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MD Anderson Cancer Center
Baylor College of Medicine, USA

- **ISHA DIAGNOSTICS**
- **Malleswaram, Bangalore**

MR IMAGING OF PROSTATE

Goals

- Detection
- Localization
- Number and Volume of lesions

- *Capsular penetration*
- *Seminal vesicle involvement*
- *Distant Metastasis*

Imaging Modalities

- PLAIN XRAYS (till 1970)
- CONTRAST STUDIES:
- ULTRASOUND (1970-80)
- NUCLEAR MEDICINE
- ANGIOGRAPHY
- CT SCAN (1980 onwards)
- MRI (1990)
- SPECT
- PET CT
- MR TOTAL BODY DIFFUSION (MR PET !)

**Not necessary to follow
the order of
Investigations!!!**

**Do the most appropriate
Investigation.....**

Early diagnosis and Treatment

- saves money, time, energy
- gives better patient care

**Which is
the most Appropriate
Imaging Method ?!!**

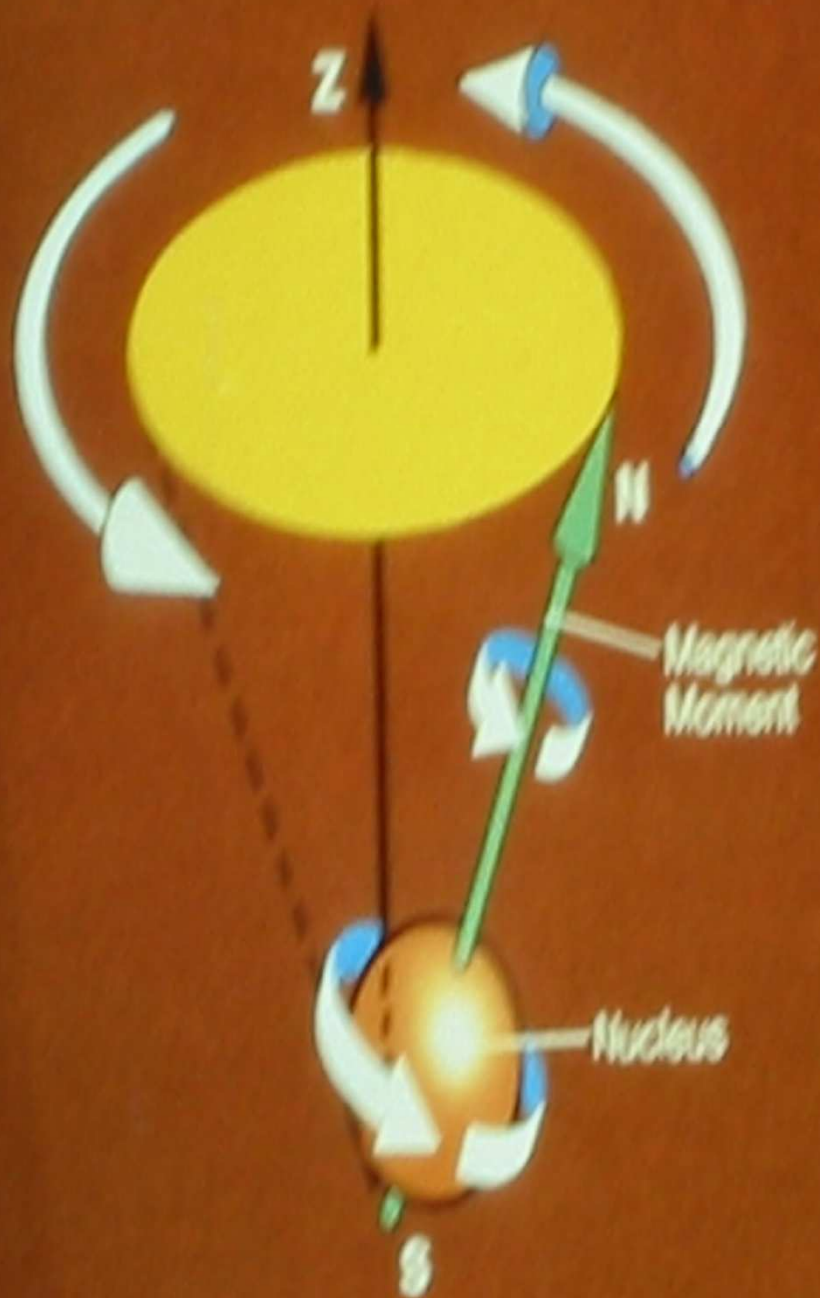
**Know the BASIC
PRINCIPLES**

Nuclear

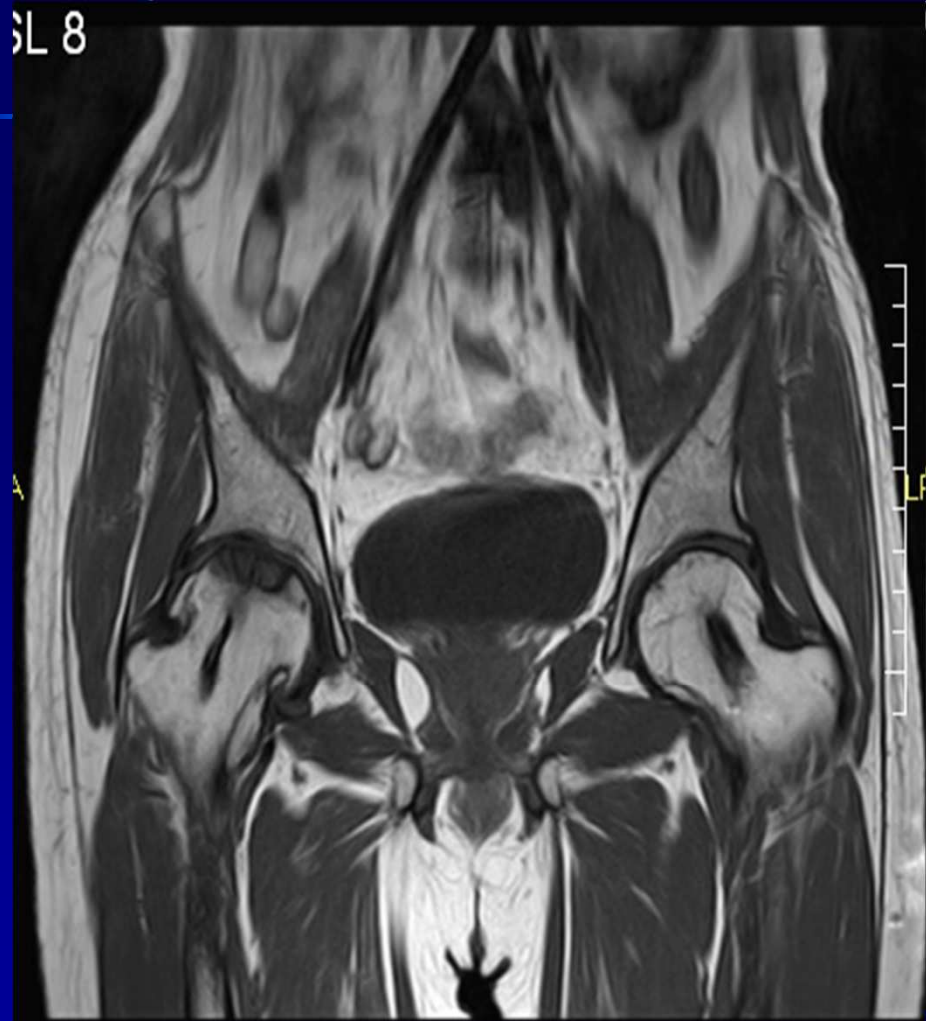
Magnetic

Resonance

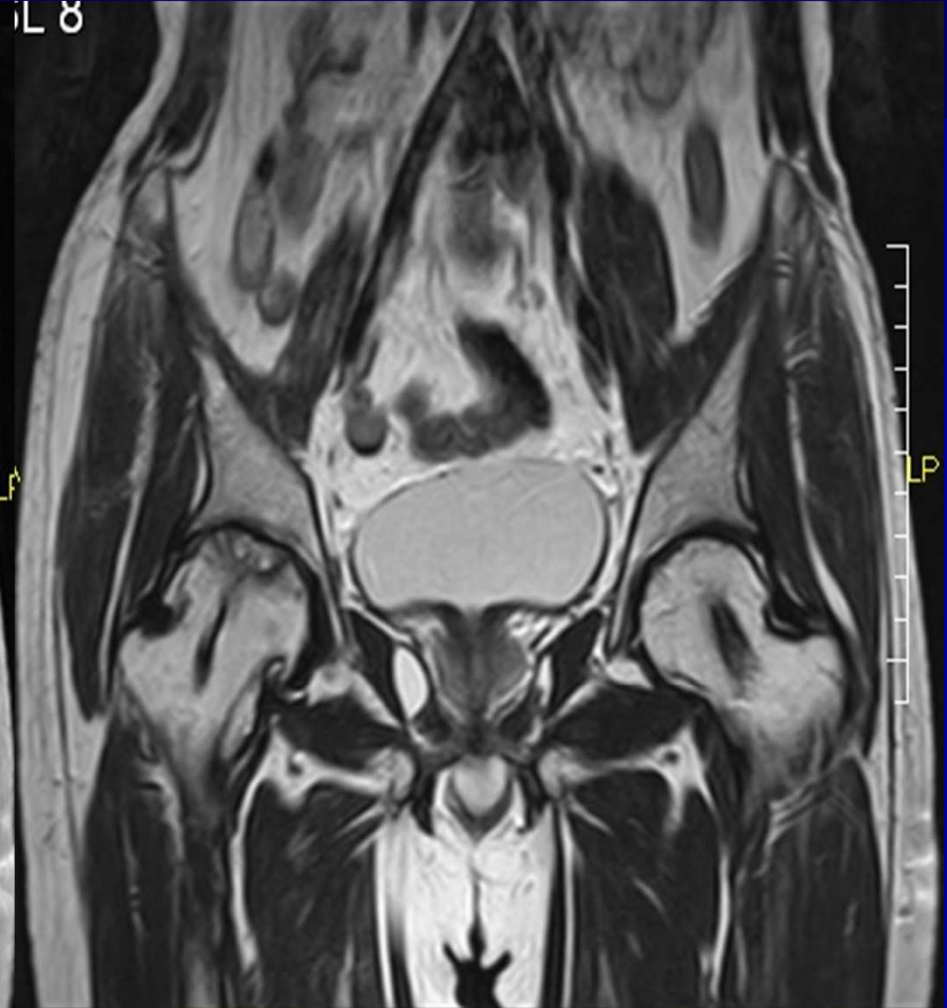
Imaging



T1



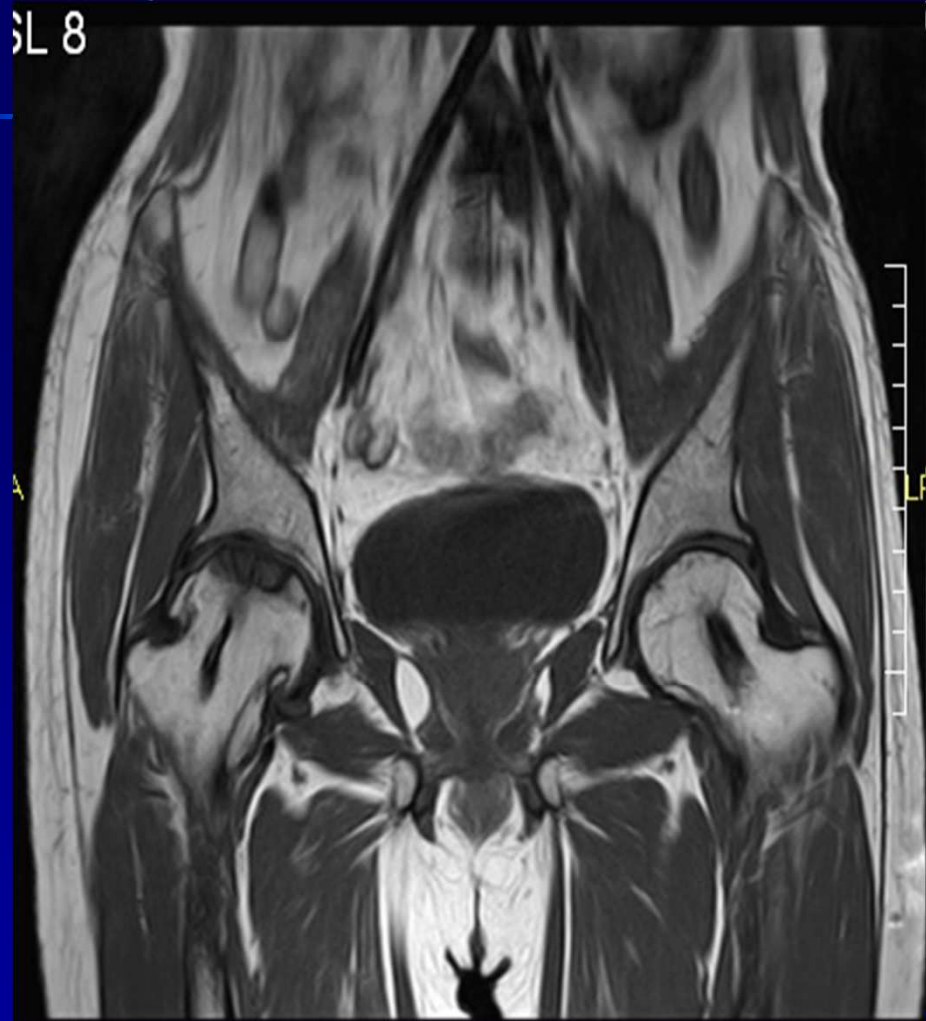
T2



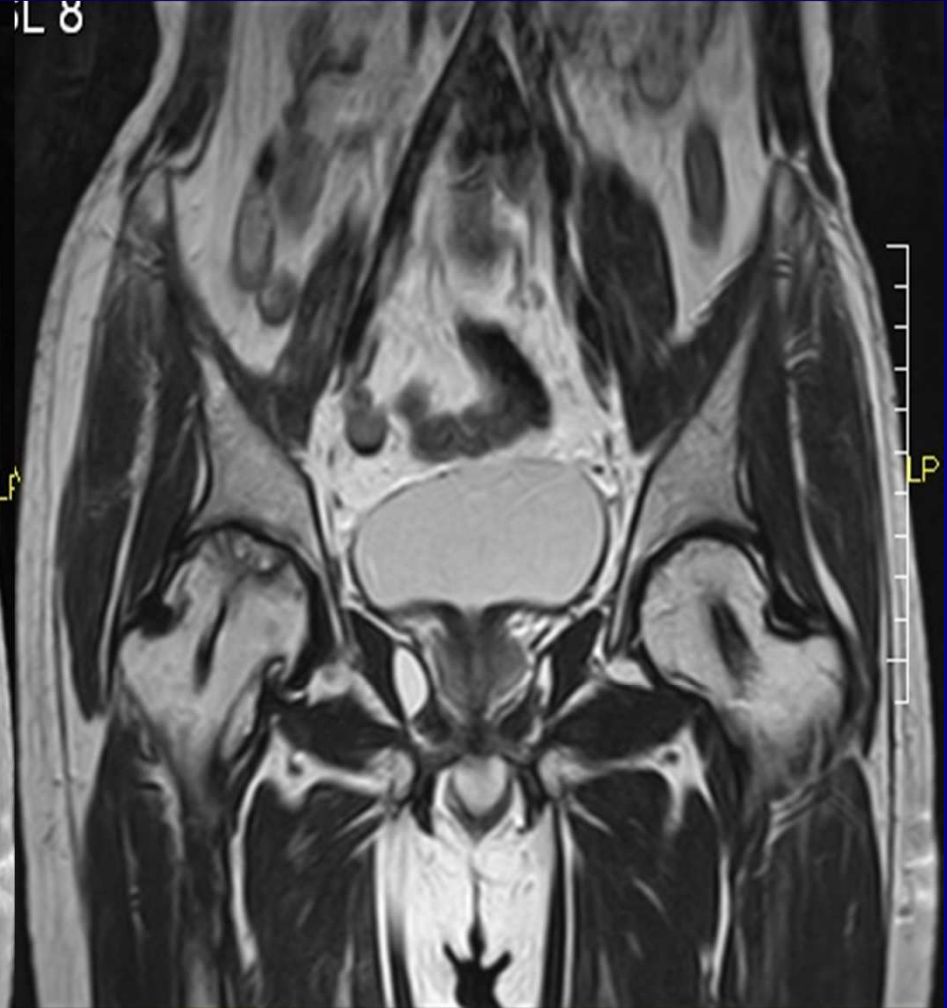
Imaging protocols

SEQUENCE	TR	TE	ANGLE
T1	SHORT 300-700	SHORT 20-40	NIL FAT
T2	LONG > 2000	LONG >100	NIL WATER
GRADIENT	SHORT	SHORT	PRESENT BLOOD Calcium

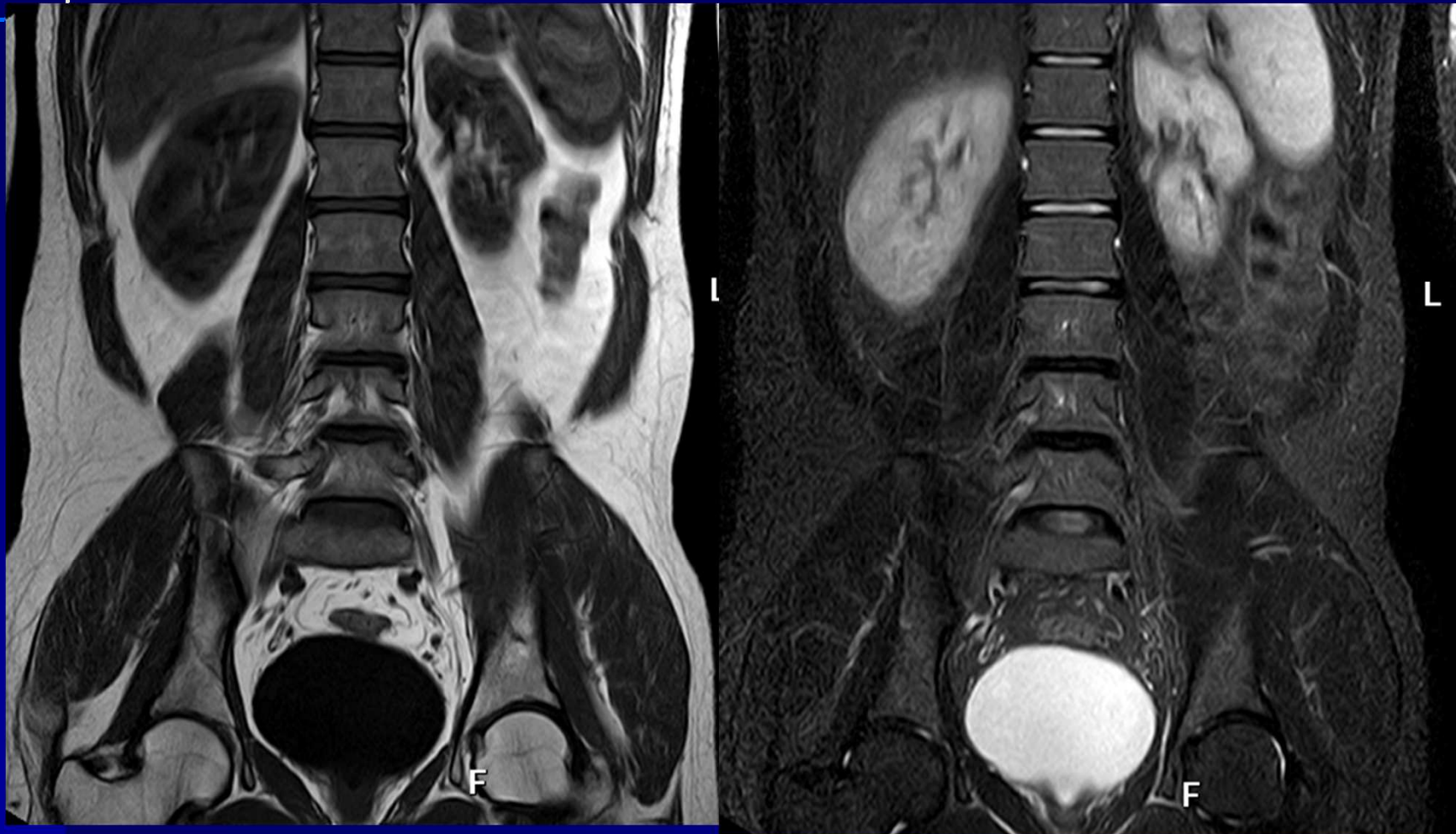
T1



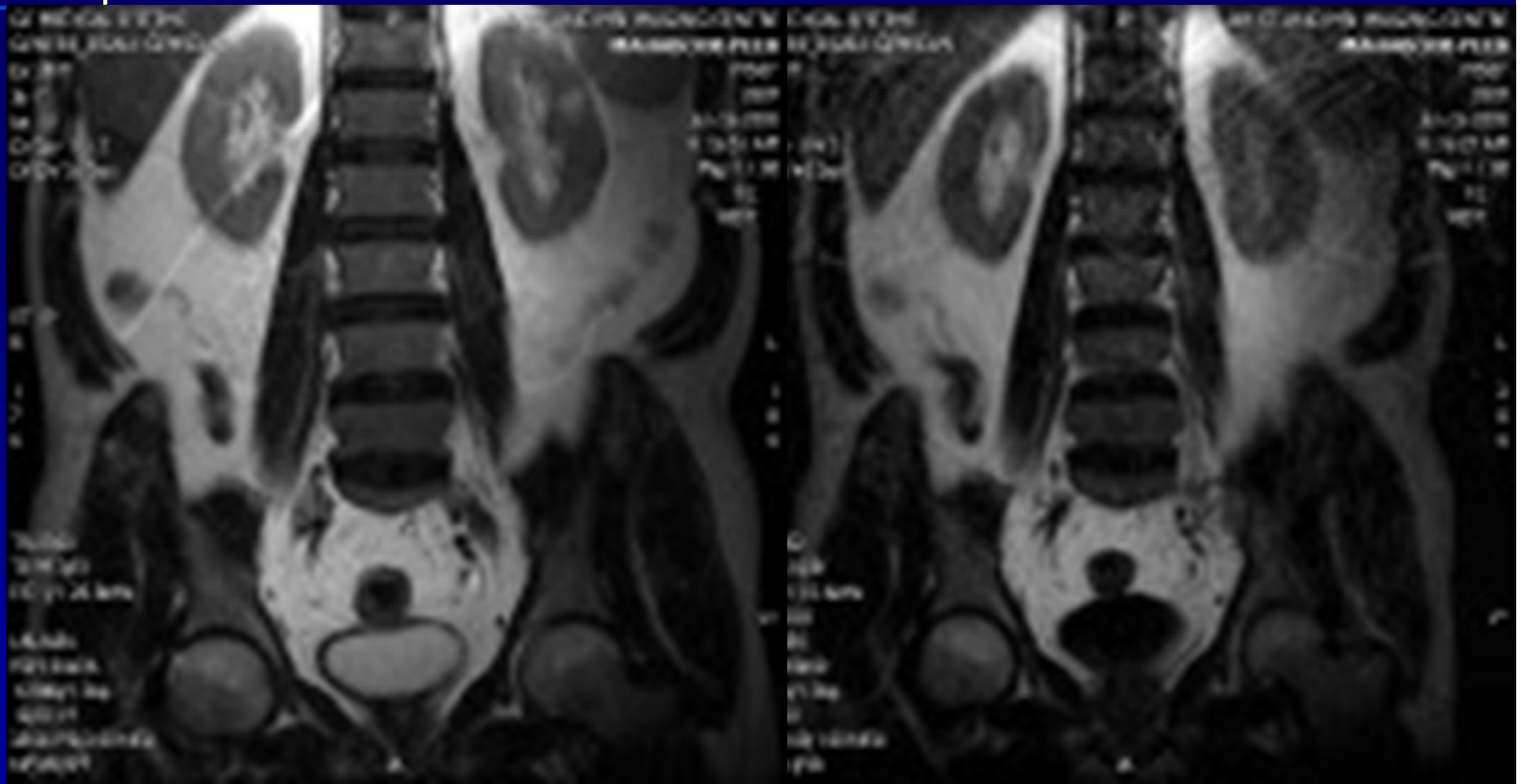
T2



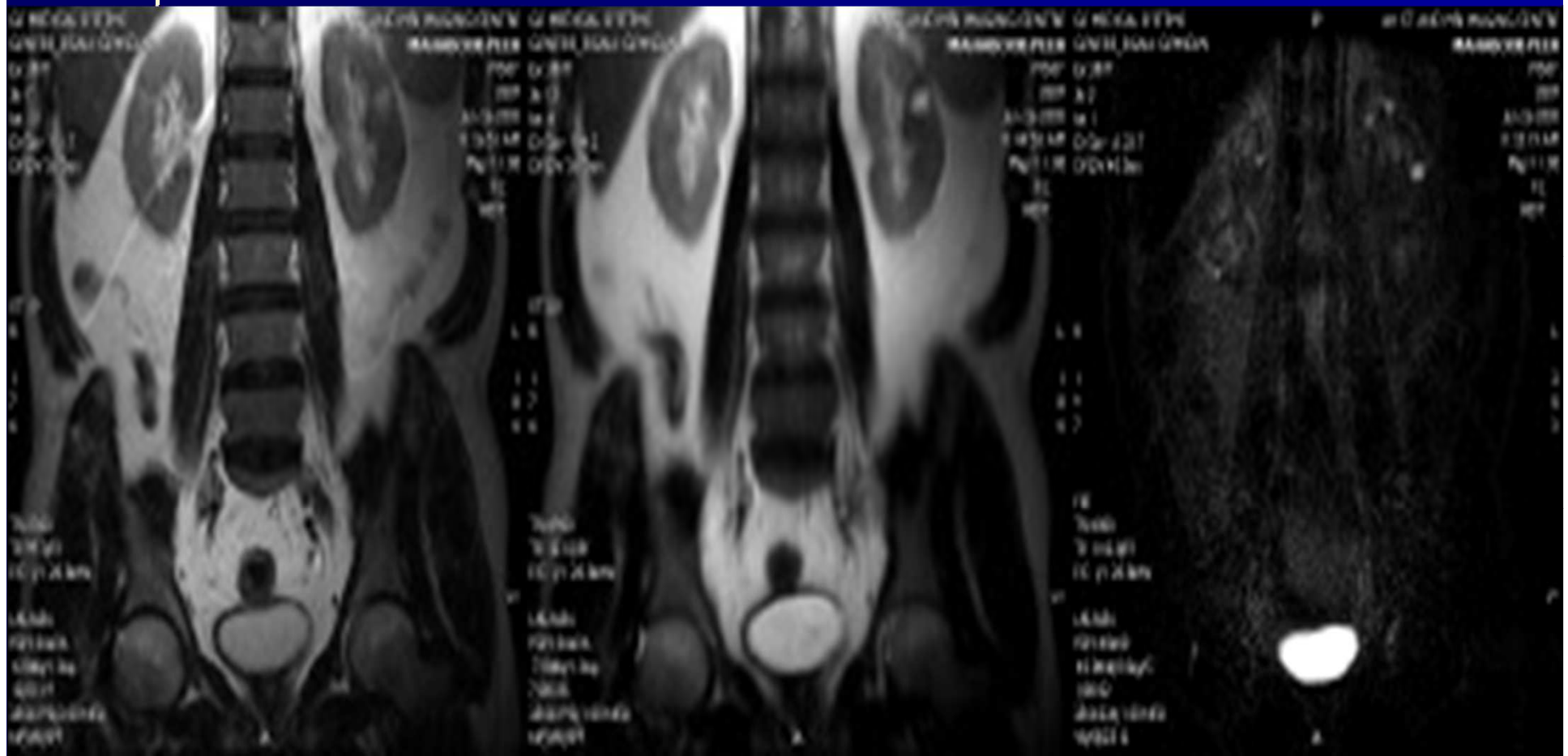
Fat Suppression



Fluid Suppression



Fluid enhancement sequence



Cor T2

MRCP



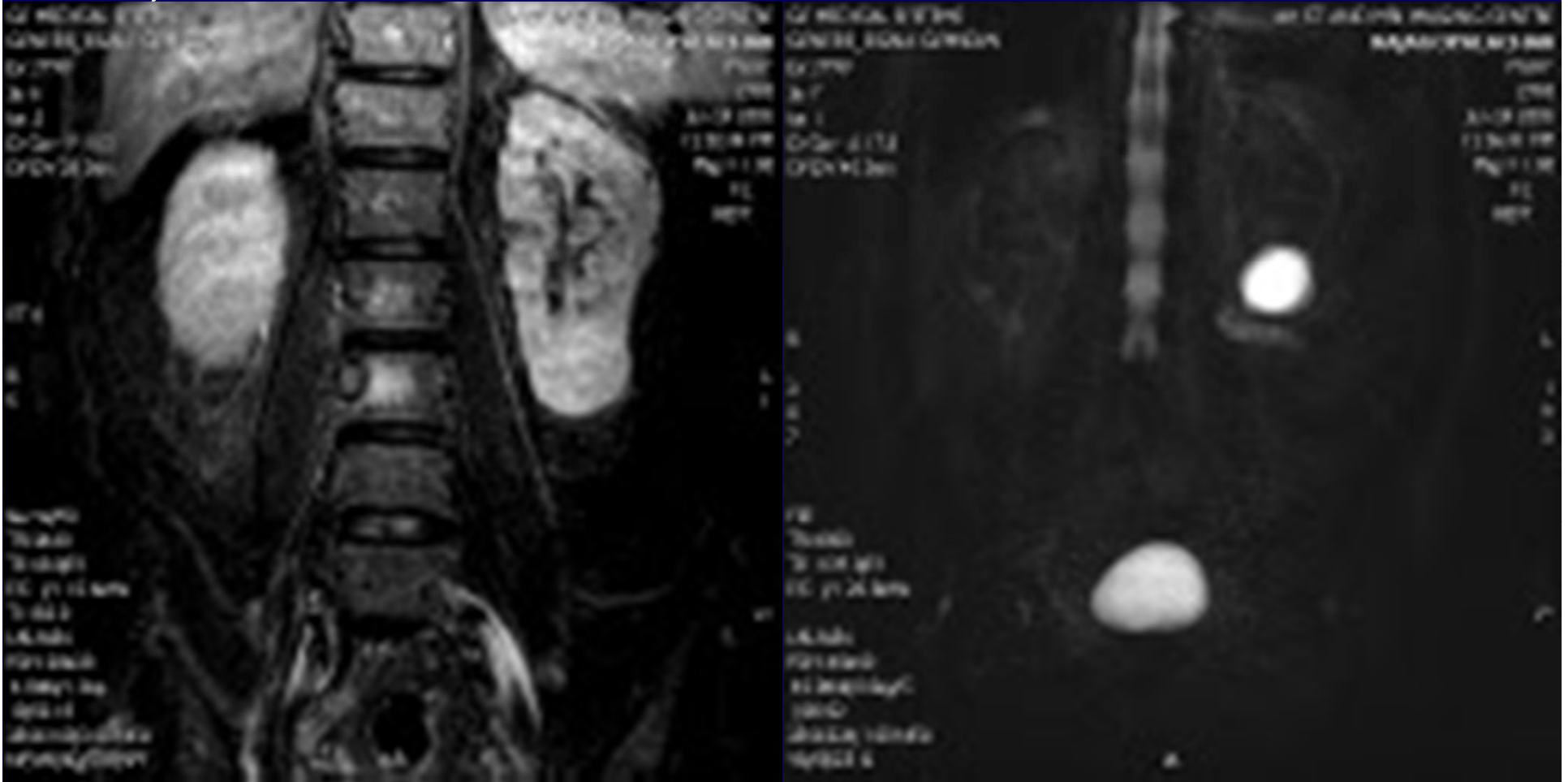
Duplex ureter
upper moiety



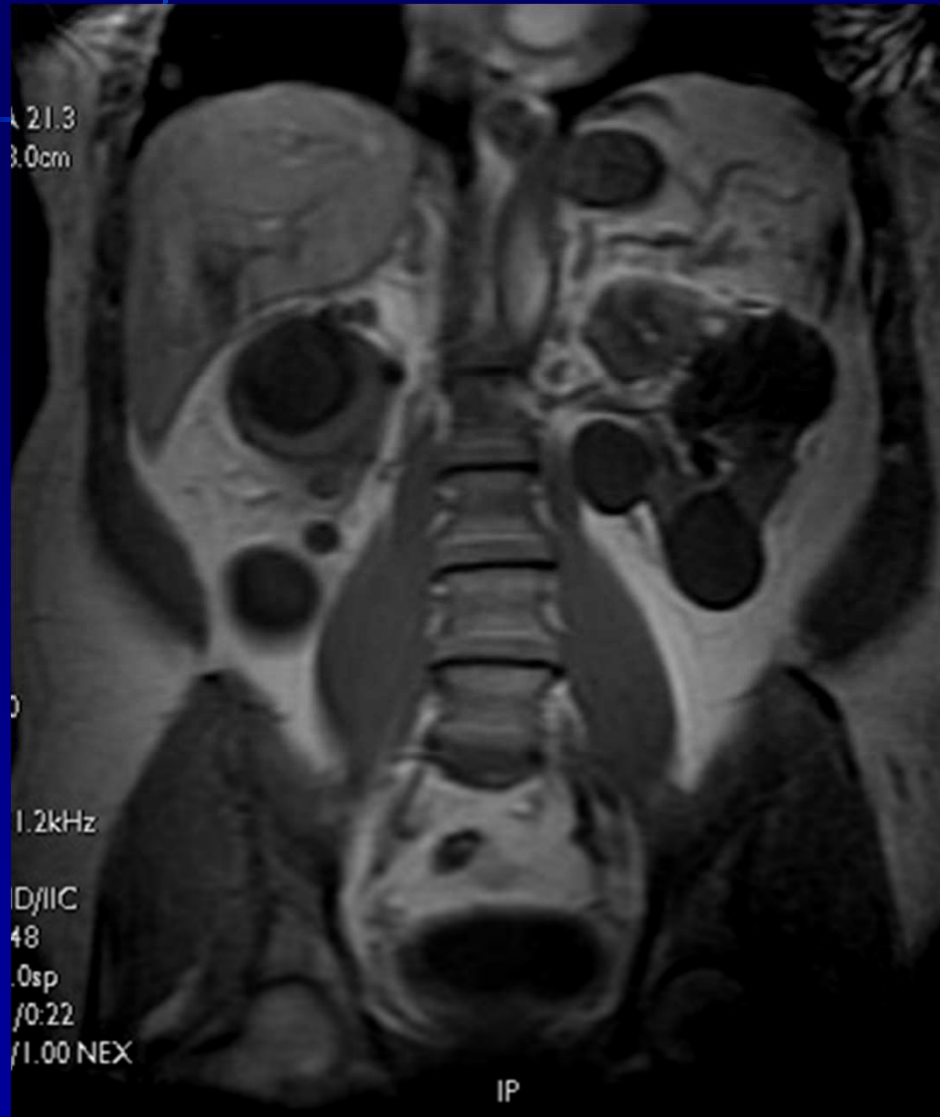
Ca Prostate
Hydroneph



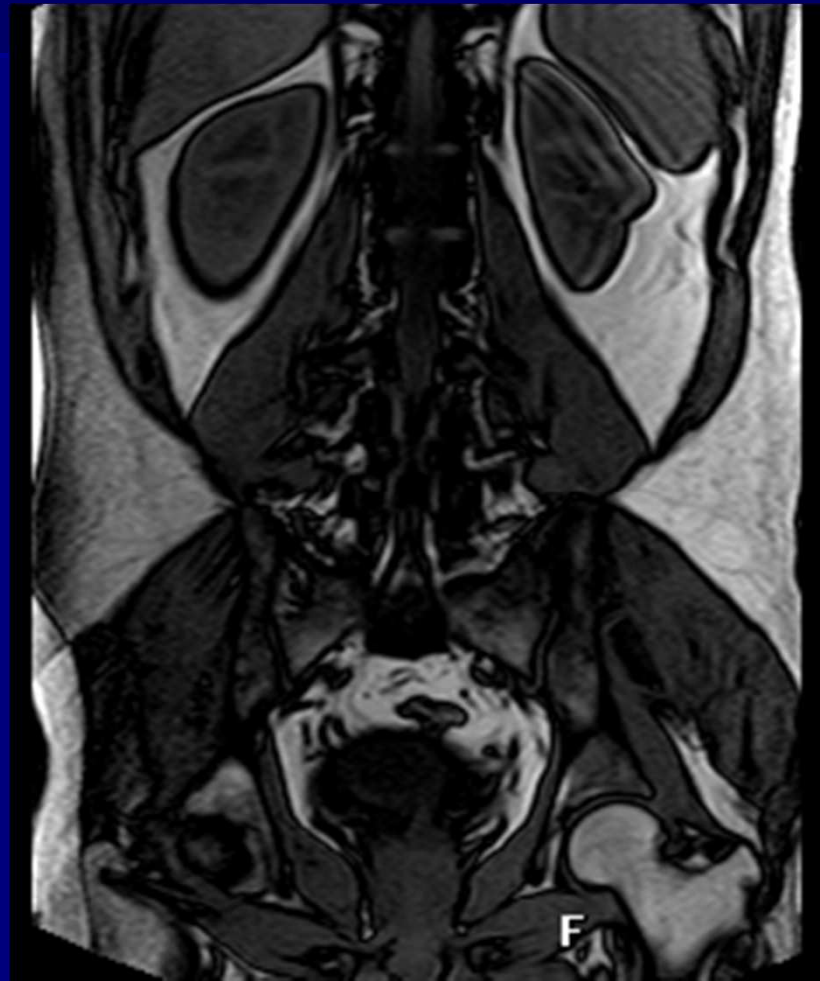
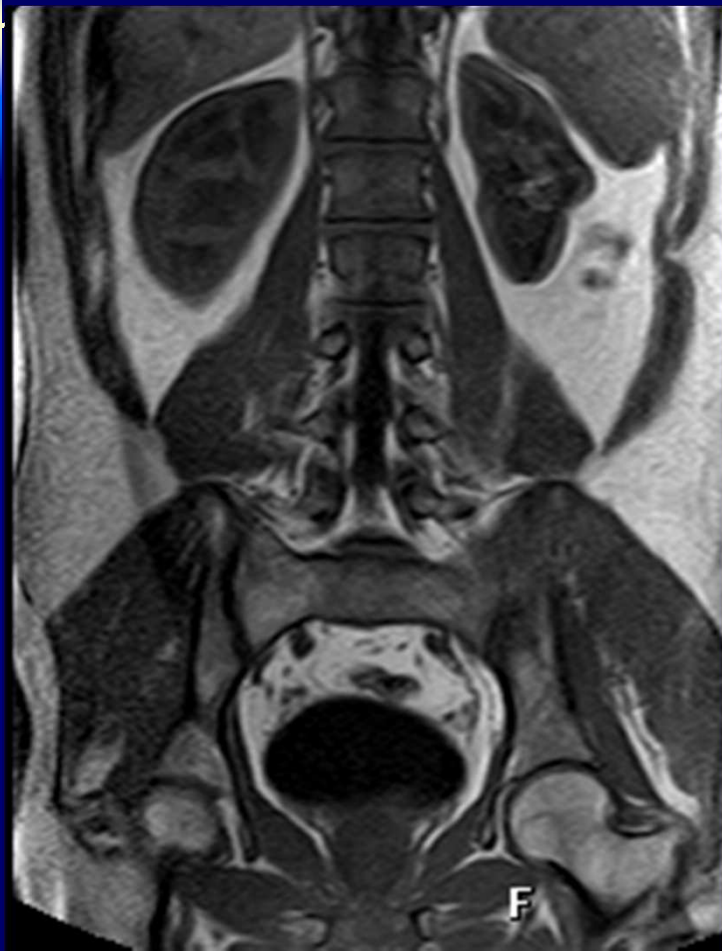
Left Lower Pole Mass



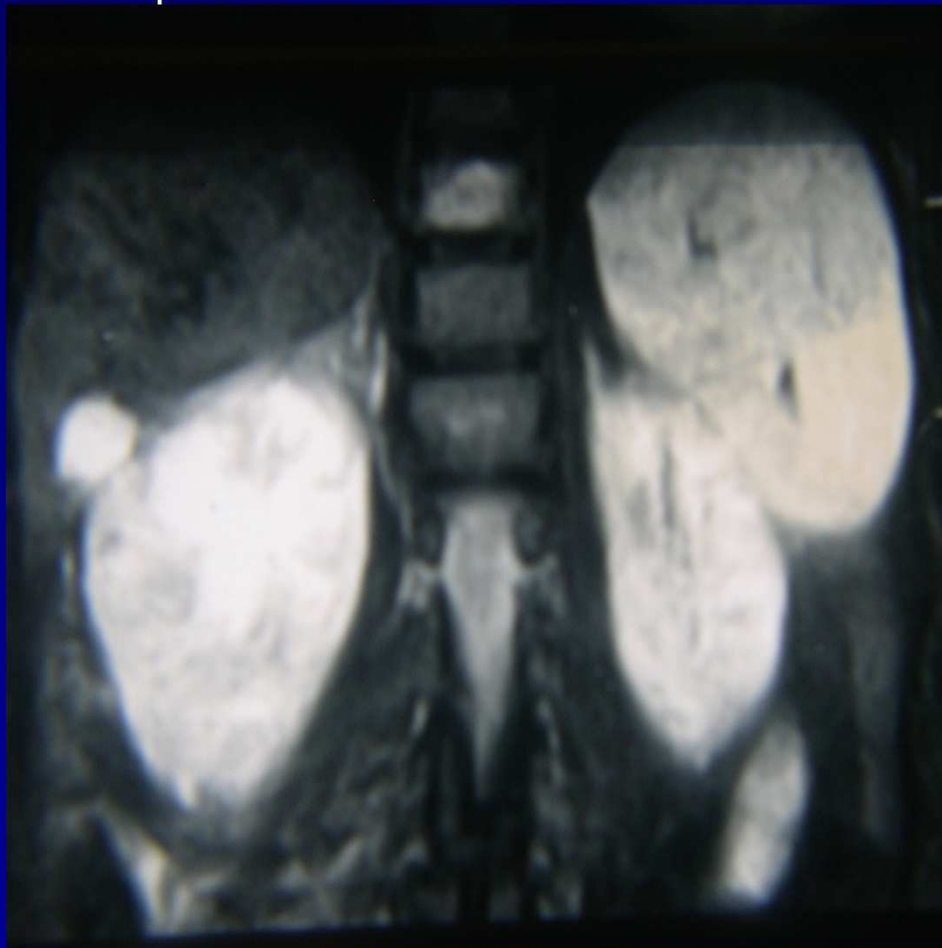
Characterization Cyst: Hemorrhagic



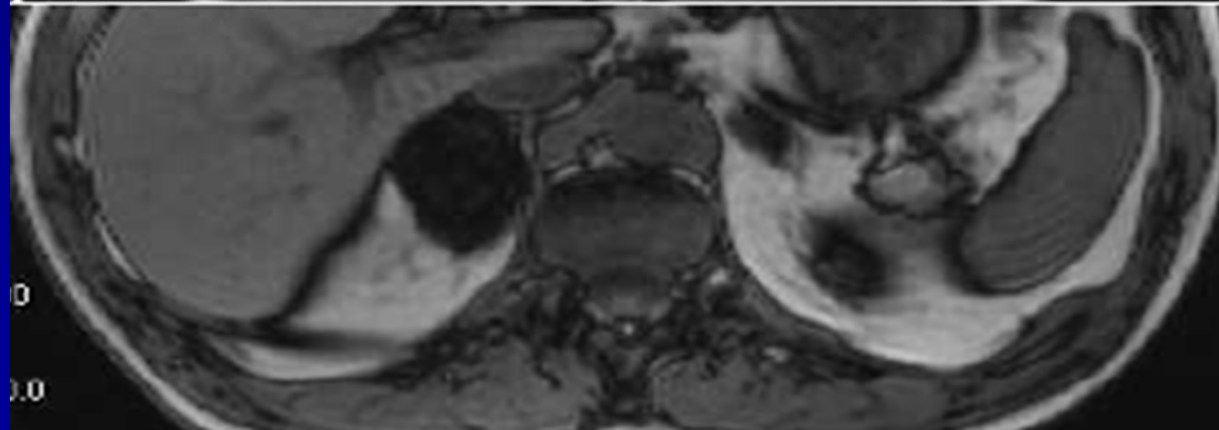
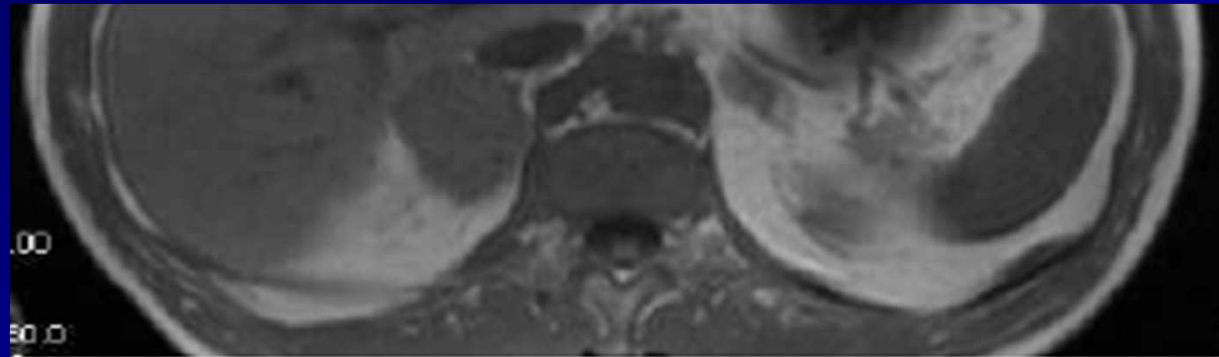
Fat Planes



RCC: Infiltrating liver



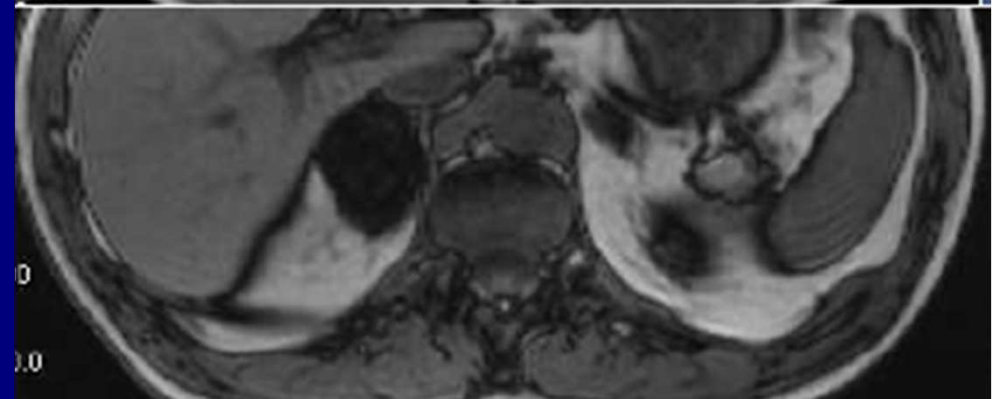
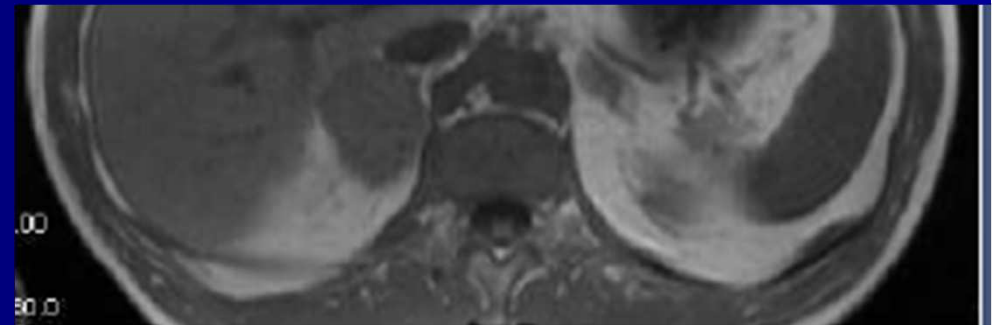
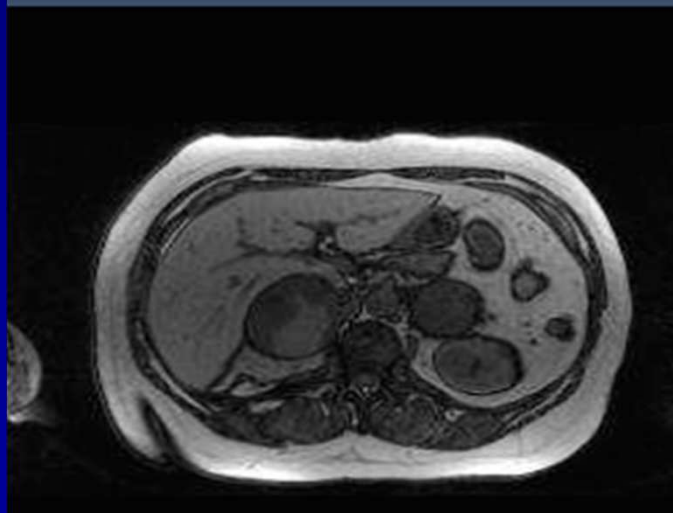
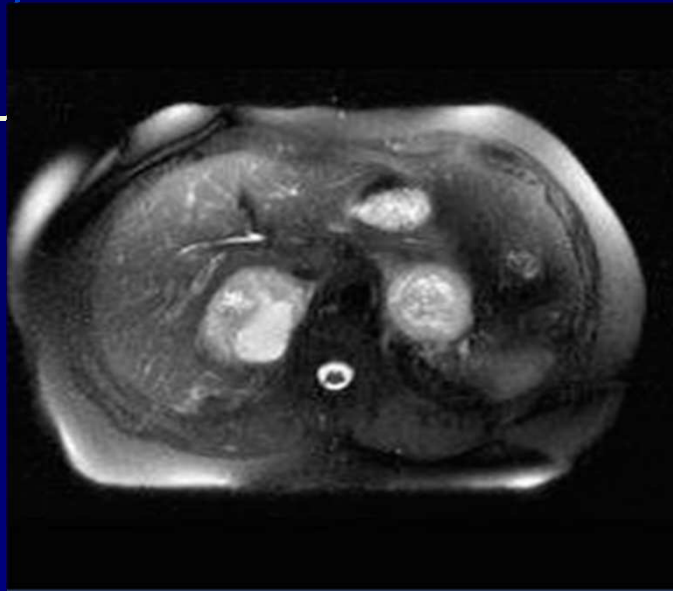
Ca prostate with adrenal mass



MR in phase out phase study

Metastasis

Incidentaloma

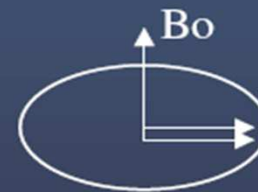


IN PHASE AND OUT OF PHASE

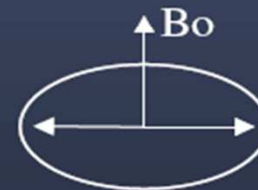
chemical shift imaging

$B_0 = 1.5 \text{ T}$

$$TE = n \times 4.2 \text{ ms}$$



$$TE = (n - \frac{1}{2}) \times 4.2 \text{ ms}$$

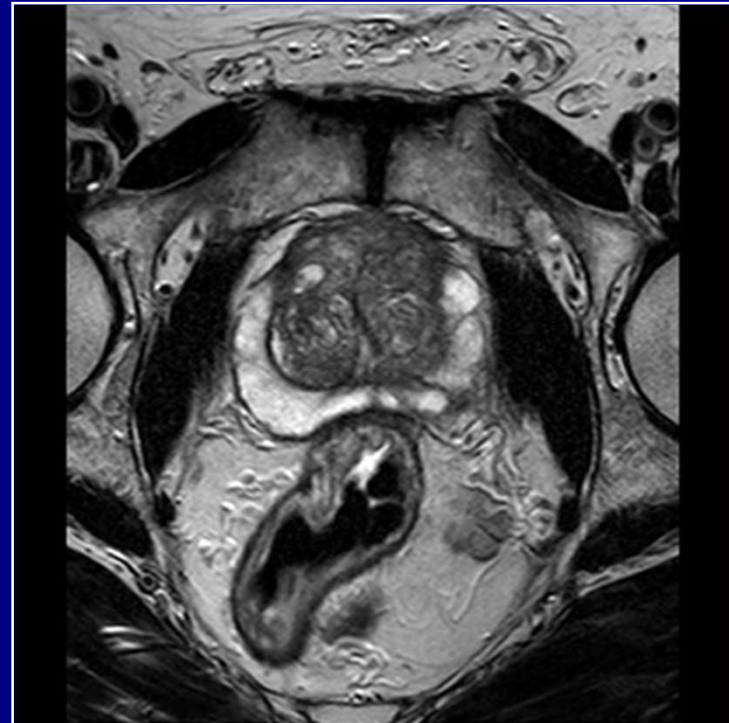


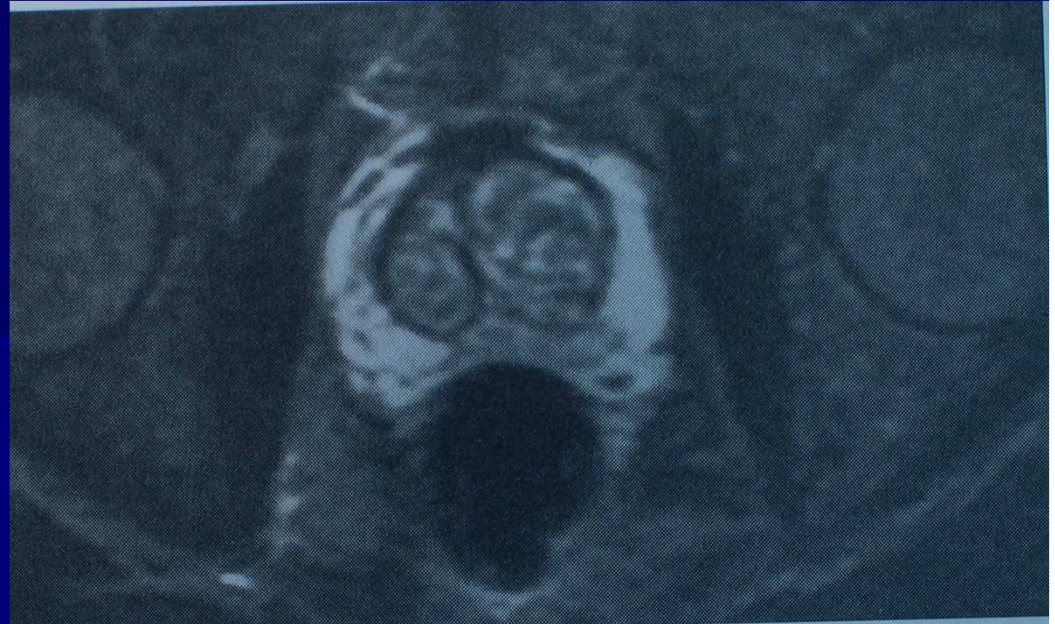
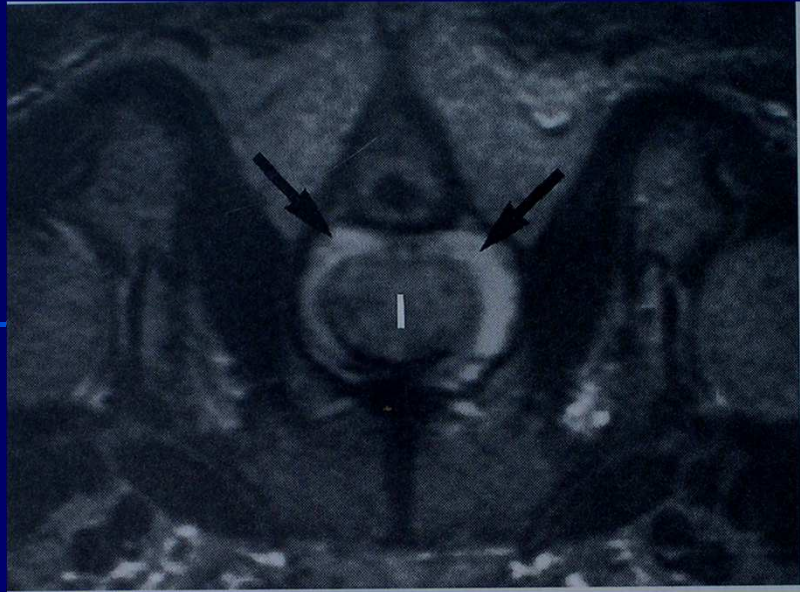
lesion	T1	T2	Early	Delayed
cyst	--	++	-	-
Hamartoma	--	++	Thin rim	rim
Hemangioma	--	++	nodule	retain
oncocytoma	- =	= +	++scar	Wash out
adenoma	++	= +	++	wash
Hemorrhage	++	++	-	-
carcinoma	-	= +	diffuse	wash
Metastasis	-	= +	ring	hetero
FAT SAT, WATER	SAT	IN	OUT	PHASE

Prostate imaging

High Resolution T2W TSE

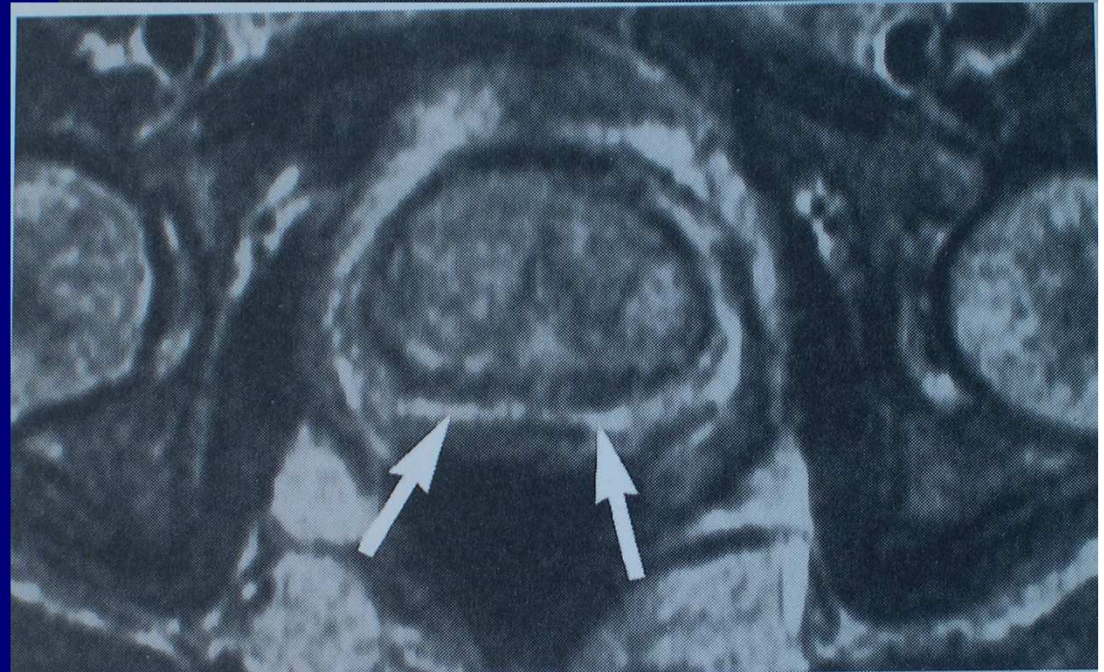
- CLEAR
- Resolution $0.75 \times 0.85 \text{ mm}^2$
- Slice Thickness 3mm





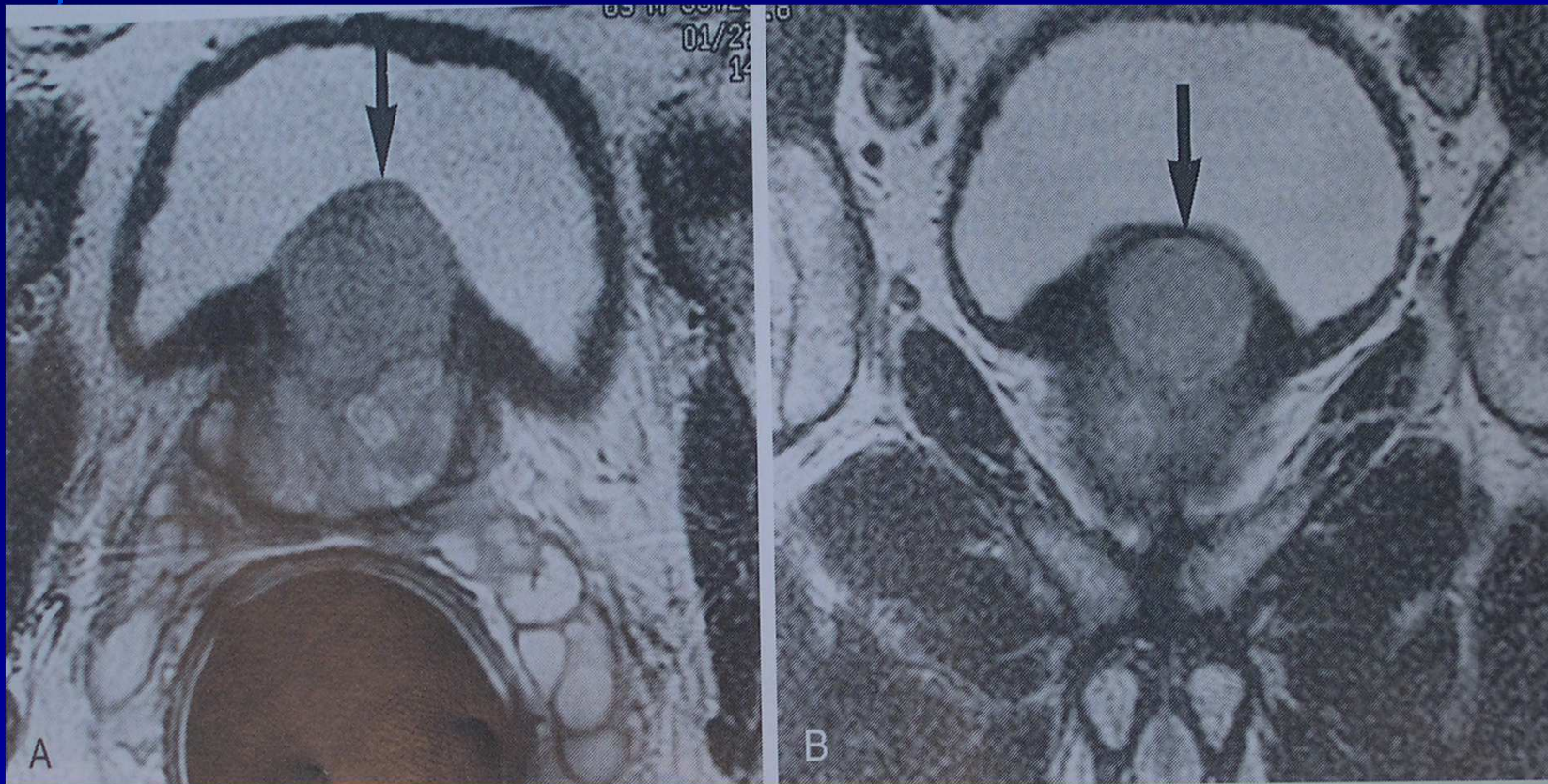
MRI: BPH

**Mild &
Moderate**

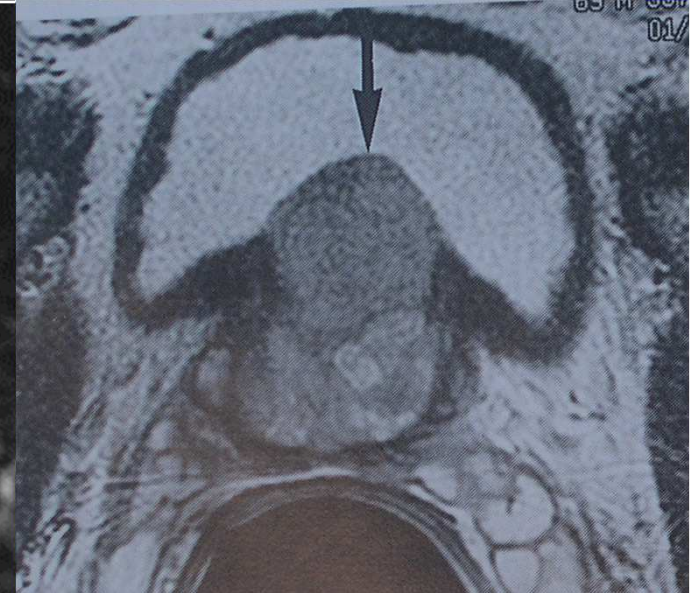
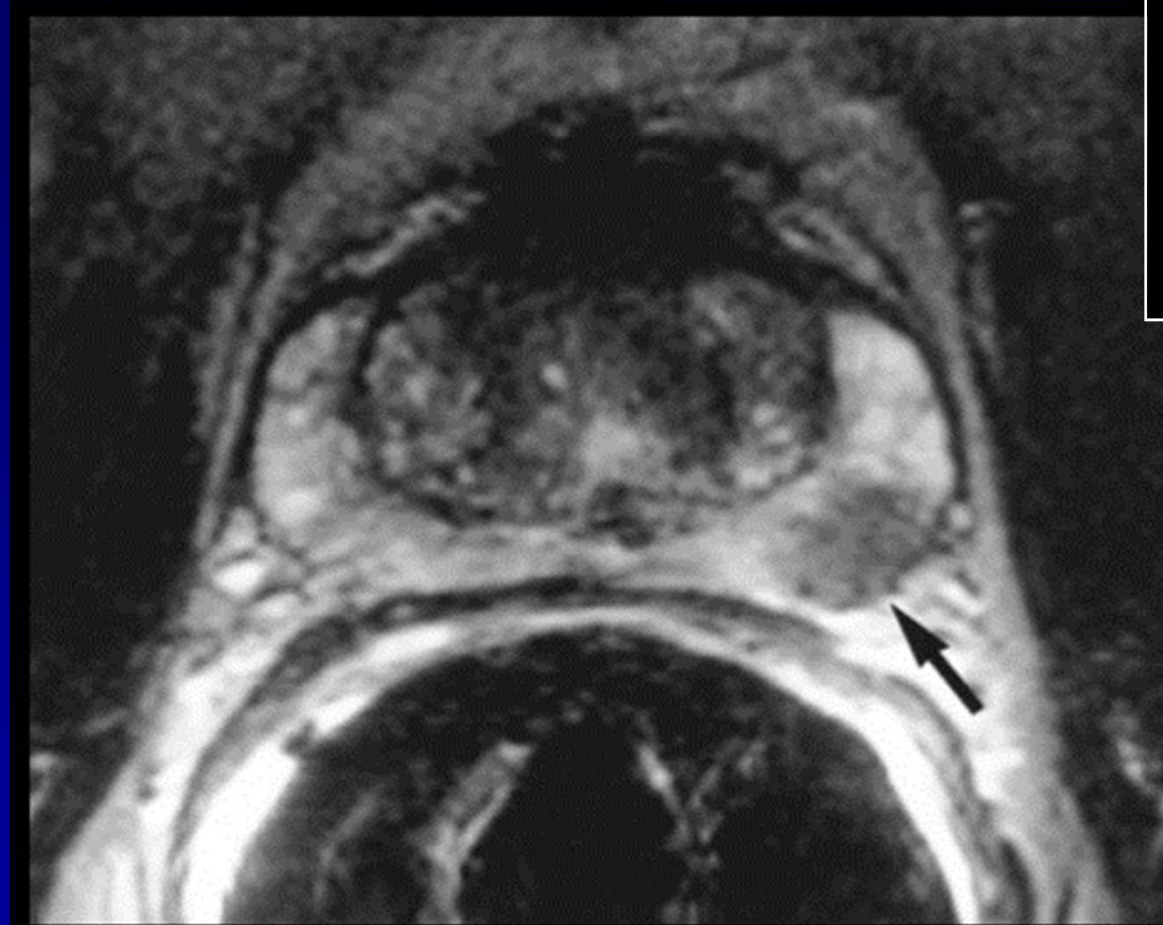


Median Lobe enlargement:

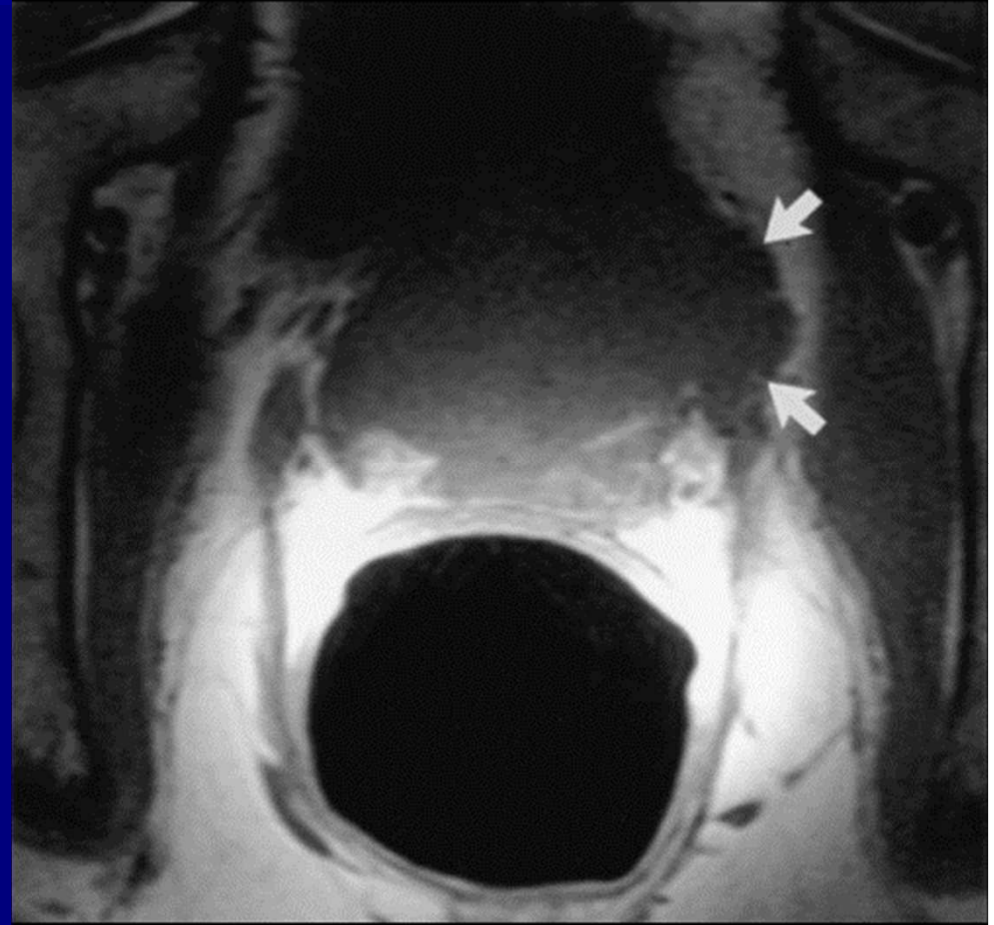
Trans urethral resection



Intra Capsular Lesion



Peripheral Ca extra capsular extension



Extension into seminal vesicle:

Axial

Coronal



Tissue characterization

- | | |
|------------------|-------------------|
| ■ Non Intense: | Calculus, Gas |
| ■ Hypo intense: | Fibrous lesions |
| ■ Hyper intense: | Malignant Lesions |
| ■ Super Intense: | Fluid (Cysts) |

Lesion Characterization

- Solid vs Cyst
- Fat vs Fluid
- Hemorrhage
- Calcification
- BENIGN vs MALIGNANT !?

Molecular Imaging

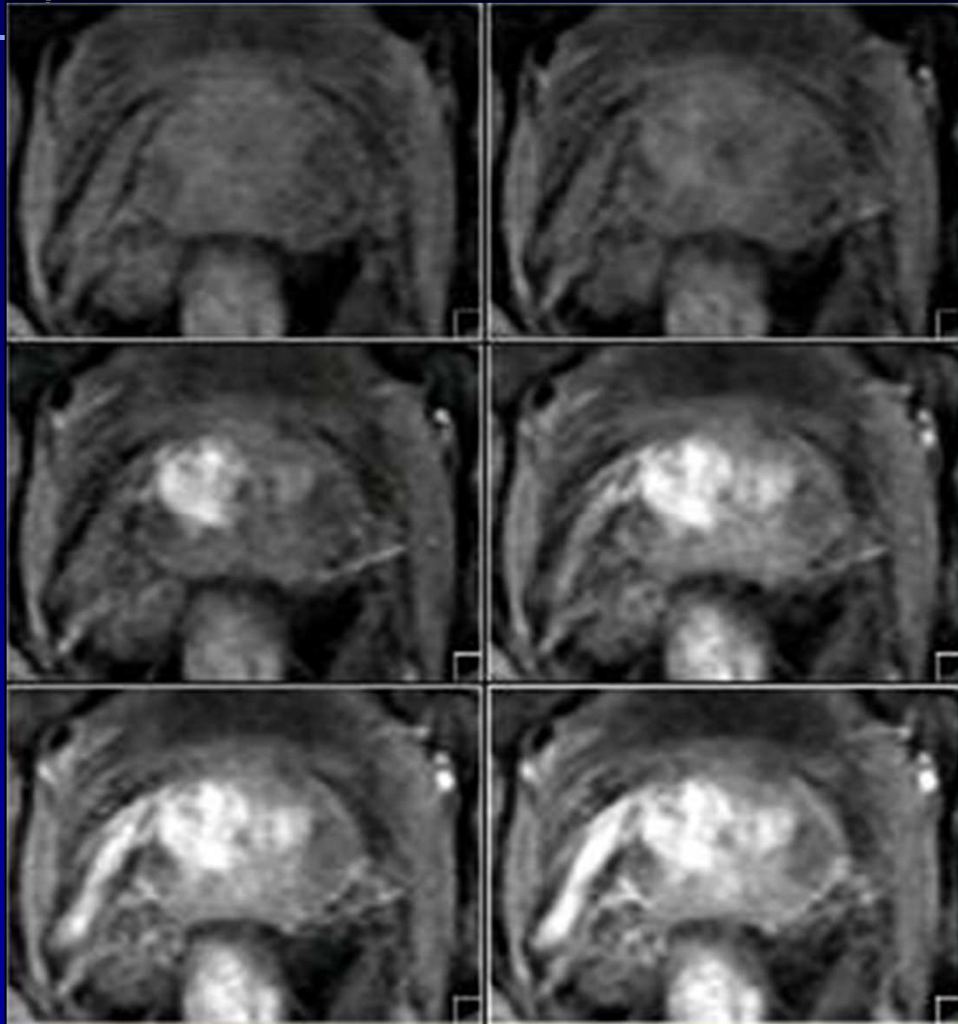
- In phase out phase
- Dynamic contrast enhancement
- Diffusion weighted (DWIBS/ MR PET)
- spectroscopy

Dynamic contrast studies

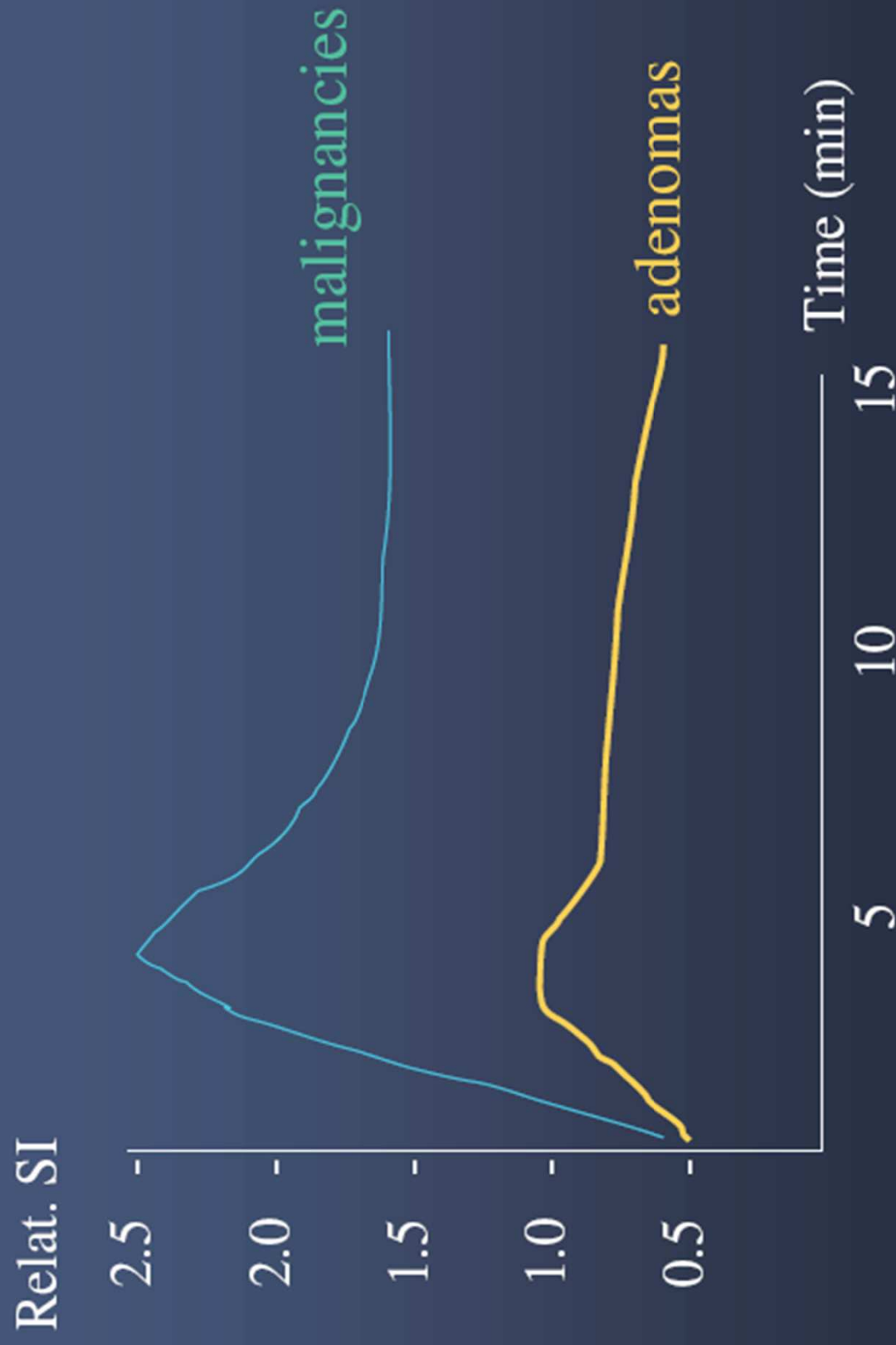
- **Benign tumors:** slow enhancement & retain contrast
- **Malignant tumors:** early take up and washout
- **Endocrinal tumors:** rapid enhance and wash out
- Cysts and Hematoma: Do not enhance

Prostate imaging

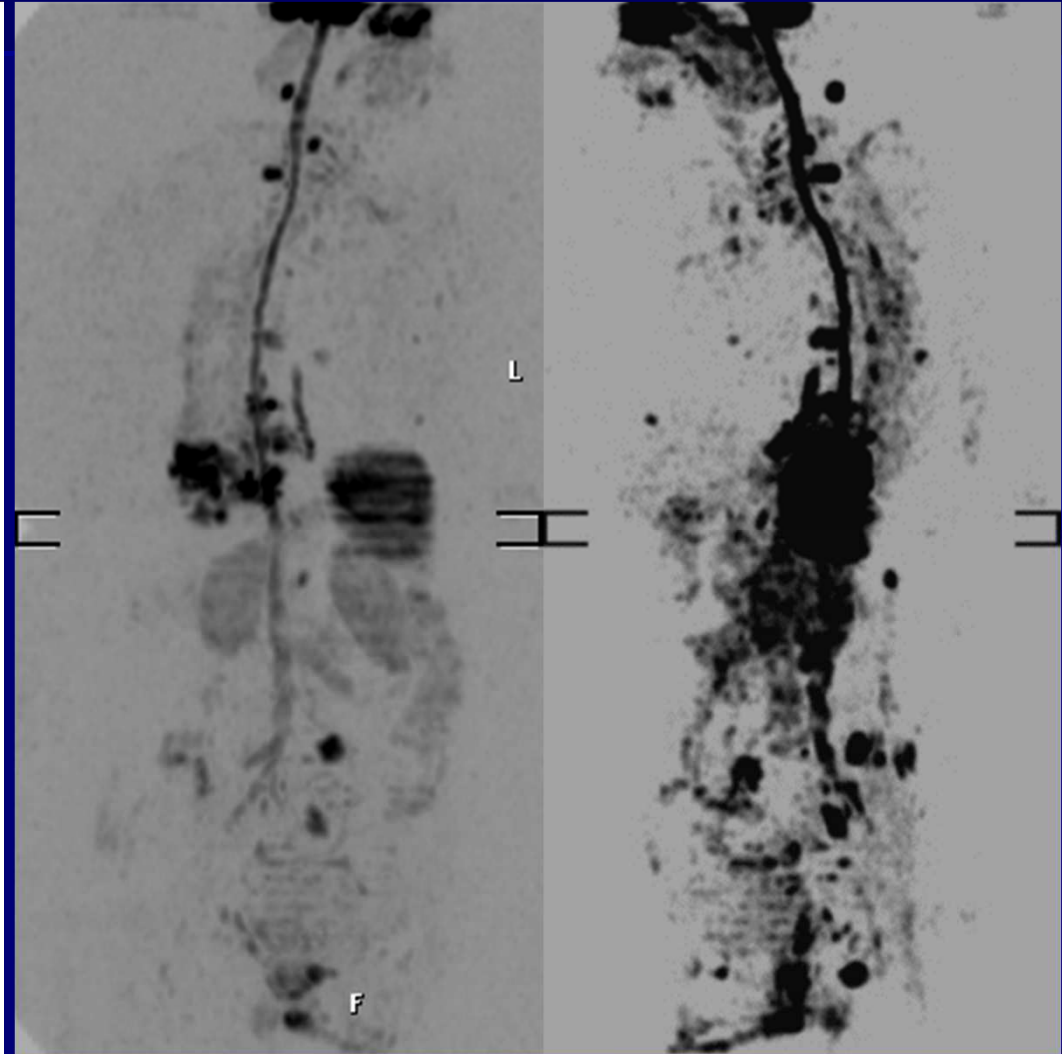
Dynamic Contrast Enhanced Imaging



Enhancement of adrenal lesions



Benign vs Malignant



MR PET

(Proton Enhanced Tomo)

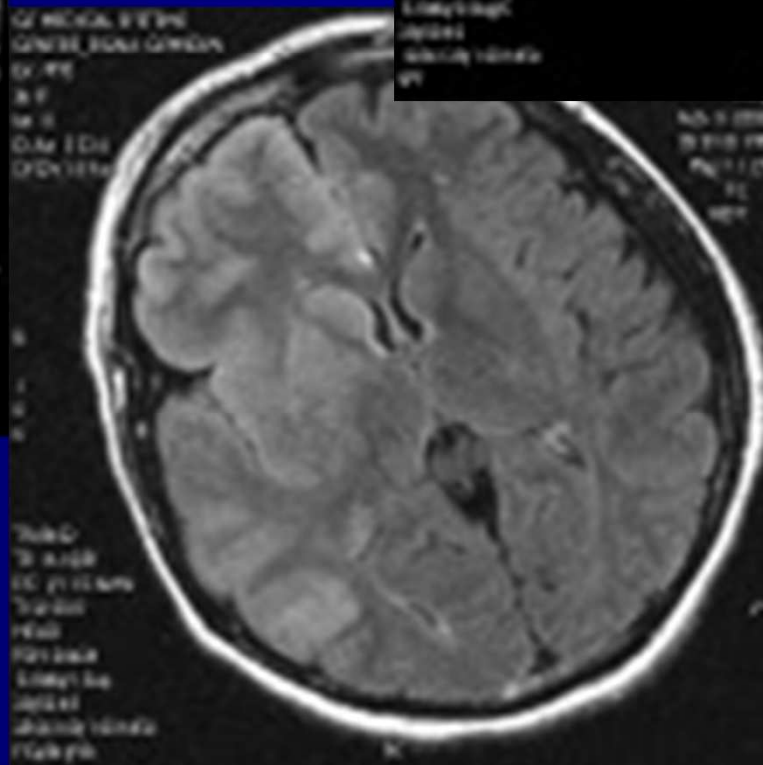
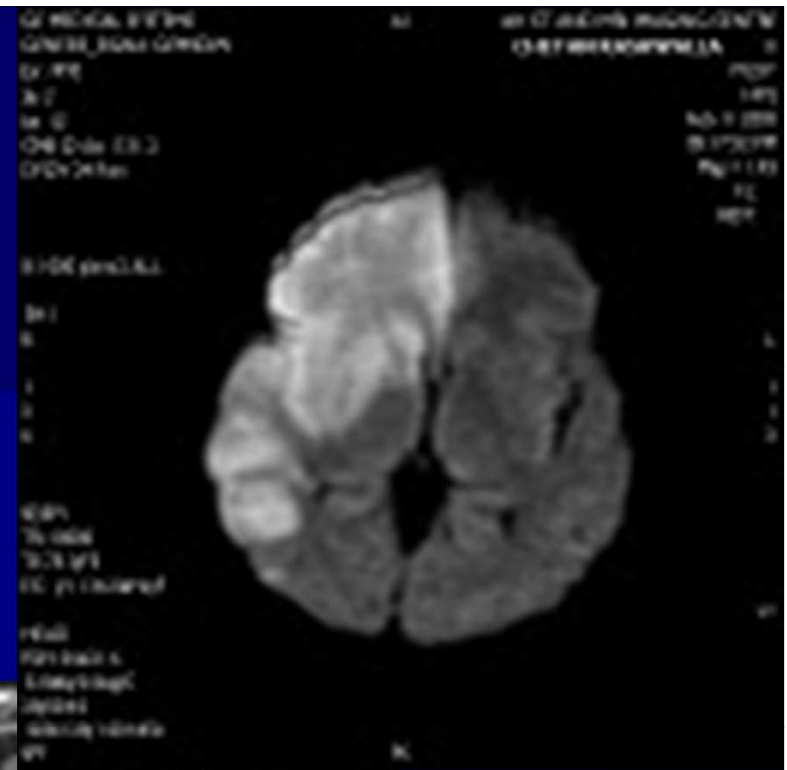
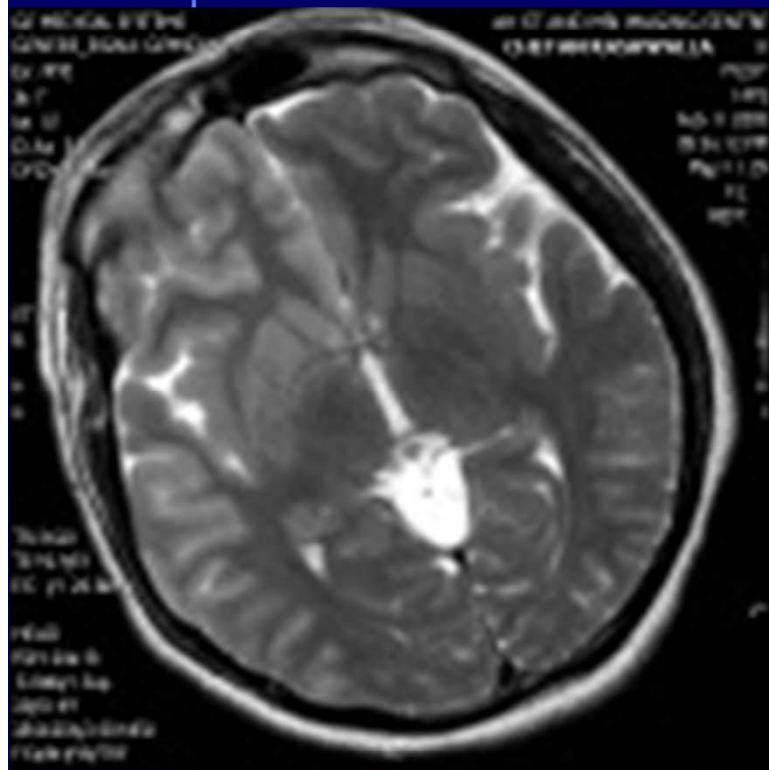
DIFFUSION WEIGHTED

IMAGING

BACKGROUND SUPPRESSION

(DWIBS)

Hyper acute infarcts

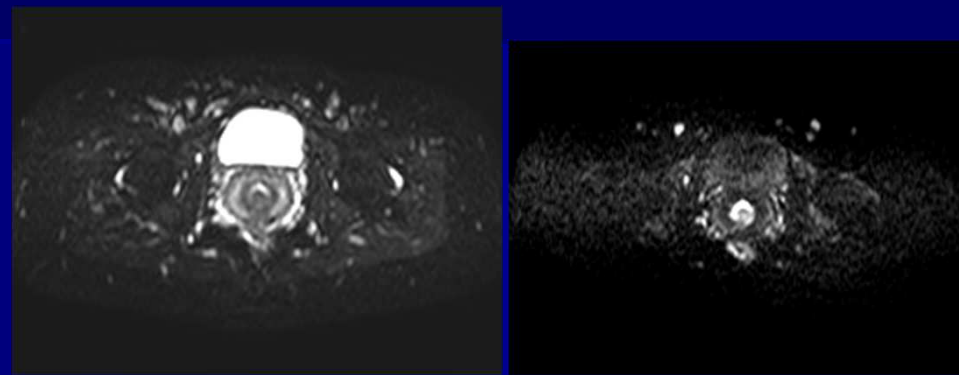


Restricted Diffusion

- Intra/extra cellular fluid ISCHEMIA
- Cell Density TUMORS
- Infective components ABSCESS

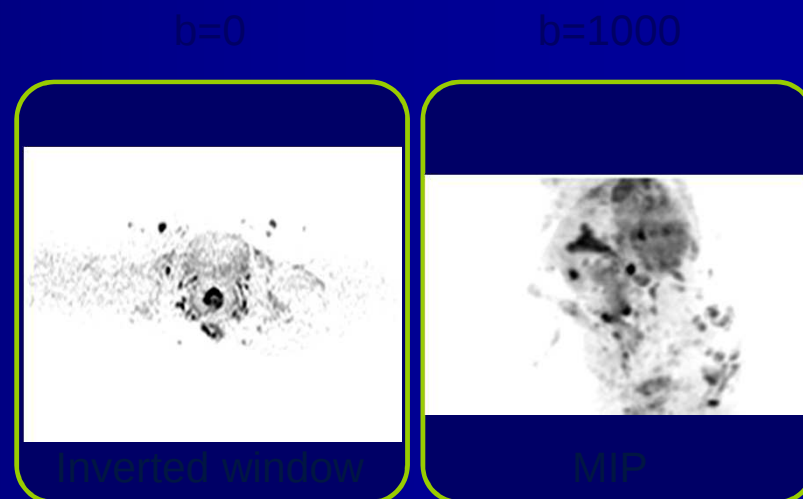
MR PET Diffusion Body Scanning

- Suppresses:
 - Fat, Blood, Fluid, Body Organs, Muscles

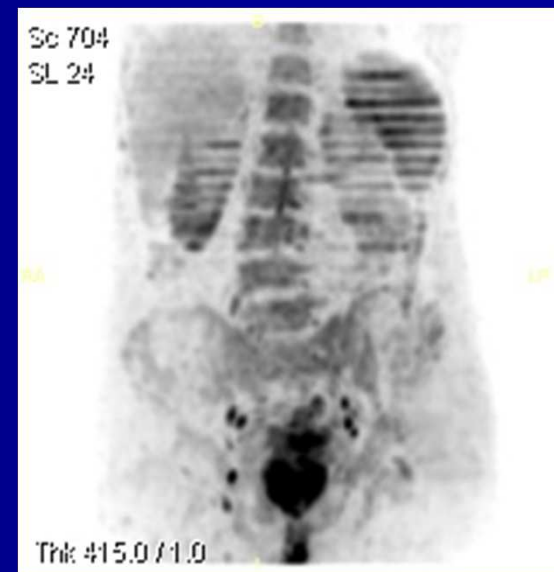
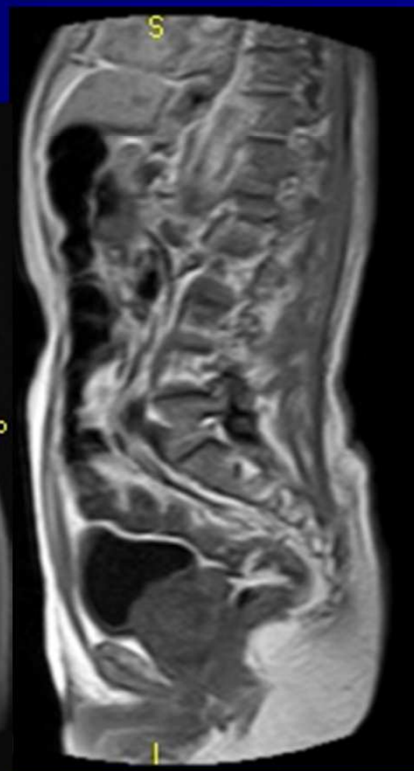
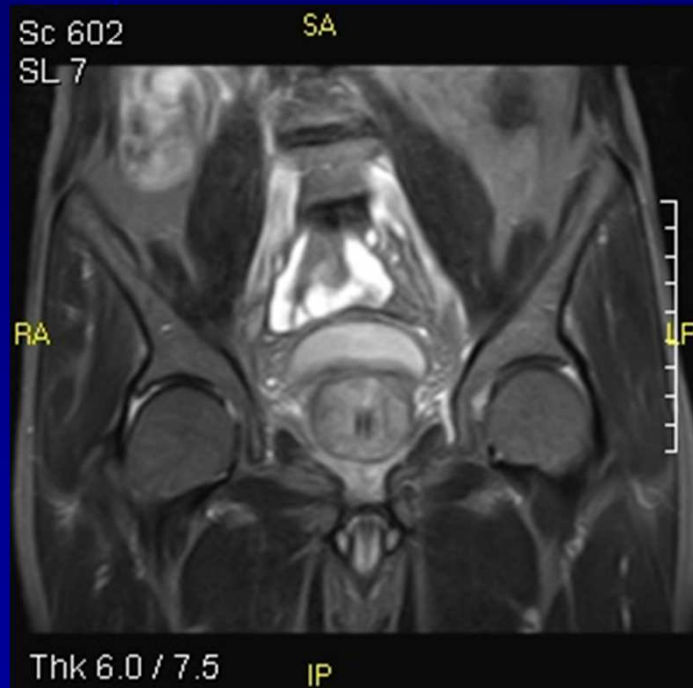
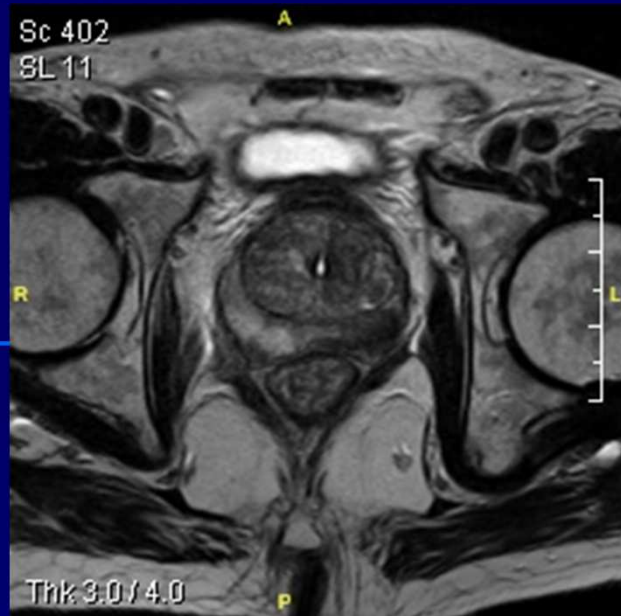


- Enhances: TUMORS

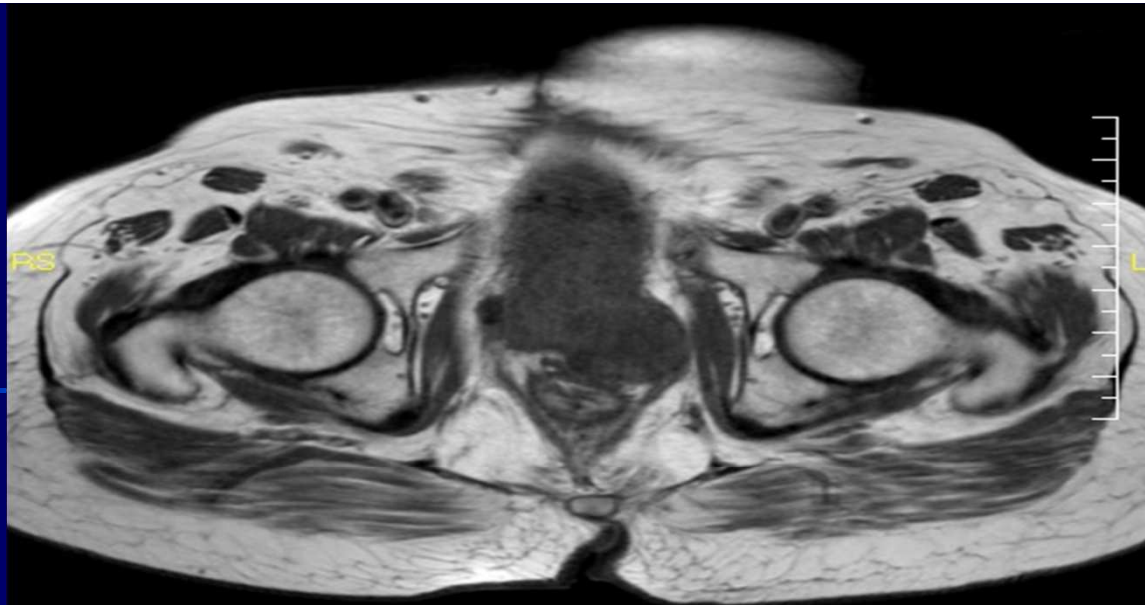
Excellent
Lesion/Background
Contrast



Prostate mass

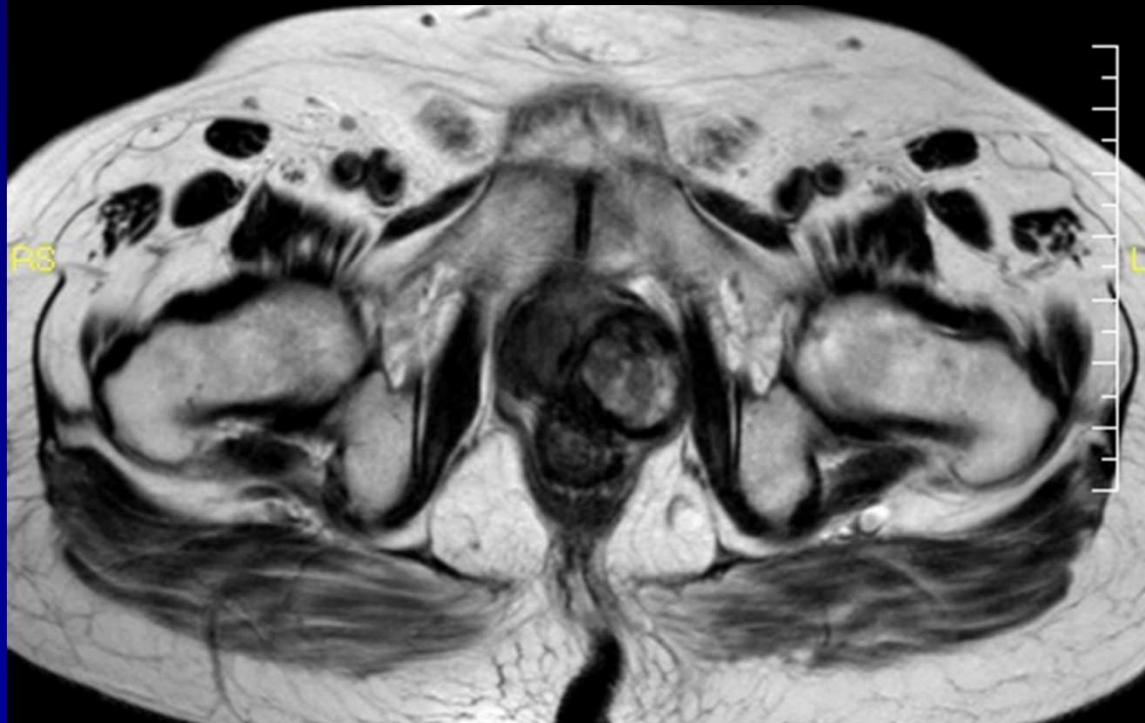


Periph nodule



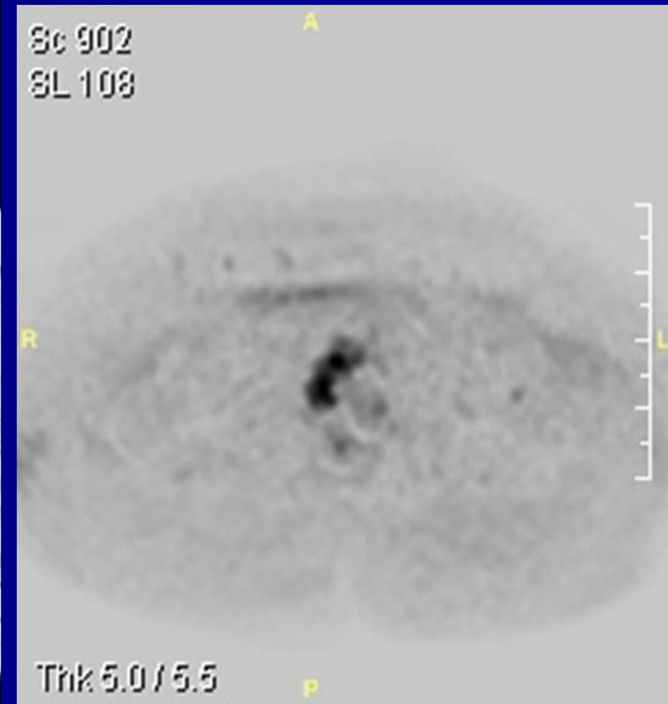
Thk 7.0 / 9.0

P



RS

LI



Sc 902
SL 108

A

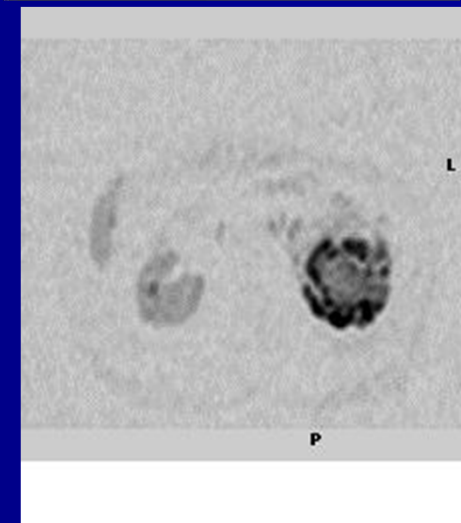
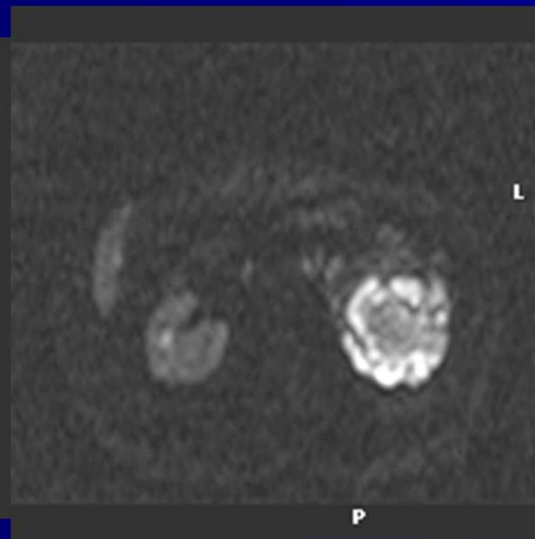
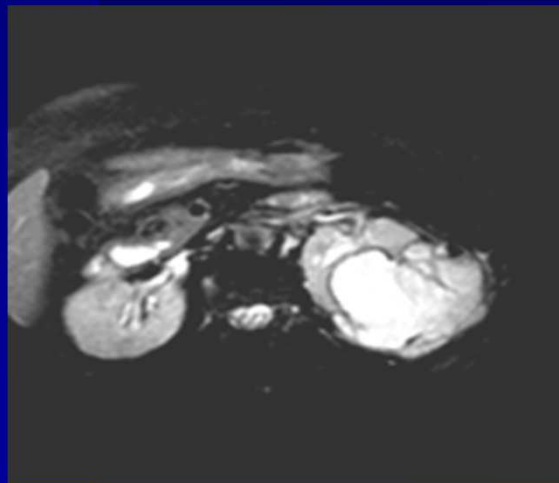
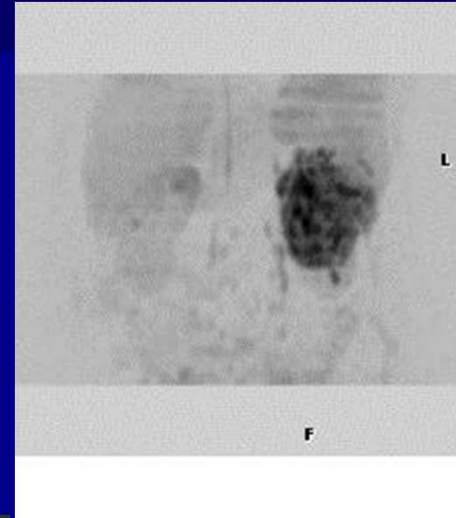
R

L

Thk 5.0 / 5.5

P

Cystic Renal lesions

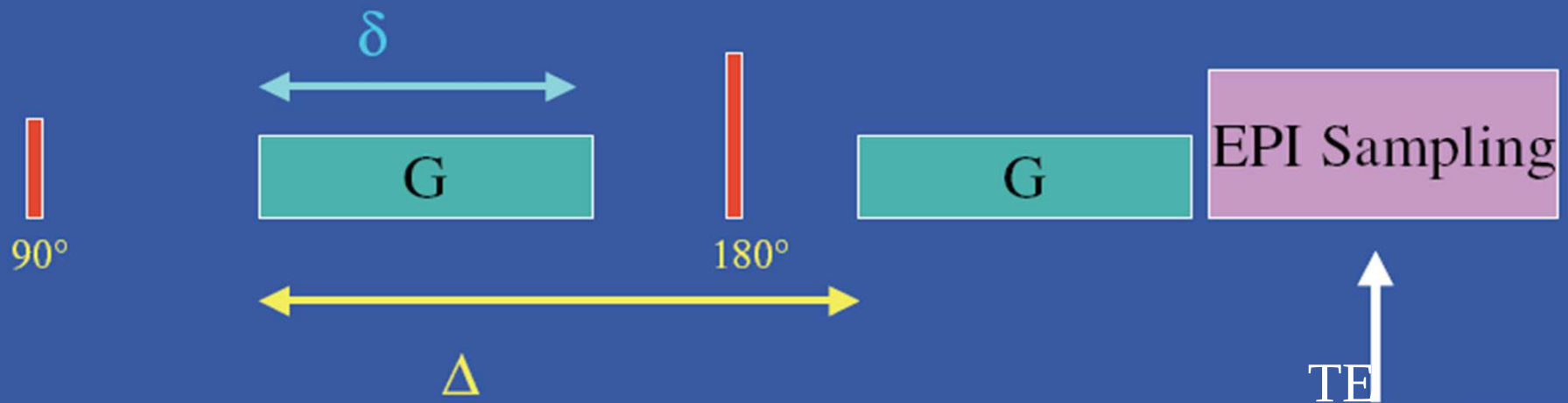


Signal with diffusion

The SE signal with isotropic diffusion:

$$M_T = M_T(0) e^{-TE/T_2} e^{-b D}$$

$$b = \gamma^2 \delta^2 (\Delta - \delta/3) G^2$$



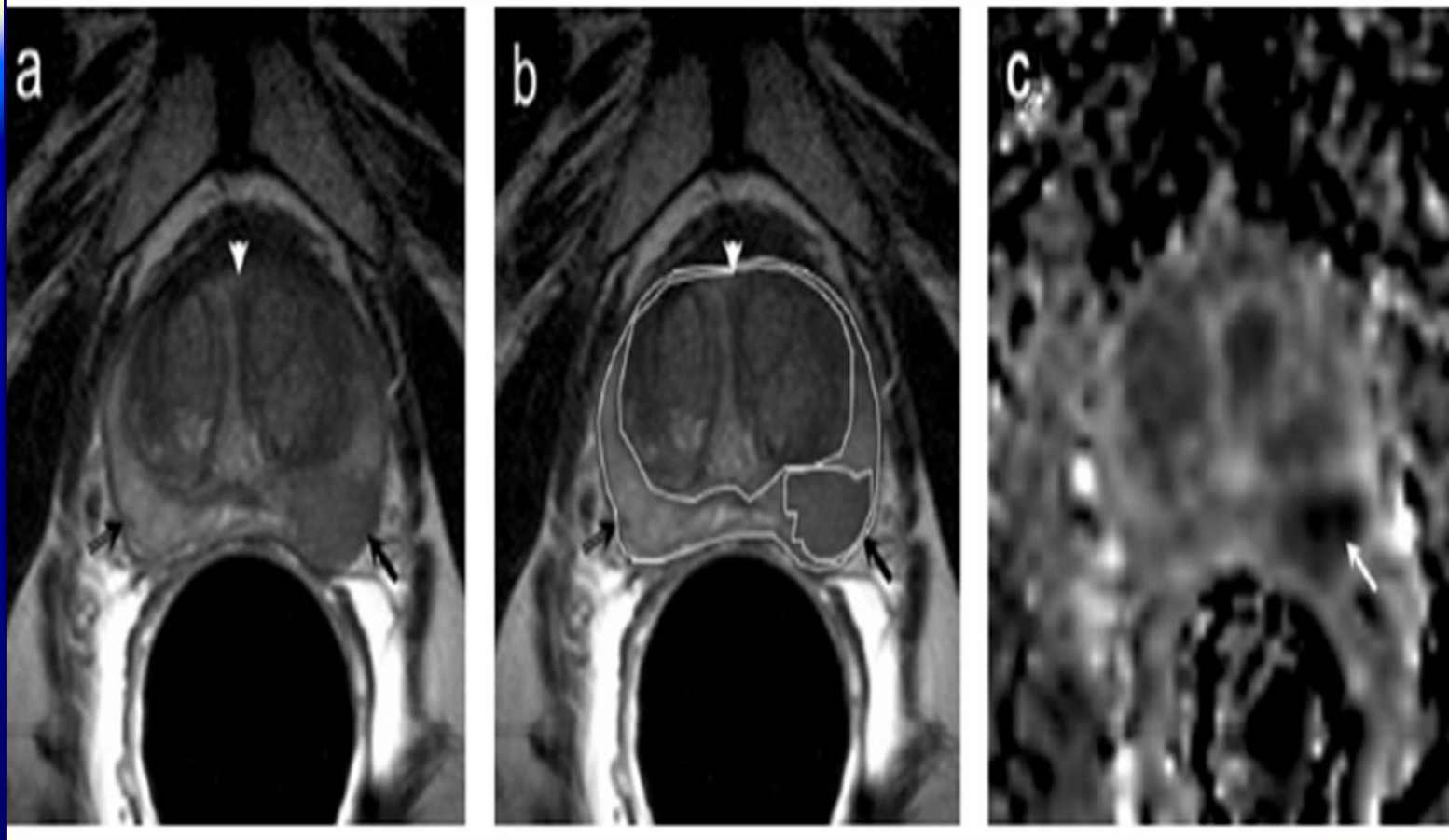
The ADC value ($\times 10^{-3}$ mm²/s) in the

- compared with **urine** **3.28 $\pm$ 0.20**
- the normal bladder wall 2.27 $\pm$ 0.24
- prostate transition zone: 1.57 $\pm$ 0.09
- peripheral zone: 1.85 $\pm$ 0.22
- seminal vesicle 2.01 $\pm$ 0.22

- **Prostate ca** **1.18 $\pm$ 0.19**

- Threshold ADC value anything less than 1.5

PROSTATE NODULE DIFFUSION MAP



DIFFUSION (ADC) Values



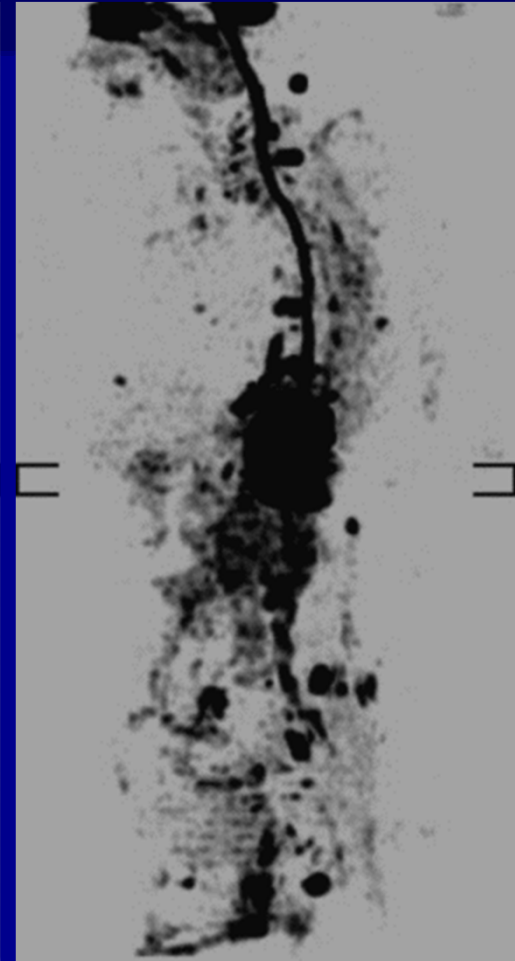
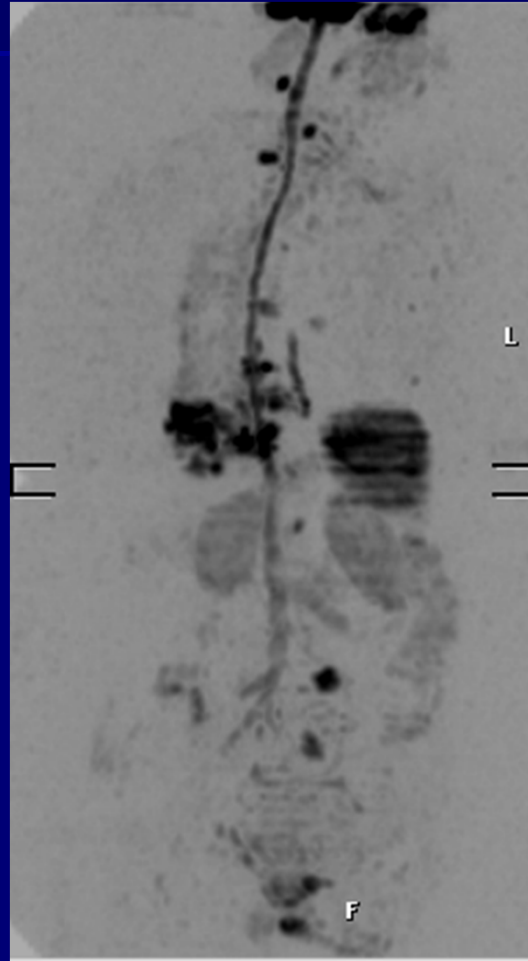
Clear fluid
mitotic lesion
caseous fluid
Acute Bacterial Infection

Shetty PB,

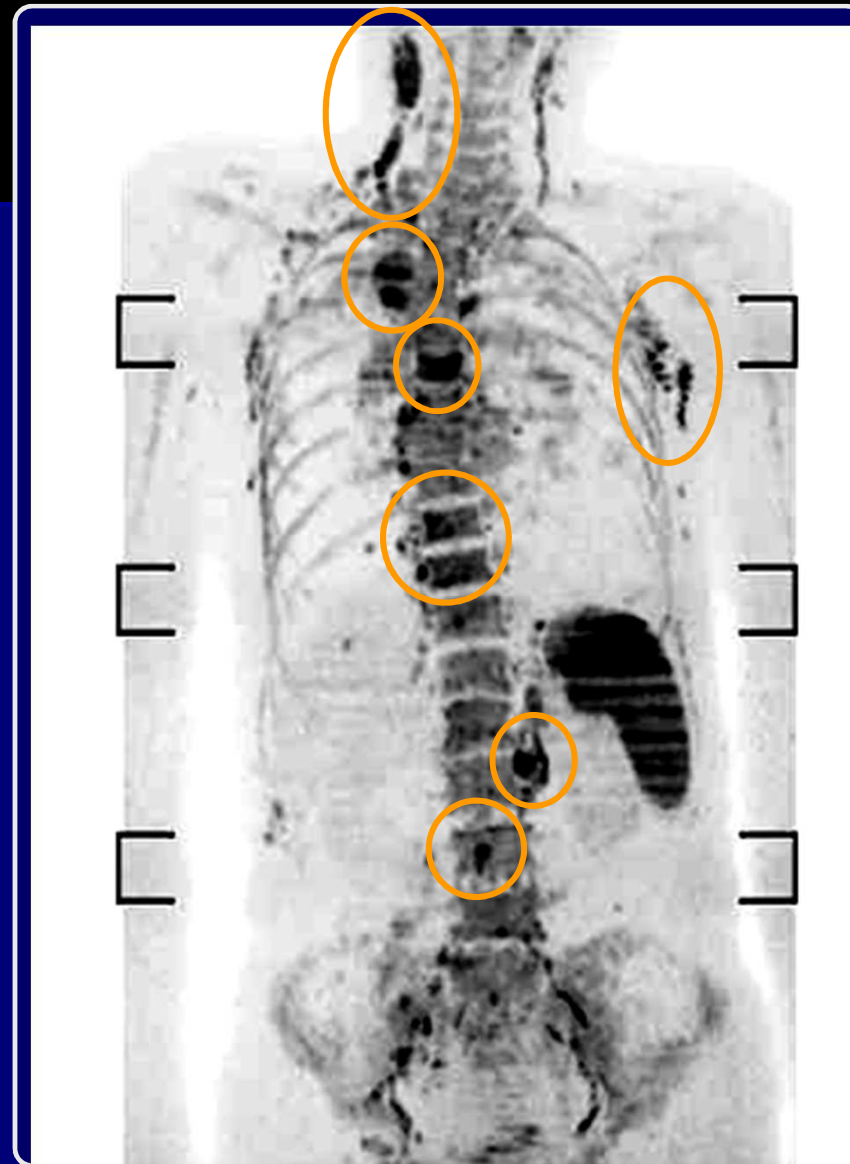
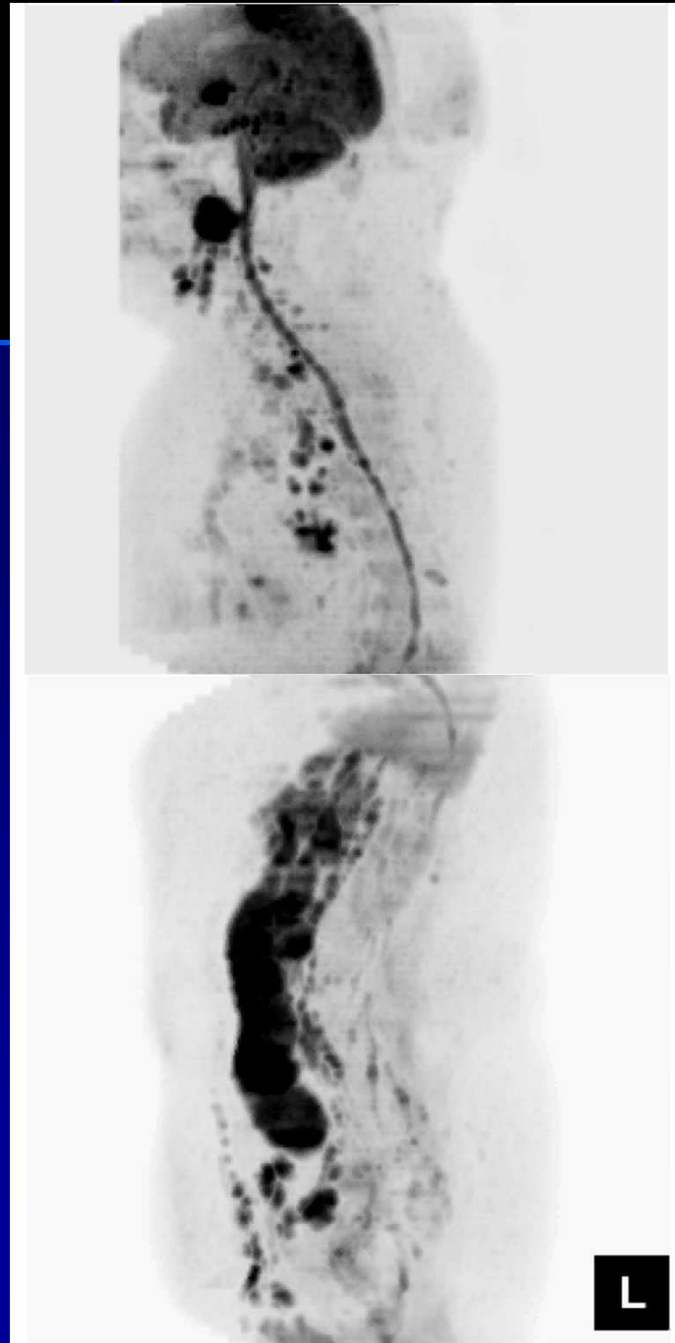
differentiation of ring enhancing cerebral lesions by diffusion weighted images, RSNA, Dec 2005.

Presence of vasogenic edema (NCC) vs Infective edema (Abscess / Koch's)

Prostate with Mets



DWI: Lymphography



MR- PET(DWIBS) vs. PET-CT

- No ionizing radiation, No Injections
- Fast (35 mns)
- Patient need not be motionless for 30 –45 mns like in PET.
- Less cost
- Better Accuracy !!?

MR PET vs PET CT

- **PET CT Scan:**
- Shows **Metabolic Activity**(FDG Utilization)
- Brown Fat to Brain: seen as hot spots.
- **All Hyper vascular lesions** Post radiation scar, Fibrosis, Post operative tissues show increased FDG uptake.

MR PET (DWIBS)

- Not metabolism related
- Intra and extra cellular water diffusion
- Cell membrane properties
- Ideal micro molecular pathogenesis for cancer detection and follow up.

Malignant tissues

- Nuclear properties Cytology
- Biochem/ Membrane MR SPECTRO DWI
- Regeneration properties Follow up
- Angiogenesis angiography
- Metabolic Activities PET CT

Tumor Response Before
Frank macroscopic changes like
size, shape
intensity hemorrhage etc.

- Chemotherapy
- Mitotic Arrest
- DNA fragmentation: 24-48hrs
- Cell shrinkage
- Increased Extra cellular Water
- Increased ADC
- MR PET hyper to lower

DWI in Tumor Follow UP

C. Asao, Y. Korogi, M. Kitajima, T. Hirai, Y. Baba, K. Makino, M. Kochi,
Diffusion-Weighted Imaging of Radiation-Induced **Brain Injury** for
Differentiation from Tumor Recurrence
AJNR Am. J. Neuroradiology., **June 1, 2005; 26(6): 1455 - 1460.**

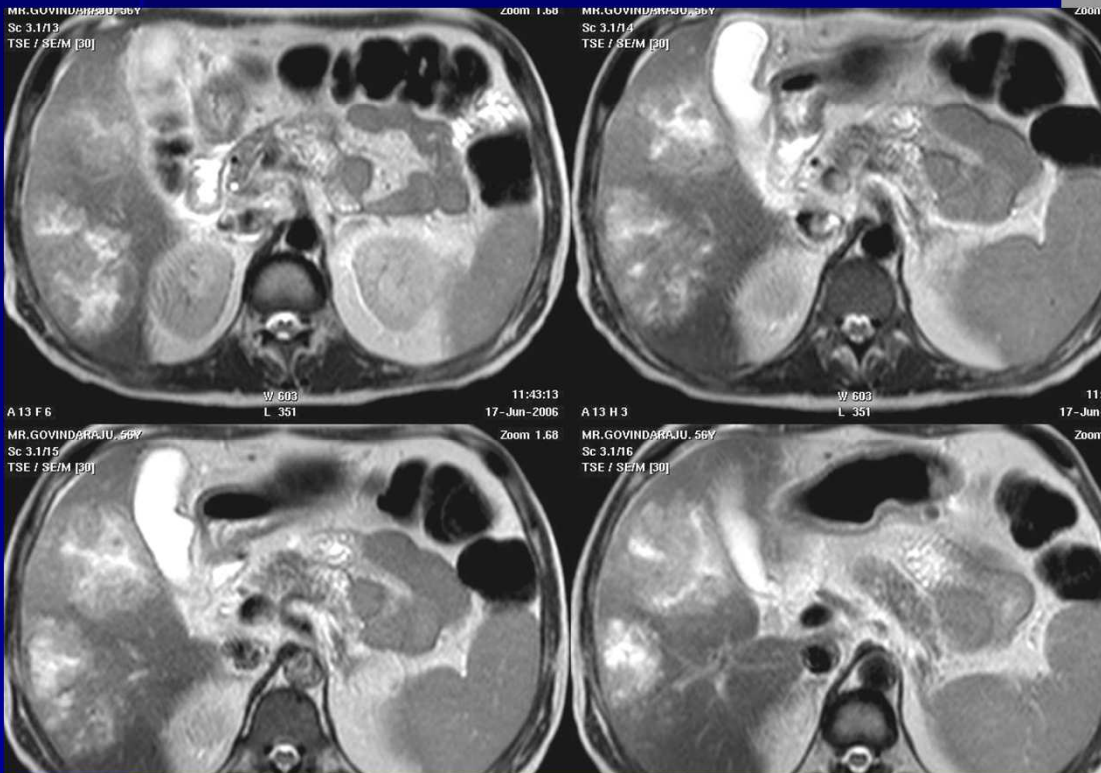
J. M. Provenzale, S. Mukundan, and D. P. Barboriak
Diffusion-weighted and Perfusion MR Imaging for Brain Tumor
Characterization and Assessment of **Treatment Response**
Radiology, June 1, 2006; 239(3): 632 - 649.

N. A. Butowski, P. K. Sneed, and S. M. Chang
Diagnosis and Treatment of Recurrent High-Grade Astrocytoma
J. Clin. Oncol., March 10, 2006; 24(8): 1273 - 1280.

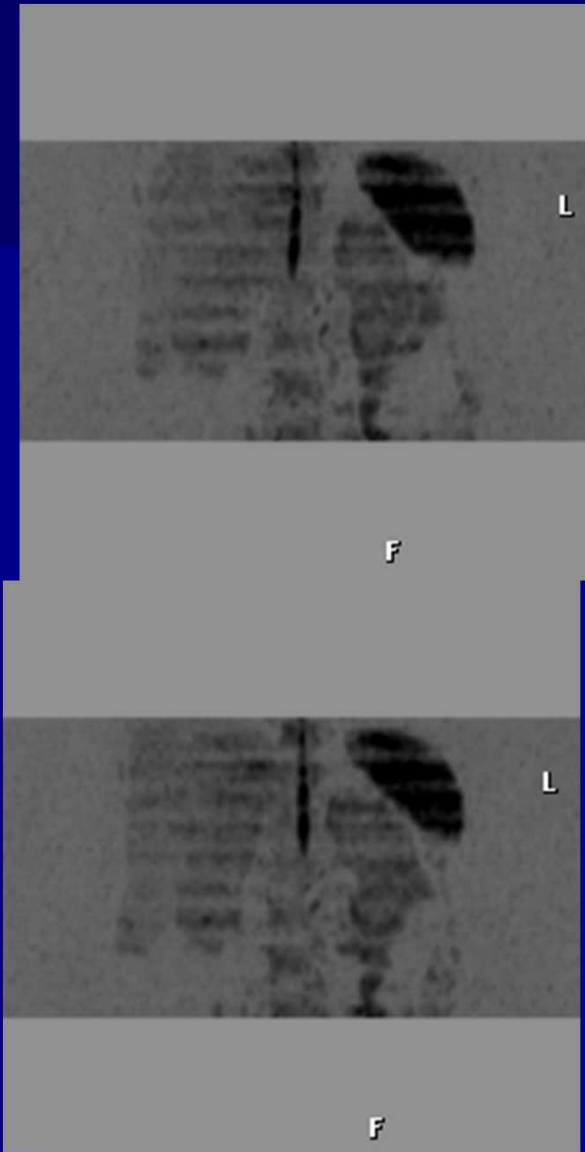
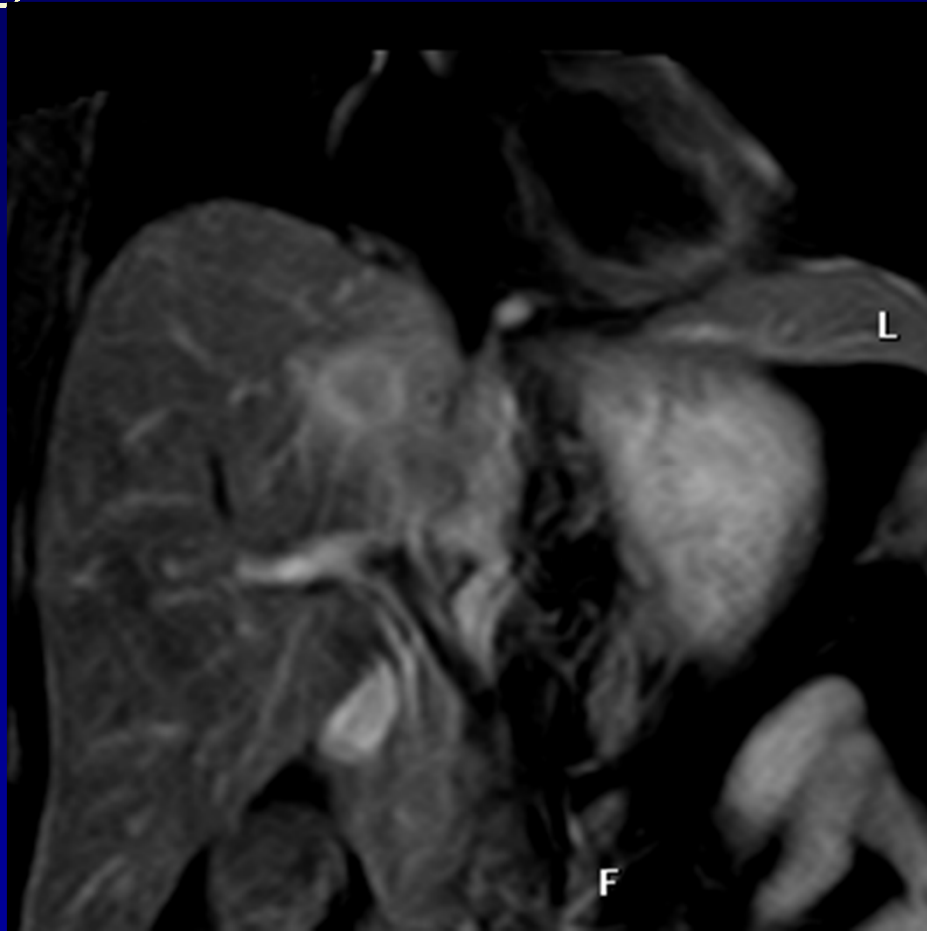
Diffusion Weighted Whole Body Imaging (DWIBS)

- **Ideal for:**
- Imaging tumors
- Immediate Follow Up
- Long term Follow up
- *Diffusion weighted whole body imaging with back ground Body Signal Suppression (DWIBS). Radiat Med.2004;22,4:275-282*

LIVER LESION:1 metastasis



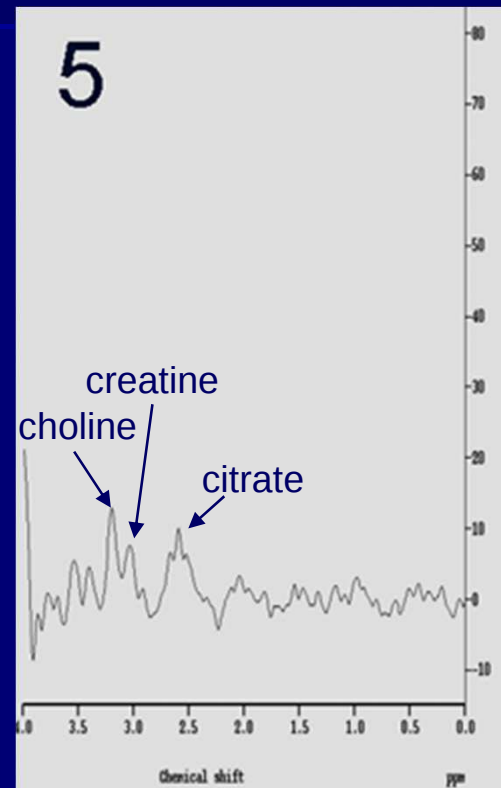
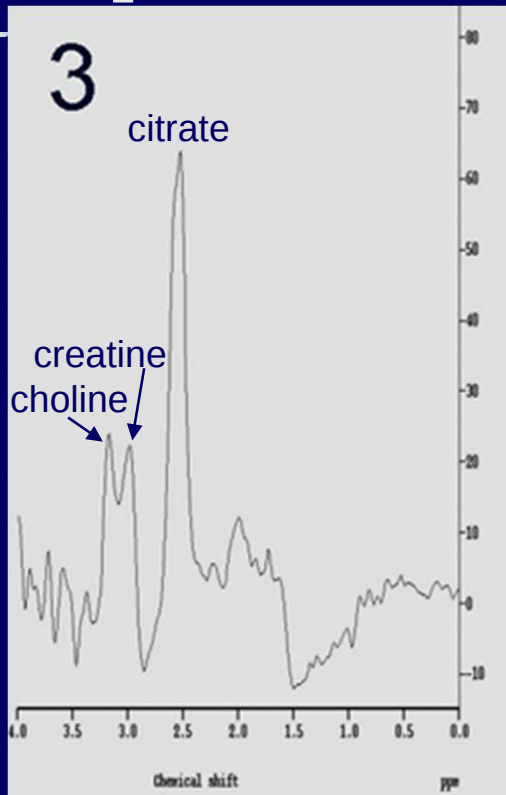
Liver lesion 2: Benign



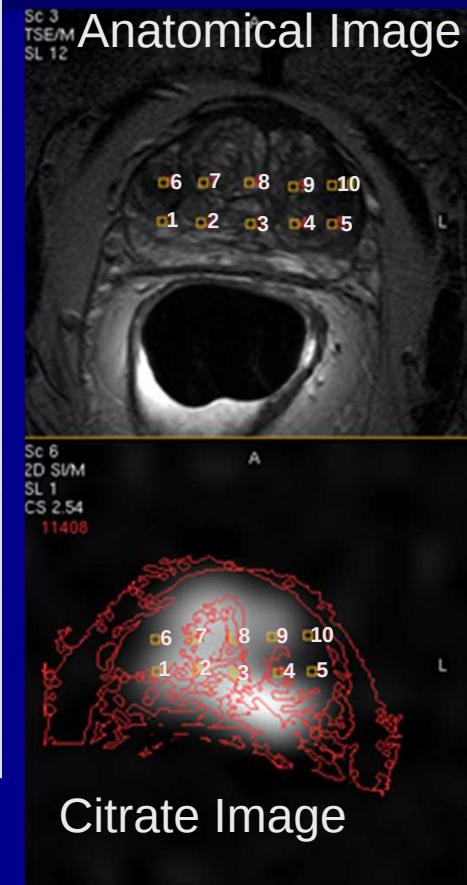
MR-Spectroscopy

- acquisition of spectra from small volumes (voxels) throughout the prostate gland
- detection of cellular metabolites
 - citrate in normal tissue and BPH
 - choline and creatine in tumor lesions

Prostate Spectroscopic Imaging

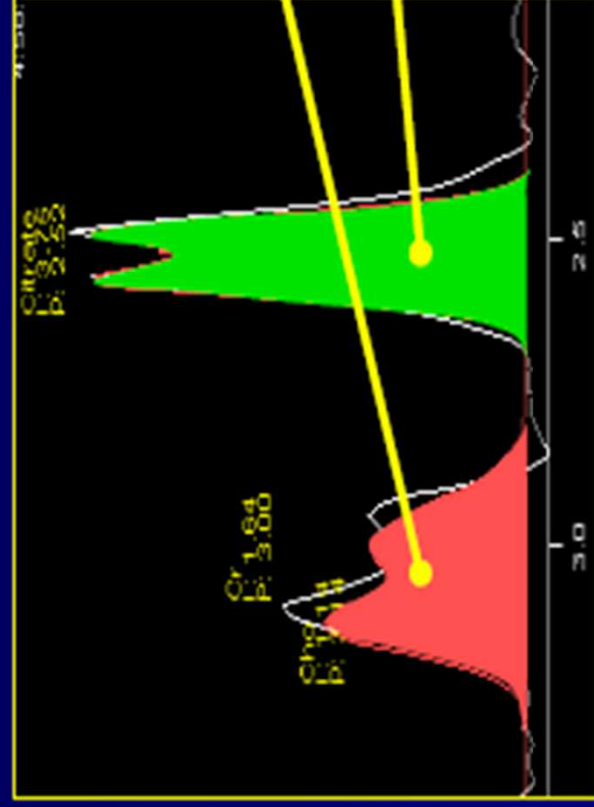


Voxel size: 0.64 cm³



MR-Spectroscopy

(Chol+Creat)/Citrate Ratio Images



Chol + Creat

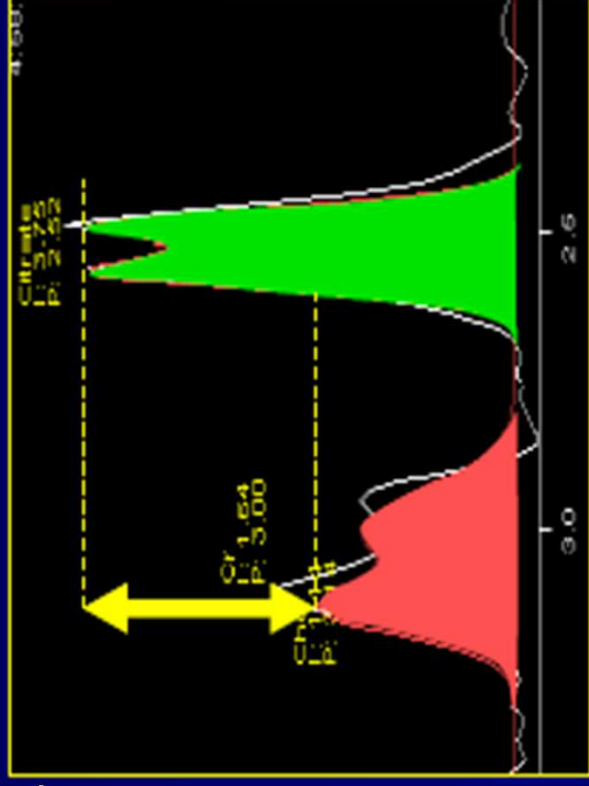
Citrate

Spectrum

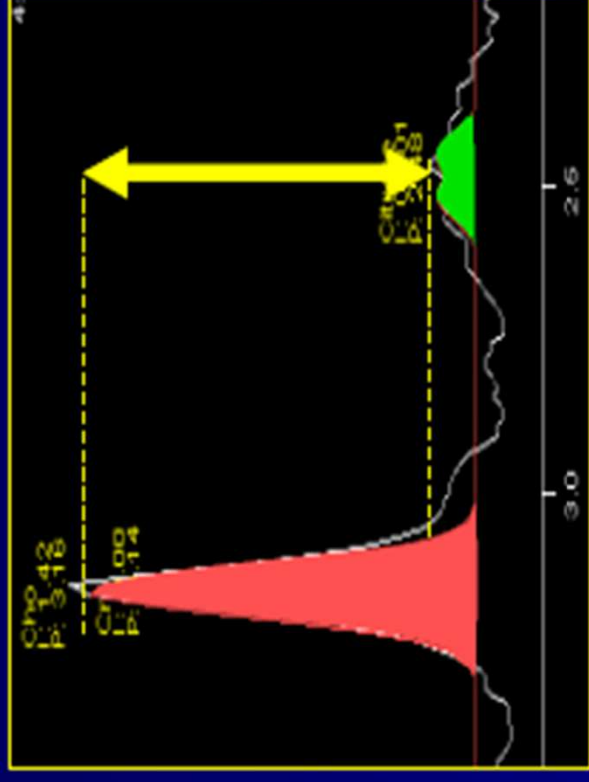
Index

MR-Spectroscopy

(Chol+Creat)/Citrate Ratio Images



Ratio in
Normal Prostate ↓



Ratio in
Prostate Cancer ↑

Diagnostic Accuracy of Ca Prostate

- MRI + MR DIFFUSION + SPECTROSCOPY

- 90-95%

- MUCH MORE THAN ANY
OTHER MODALITY

MR Prostate: Advantages

- No Radiation
- No contrast or Injections
- No Iodine side effects/ Nephro toxicity
- Imaging in Pregnancy,
- Children, Young Adults.

Radiation (micro Gy)

	marrow	Ovaries	Testis
KUB	500	2100	150
CT Abd	1700	180	170

COMMONLY ASKED ??

- WHY SHOULD I TAKE RADIATION RISK
- ANY ALTERNATE IMAGING MODALITIES
- WHY THE PHYSICIAN DID NOT SUGGEST IMAGING WITHOUT RADIATION RISK

MR PROSTATE ONE STEP EVALUATION

DIAGNOSIS: BENIGN vs malignant

**DYN Contrast Enhancement MR
MR DIFFUSION
Spectroscopy**

STAGING

- INTRA OR EXTRA CAPSULAR
- DIFFUSION STUDY OF WHOLE BODY TO DETECT METASTASIS IN
- LYMPH NODES
- BONES
- LIVER

FOLLOW UP

Thank You

mail or sms your comments

drbalashetty@gmail.com

99720-41394