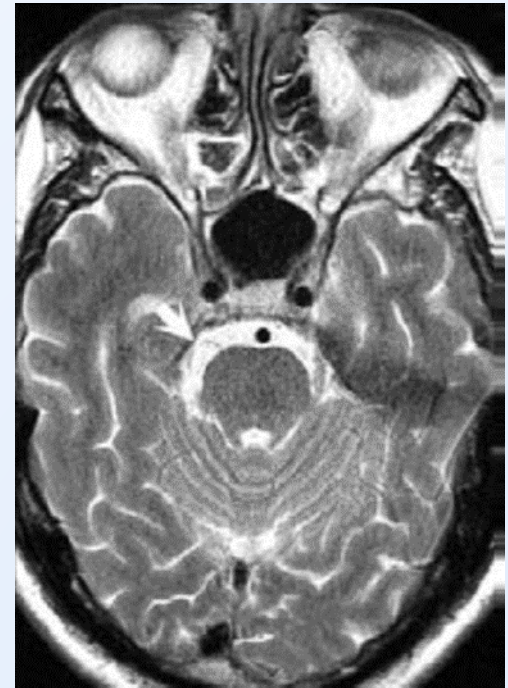
SE image

- To demonstrate the power of FSE, consider the image acquired using SE with:
- TR: 3500 msec
- TE: 85 msec
- The total scan time: 10 minutes, 51 seconds.



FSE image

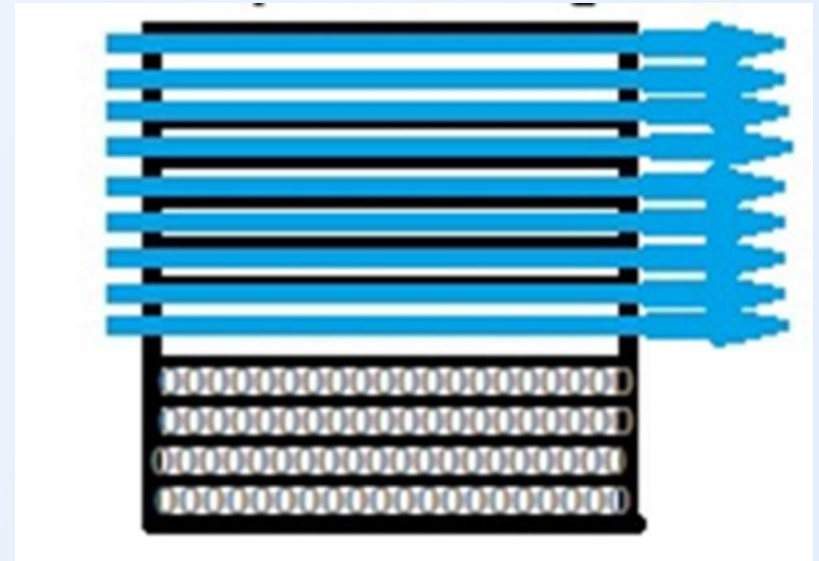
- The FSE sequence was acquired using:
- The **same TR and TE**
- ETL: 19
- Scan time: 35 seconds
- (10:51 divided by 19)



HASTE or SSFSE

HASTE or SSFSE

- HASTE: Half Acquisition Single-Shot Fast Spin Echo
- SSFSE: Single Shot Fast Spin Echo
- This sequence combines half-Fourier and fast spin echo imaging.



HASTE or SSFSE

- Advantages:
- Decrease scan time
- Minimize the impact of patient motion

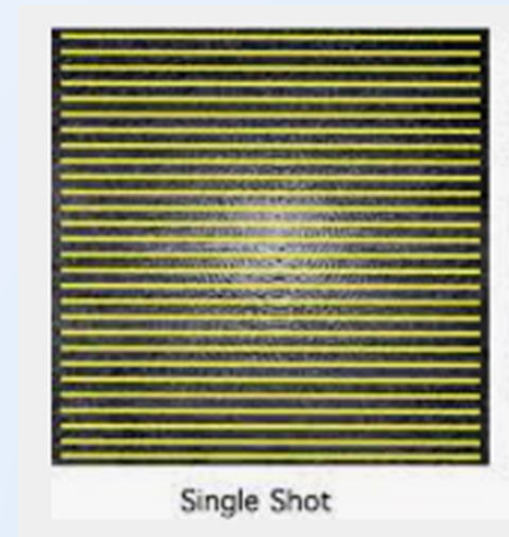
Echo planar imaging (EPI)

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- Fill all of K space in one TR.
- SE-EPI
- GE-EPI

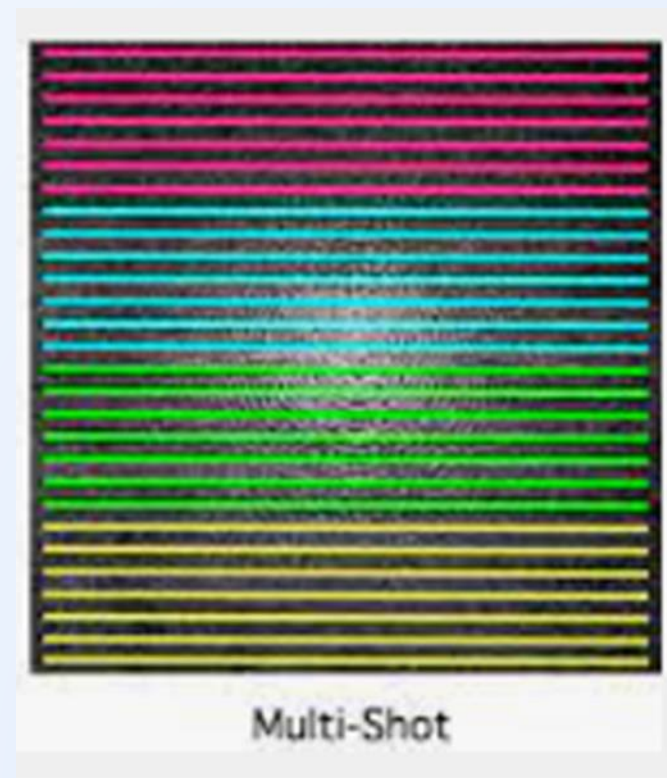
Single-shot EPI

- SS-EPI:
- All of K space is filled in one TR
- For applications requiring very fast acquisitions such as functional MRI (fMRI) studies.
- SS-EPI sequences are very prone to artifacts.



Multi-shot EPI

- EPI sequences are often used in multi-shot mode.
- A quarter or a half of K space is filled per TR.



Summary

- Fast spin echo
- HASTE
- Echo planar imaging (EPI)