SEQUENCE PARAMETERS

AND

OPTIONS

MODULE FIVE

IMAGE QUALITY

- Image Quality in MRI is a measure of the diagnostic accuracy and appearance of an image.
- It is defined by the contrast of the images, the ability to spatially resolve detail and the signal-to-noise ratio.

CONTRAST DISCRIMINATION

- Contrast is the difference in relative brightness between pixel values and is the result of the signal received from each voxel after scanning.
- The perception of contrast depends on the number of pixel intensities represented by each gray scale.

CONTRAST DISCRIMINATION

- Fourier transform separates the encoded signal into its individual frequency components.
- These signals are translated into a gray scale ranging between 256 shades of gray.

CONTRAST DISCRIMINATION

- Pixels with the most intense signal are assigned the highest value and are the brightest.
- Pixels with the lowest signal intensity are assigned the lowest value and are represented as the darkest.

FACTORS AFFECT CONTRAST

- TR, TE, ETE, ETL, TI
- Pulse Sequence
- Flip Angle
- Relaxation rates
- Hydrogen density
- Flow
- Contrast Media

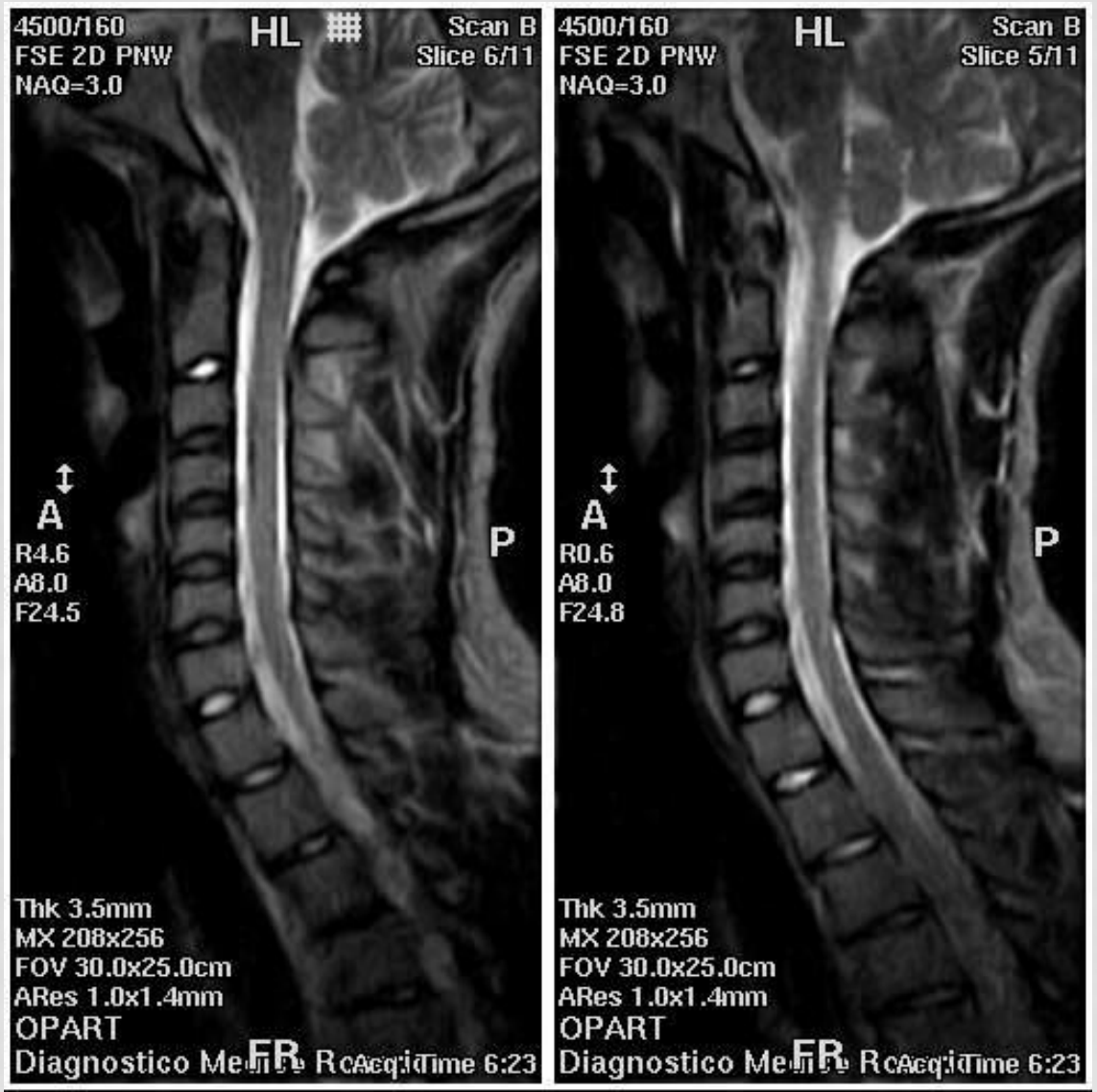
(TR) TIME OF REPETITION

- TR is the time between successive RF pulses applied to the same slice.

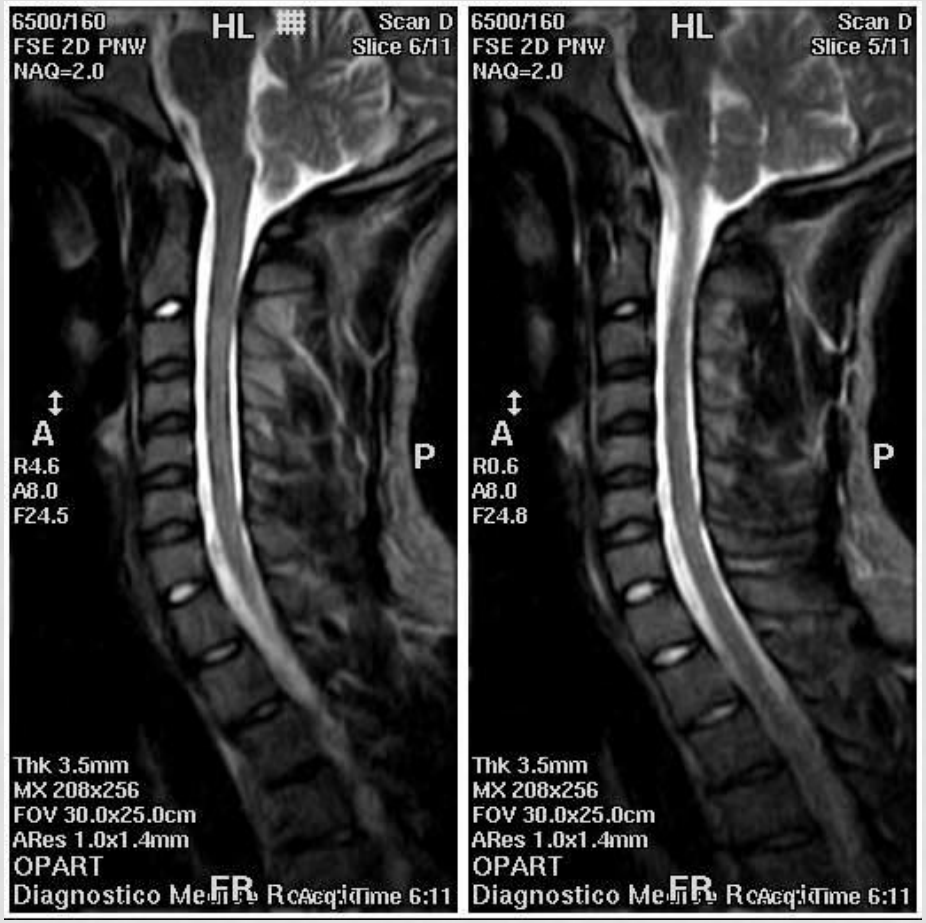
- TR affects T1 contrast

- short TR → enhances T1 contrast
- long TR → minimizes T1 contrast

FSE: TR = 4500MS



FSE: TR = 6500MS



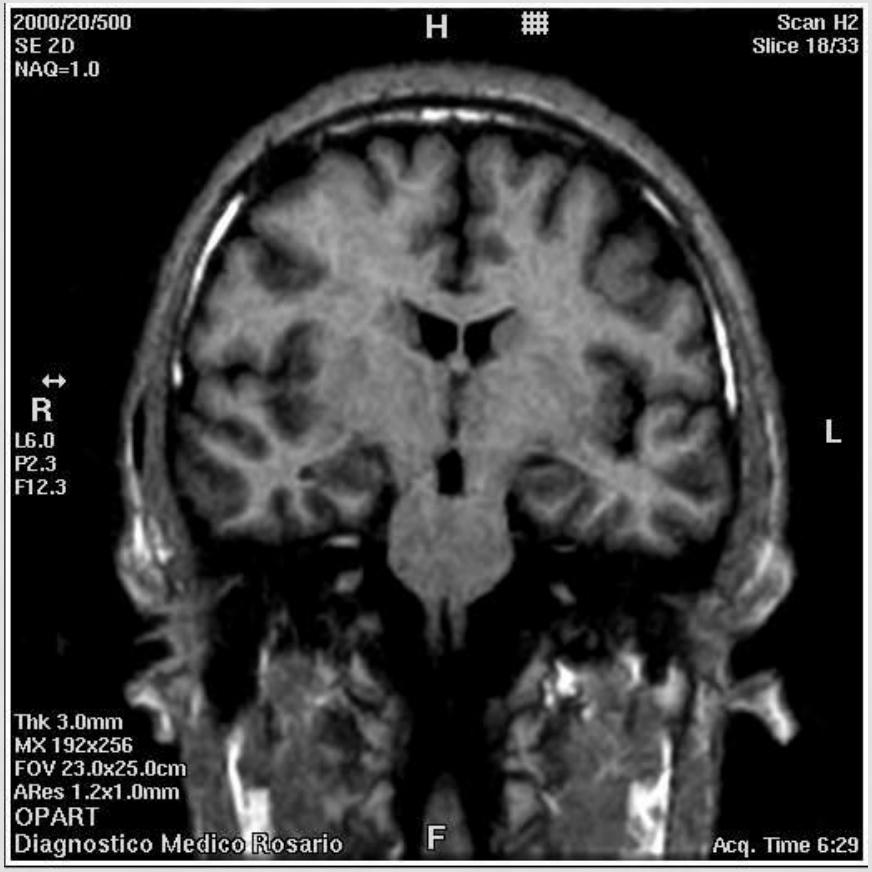
(TE) TIME TO ECHO

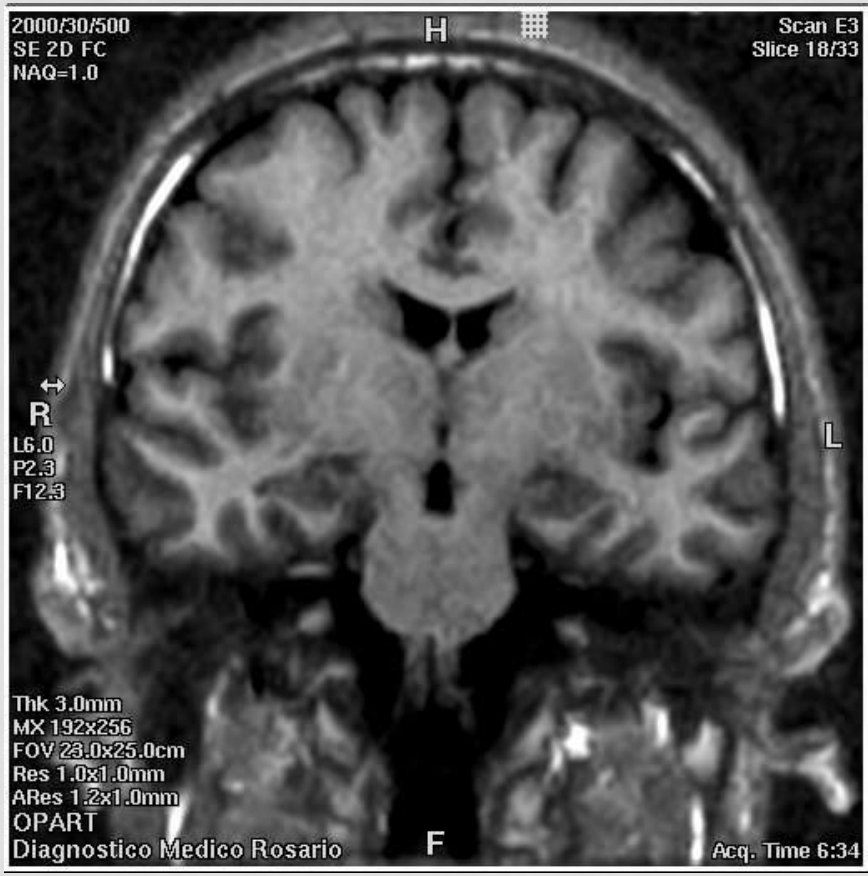
- TE is the time from the initial RF pulse to the middle of the listening window (echo).

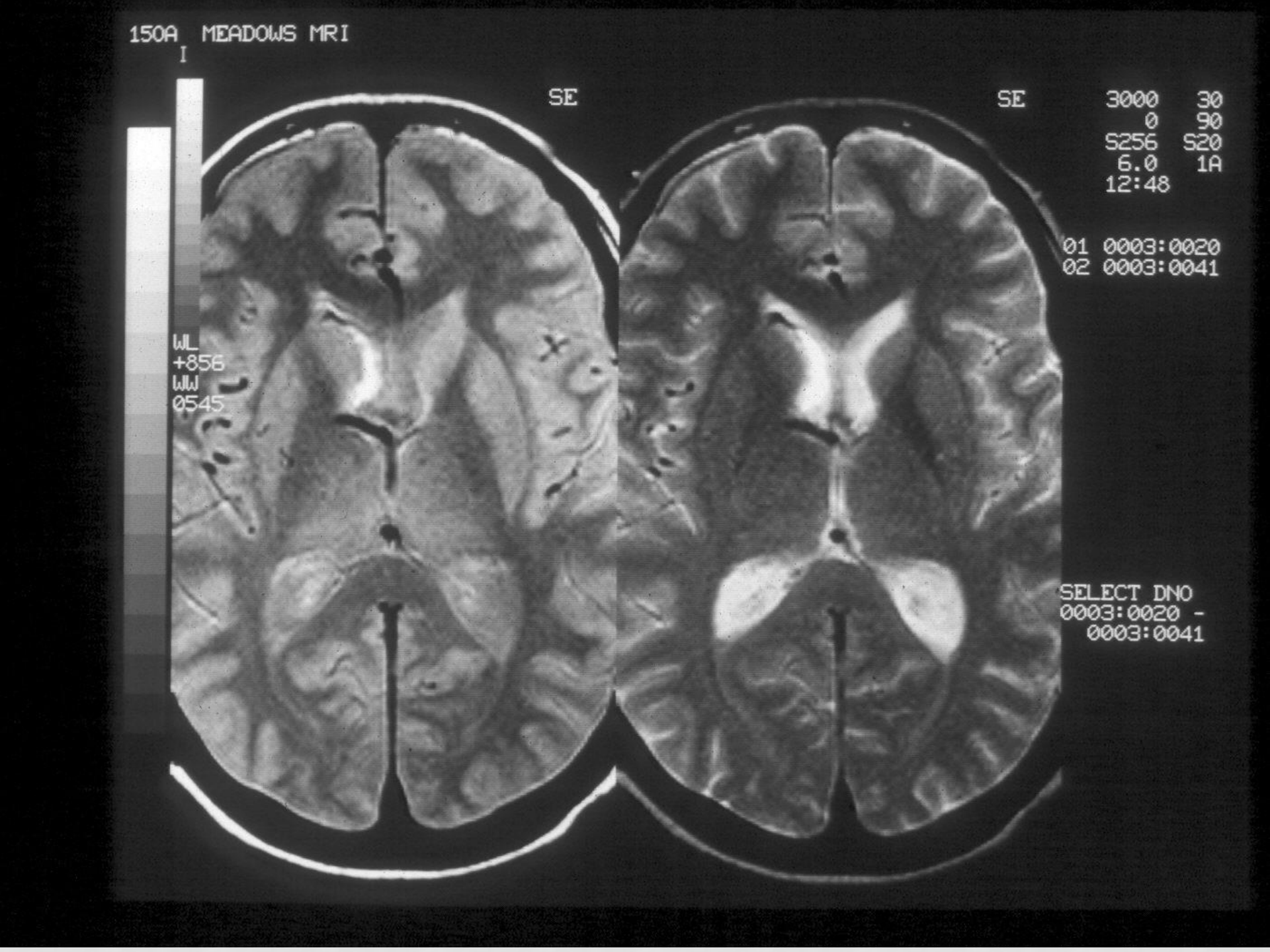
- TE affects T2 contrast.

- short TE → minimizes T2 contrast
- long TE → enhances T2 contrast

SE: TE COMPARISON






150A MEADOWS MRI
I
SE
SE
3000 30
0 90
S256 S20
6.0 1A
12:48
01 0003:0020
02 0003:0041
WL
+856
WW
0545
SELECT DNO
0003:0020 -
0003:0041

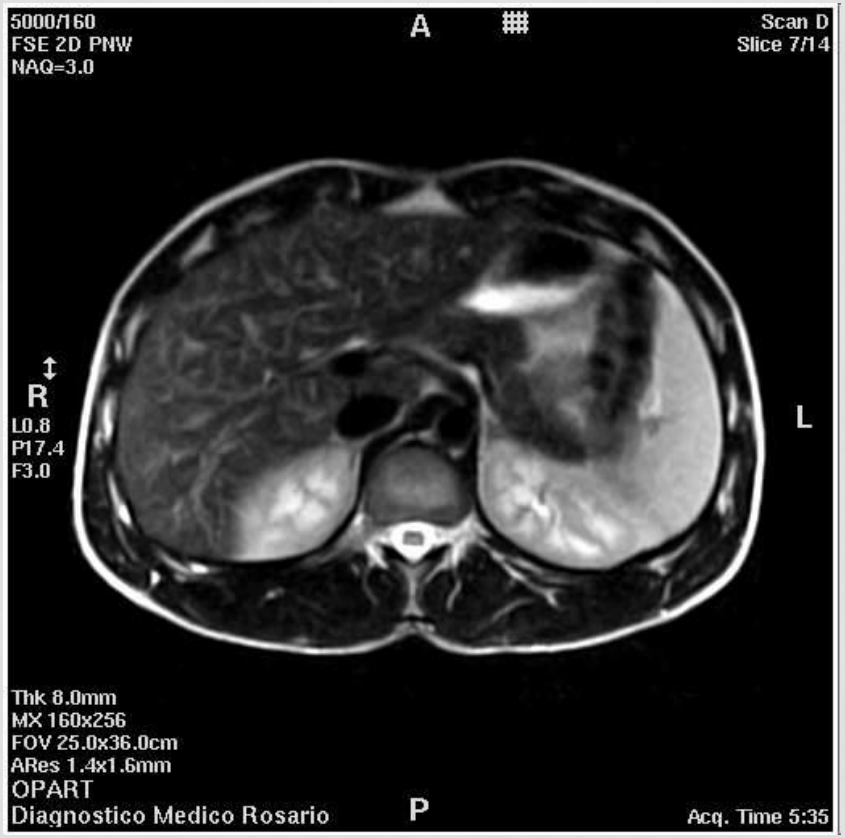
(TI) TIME OF INVERSION

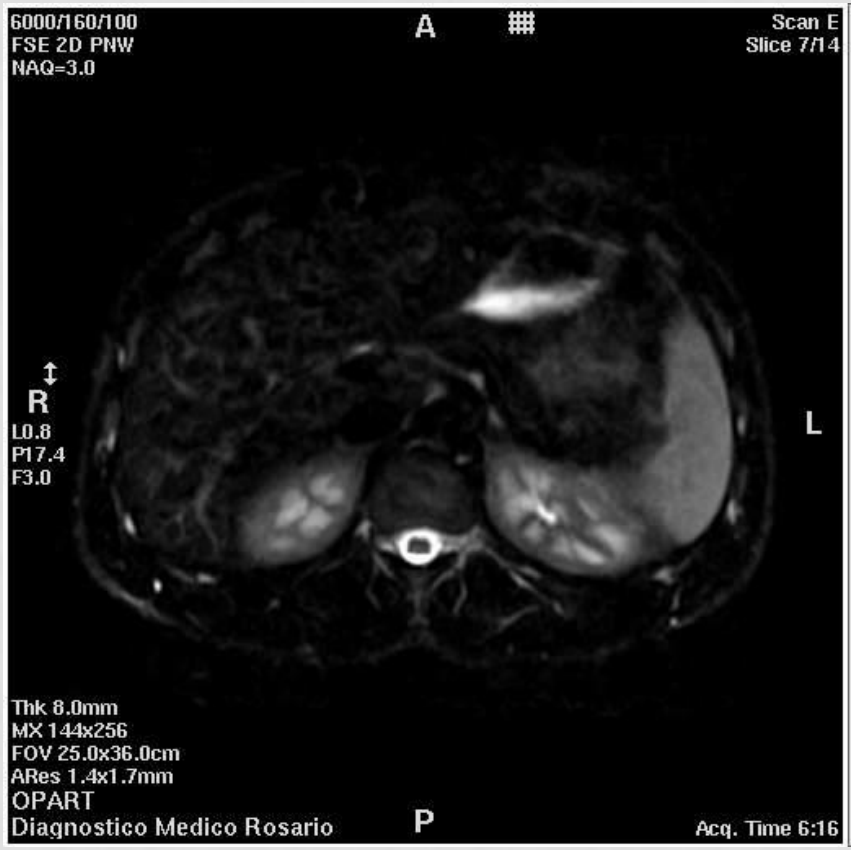
- TI is the time from the inverting pulse to the start of the 90° or partial RF pulse.

- TI affects T1 contrast.

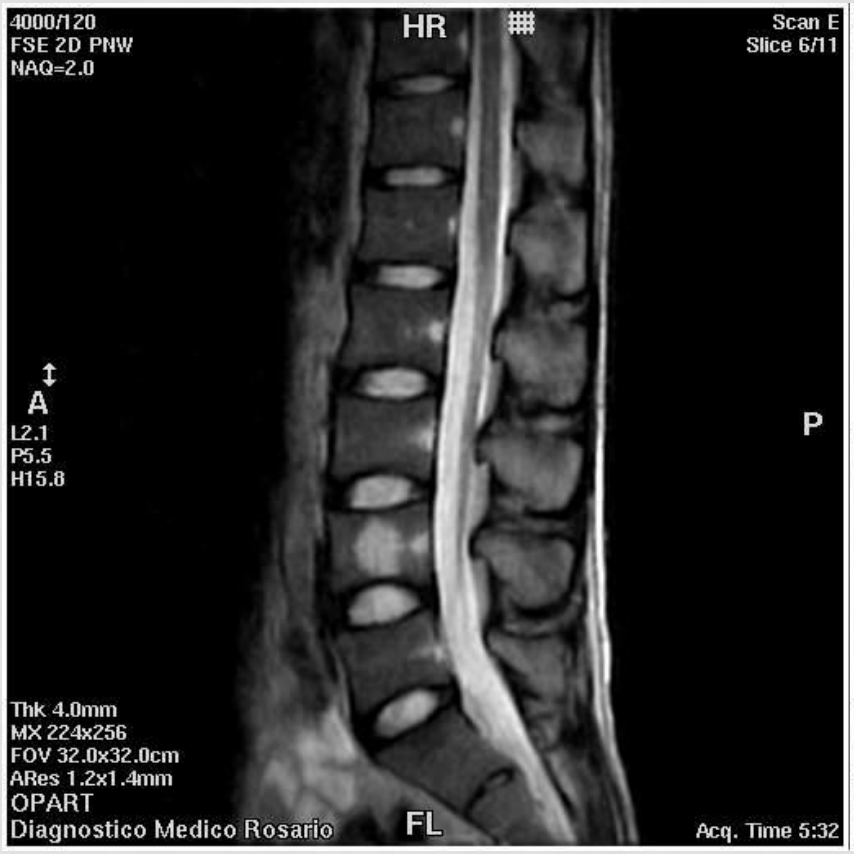
- short TI* → minimizes T1 contrast
- long TI* → enhances T1 contrast

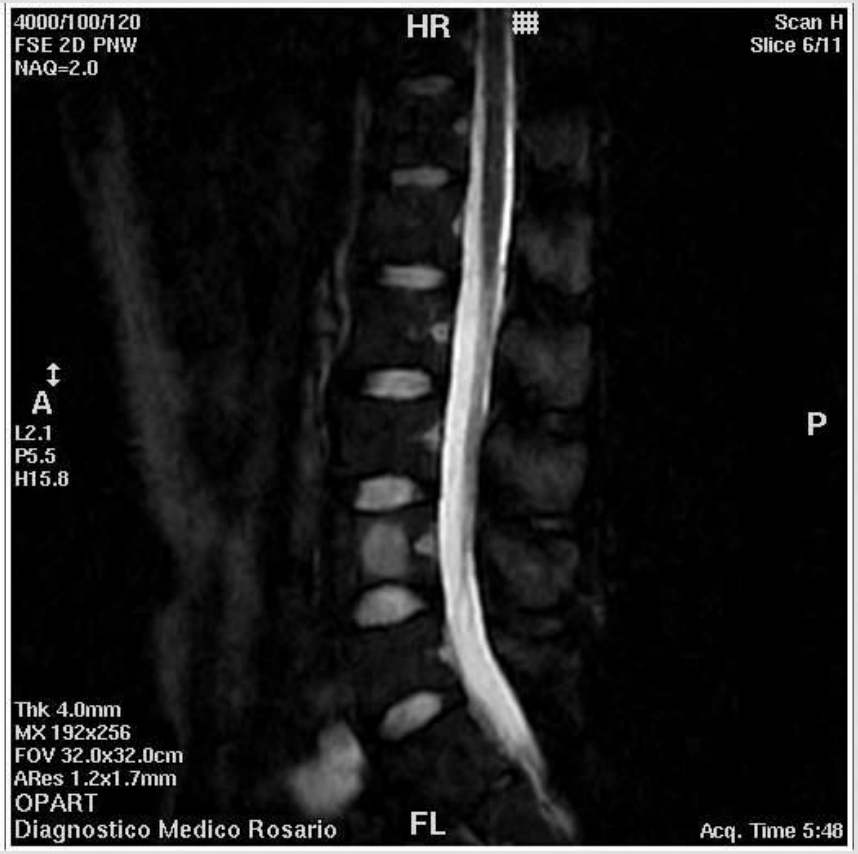
FSE: FSE - STIR


5000/160
FSE 2D PNW
NAQ=3.0
A
Scan D
Slice 7/14
R
L0.8
P17.4
F3.0
L
Thk 8.0mm
MX 160x256
FOV 25.0x36.0cm
ARes 1.4x1.6mm
OPART
Diagnostico Medico Rosario
P
Acq. Time 5:35


6000/160/100
FSE 2D PNW
NAQ=3.0
A
Scan E
Slice 7/14
R
L0.8
P17.4
F3.0
L
Thk 8.0mm
MX 144x256
FOV 25.0x36.0cm
ARes 1.4x1.7mm
OPART
Diagnostico Medico Rosario
P
Acq. Time 6:16

FSE: FSE - STIR


4000/120
FSE 2D PNW
NAQ=2.0
HR
Scan E
Slice 6/11
A
P
L2.1
P5.5
H15.8
Thk 4.0mm
MX 224x256
FOV 32.0x32.0cm
ARes 1.2x1.4mm
OPART
Diagnostico Medico Rosario
FL
Acq. Time 5:32


4000/100/120
FSE 2D PNW
NAQ=2.0
HR
Scan H
Slice 6/11
A
P
L2.1
P5.5
H15.8
Thk 4.0mm
MX 192x256
FOV 32.0x32.0cm
ARes 1.2x1.7mm
OPART
Diagnostico Medico Rosario
FL
Acq. Time 5:48

STIR / FATSAT


2000/30/100
SE 2D FC
NAQ=1.0
A
Scan D
Slice 14/19
R
L7.3
A10.7
H39.1
L
Thk 4.0mm
MX 160x256
FOV 14.0x16.0cm
ARes 0.9x0.6mm
OPART
Diagnostico Medico Rosario
P
Acq. Time 5:26


Signa 1.5T SYS#MRS00CO
DIAGNOSTICO MEDICO ROSARIO
A82
ZAPATA CESAR
22 M 34554
24/05/99
15:36
Ex:11386
Se:2/4
Im:6/13
ET:9
R
1
3
8
L
1
5
FSE
TR:3500
TE:28/Ef
EC:1/1 31.3kHz
EXTREM
FOV:16x16
5.0thk/1.0sp
19/02:13
256x160/2 NEX
StF/NP/VB/ED/SPF
P75
W = 680 L = 285

PULSE SEQUENCES

- Pulse sequences are a series of RF pulses and gradient applications in an event.
- Pulse sequences are chosen to enhance or accentuate specific tissue contrast.

• Spin Echo or FSE	T1, T2, PD
• Gradient Echo or FFE	T1, T2*, PD
• IR, STIR	T1, Fat Suppression
• FLAIR	Fluid Suppression

FLIP ANGLES

- Flip angles partially flip net longitudinal magnetization into the transverse plane.
- Lowering the flip angles flips less of net longitudinal magnetization into the transverse plane.
- Flip angles vary based on the type of contrast expected.

CONTRAST PARAMETERS

Flip Angle	Contrast
short	T2-wt.-like or T2*
medium	PD-wt.
long	T1-wt.

RELAXATION TIMES

- T1 relaxation times are dependent on the field strength of the magnet.
  - As field strength increases, T1 lengthens.
- T2 relaxation times do not change significantly with magnetic field strength but do change based on chemical and molecular bonding.

RELAXATION TIMES

- Hydrogen Density is the number of hydrogen atoms present in the tissue.
- Hydrogen Density is one of the major determinants of tissue contrast.
- Flow refers to hydrogen in motion during the acquisition. Imaging techniques cause different appearances of flowing spins.
- Contrast Media shortens the T1 & T2 relaxation times of tissues causing a change in contrast.

SPATIAL RESOLUTION

- Is the ability to distinguish or represent small objects defining the sharpness of an image.
- Spatial resolution is controlled by parameters that affect the amount of tissue or signal represented by the pixel or voxel.
- Images have three dimensions:
  - length and width — pixel size or resolution
  - depth — slice thickness

SPATIAL RESOLUTION FACTORS

- Factors that affect Spatial Resolution
  - voxel size
  - pixel size
  - slice thickness
  - matrix size
  - field of view (FOV)

SPATIAL RESOLUTION

- Anything that makes a geometric change in the size of the image will affect spatial resolution.

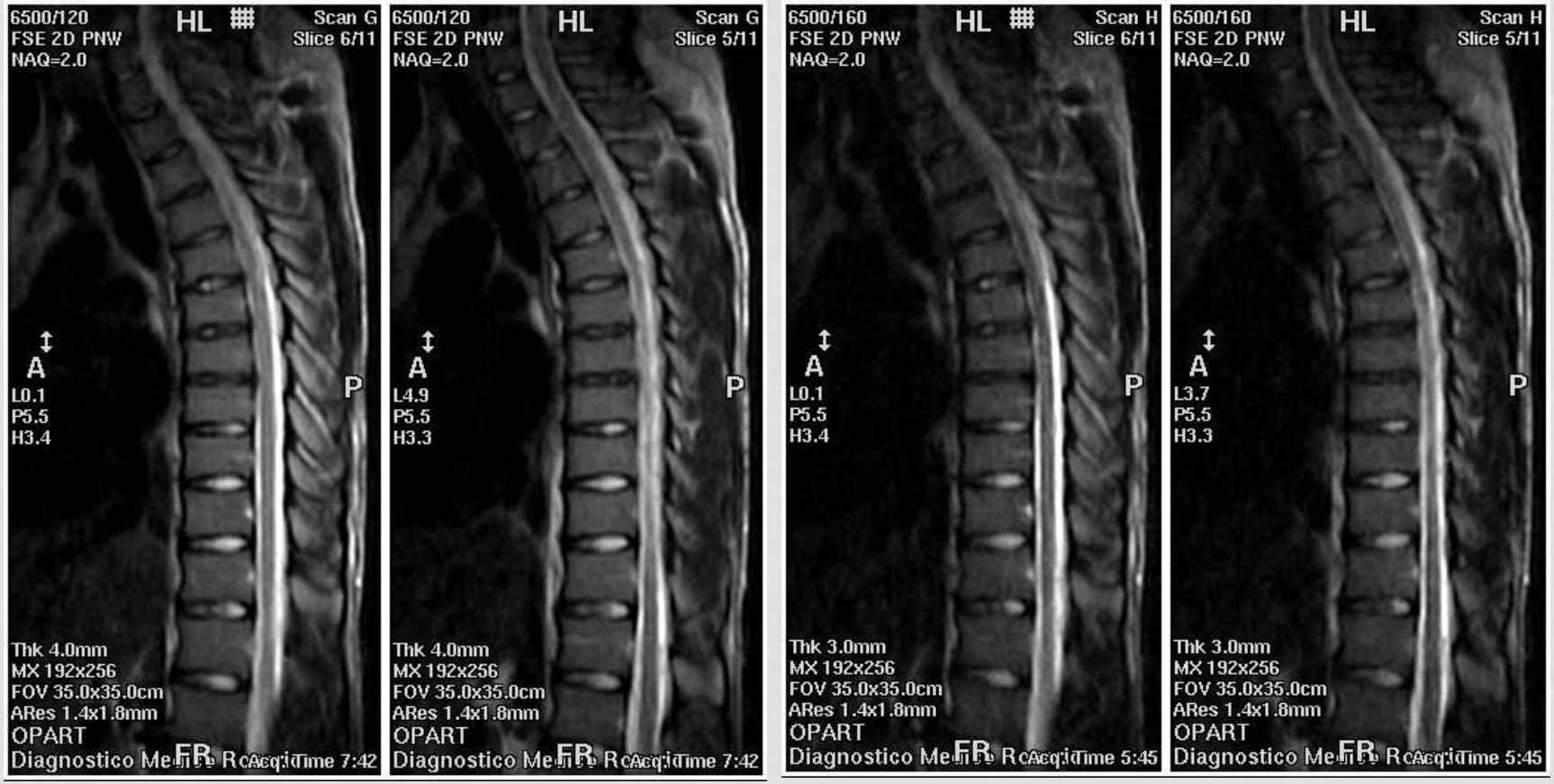
SPATIAL RESOLUTION FACTORS

- Voxel Size
  - Voxels are three-dimensional volume elements.
  - pixel resolution x slice thickness = voxel size.
- Pixel Size
  - Pixels are two-dimensional picture elements.
  - pixels have length and width.
- Decreasing the voxel or pixel size increases resolution

SLICE THICKNESS

- Slice thickness
  - As the slice thickness changes so does the amount of information collected within the voxel.
  - The smaller the amount collected the more accurately the pixel is able to represent the information contained in the image.

FSE: TE/SLICE THICKNESS



MATRIX SIZE

- Matrix size
  - Matrix size defines the length and width of the imaged area and is comprised of pixels.
  - Matrix is selected by the number of phase encoding and frequency encoding steps used to create the image.
  - The more steps and the smaller each step the better the spatial resolution.

FIELD OF VIEW (FOV)

- Field of View (FOV)
  - Field of view is defined as the area of interest demonstrated on the image.
  - Field of view is comprised of a matrix with a particular number of pixels and each pixel a specific slice thickness - voxels
  - The smaller the FOV the better the spatial resolution.

FOV = Matrix x Resolution (pixel)

SIGNAL-TO-NOISE RATIO

- Signal-to-noise ratio is used to describe the relative contributions to a detected signal made by the true signal and by random superimposed signals or (noise).
- As the signal strength increases the signal-to-noise ratio increases and better image quality results.

SIGNAL-TO-NOISE RATIO

- Noise superimposed on the signal causes the pixel values to oscillate about a mean value.
- Noise blurs the edges of the tissue interfaces reducing edge acuity.
- Noise is created either by the tissues (non-hydrogen substances) or by the imaging system.

SIGNAL-TO-NOISE RATIO FACTORS

- These factors affect signal-to-noise-ratio
  - proton density
  - field homogeneity
  - voxel volume
  - slice thickness, gap
  - TR,TE,TI
  - NEX
  - Field of View

TIME OF REPETITION (TR)

- TR
  - Lengthening the TR allows more time for the tissues to return signal after being disturbed by the RF pulse.
  - Signal-to-noise ratio is increased with increase in TR.

TIME TO ECHO (TE)

- TE
  - The longer the TE the more T2 relaxation has occurred and the more decay of the transverse magnetization.
  - Increasing TE will decrease the S/N ratio.

TIME TO ECHO (TE)

- TE
  - The longer the TE the more T2 relaxation has occurred and the more decay of the transverse magnetization.
  - Increasing TE will decrease the S/N ratio.

NUMBER OF EXCITATIONS (NEX)

- NEX
  - The number of times the information is collected and averaged to create the image, the higher the signal-to-noise ratio.
  - This is also referred to as the number of acquisitions or signal averages.
  - S/N ratio will be improved by the square root of two, when doubling the NEX which is a 41% increase in signal-to-noise.

MATRIX SIZE

- Matrix Size
  - Most matrix size adjustments require that either the pixel size or resolution also change to maintain, decrease, or increase the FOV.
  - Overall, there may be an increased S/N ratio by the sheer fact that the more number of lines within the matrix requires additional phase encoding steps which will increase S/N ratio.

FIELD OF VIEW (FOV)

- Field of View (FOV)
  - The relationship between the matrix and the FOV has a definite impact on the signal-to-noise ratio by determining the size of the pixels represented in the matrix.
  - Usually when the FOV is decreased while maintaining the matrix size, the pixels decrease in size decreasing S/N.

RECEIVER BANDWIDTH

- The receiver bandwidth is the range of frequencies received during the acquisition.
- In general, the narrower the bandwidth, the higher the signal-to-noise ratio.

RECEIVER BANDWIDTH

- The range can be varied in several ways:
  - sampling the same number of data points over a shorter/longer listening window.
  - changing the number of samples or data points while maintaining the listening window.
  - increasing or decreasing the amplitude of the readout gradient.