Republic of Iraq
Ministry of Higher Education
Al-Mustaqbal University
Radiology Techniques Department
Second Stage \ Special Radiological Procedures-1

Lecture No. (9)

Magnetic Resonance of the Urinary Tract

By

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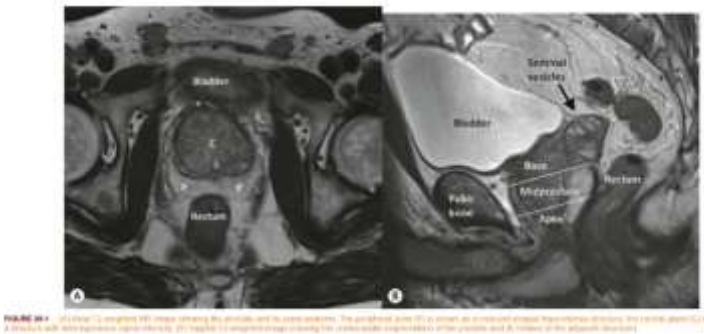
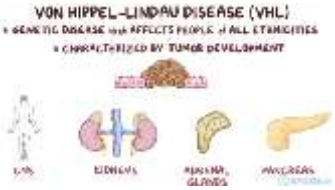
Magnetic Resonance Urinary Tract

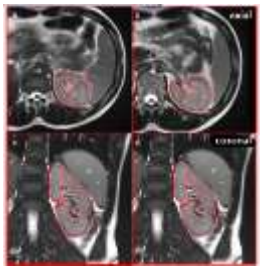
Indications



1. Local staging of prostatic cancer
2. Local staging of bladder cancer
3. Staging of pelvic lymph nodes
4. Renal mass
5. Screening of patients with von Hippel–Lindau disease or their relatives, or other genetic conditions



6. MR urography where i.v. or CT urography contraindicated
7. MR angiography: potential living related donors, suspected renal artery stenosis

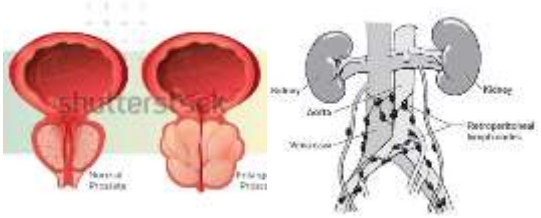


Technique

Technique will be **tailored to the clinical indication**.

***MR of the **kidneys** and **upper abdomen** will generally include T1 and T2 weighted sequences in **axial** and coronal planes with **or** without fat saturation; with pre- and postcontrast T1 weighted imaging at 30 and 70 s.

*MRI of the **abdomen** and **pelvis** can be **obtained to assess** retroperitoneal lymphadenopathy as part of the **staging investigations** for patients with **bladder** and **prostate cancer**, but CT is **often used for this purpose** with **MRI reserved for** local staging.



Magnetic Resonance Imaging of the Prostate

Technique/Example Protocol

1. *Patient supine. *Phased array body coil. *The best images will be obtained with an endorectal coil, but many authorities do not use these. *1.5T or 3T scanners are both used. *3T scanners afford better signal-to-noise ratio, *but may be **subject** to more artifacts—notably susceptibility.

2. ***Antiperistaltic drugs** (hyoscine butyl-bromide (Buscopan) or glucagon are recommended)

3. *T1W and T2W axial scans **whole pelvis**

4. *Thin-section (3–4 mm) ***small field of view** *T1-weighted spin echo (SE) scans in ***axial plane** *orthogonal* to the axis of the **prostate** to evaluate for postbiopsy haemorrhage

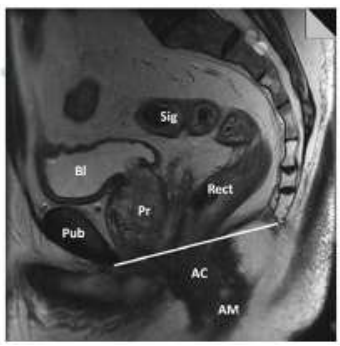
5. *Thin-section (3–4 mm) ***small field of view** *T2-weighted SE scans in* transverse (**axial**), *sagittal and *coronal **planes** *orthogonal* to the axis of the **prostate.**

6. ***Multiparametric MRI**—there is **increasing use** of the following functional studies:

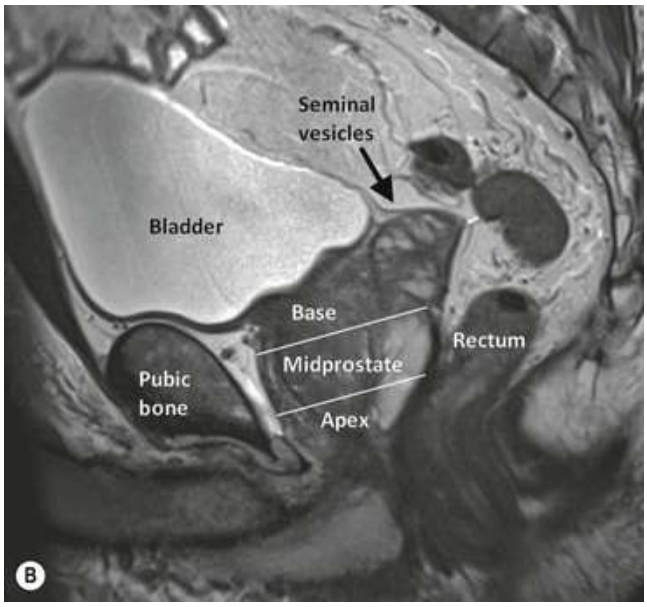
(a) ***Diffusion weighted imaging** **b values** 0, 100 and 800–1400 s mm−2 with **apparent diffusion coefficient** (ADC) map

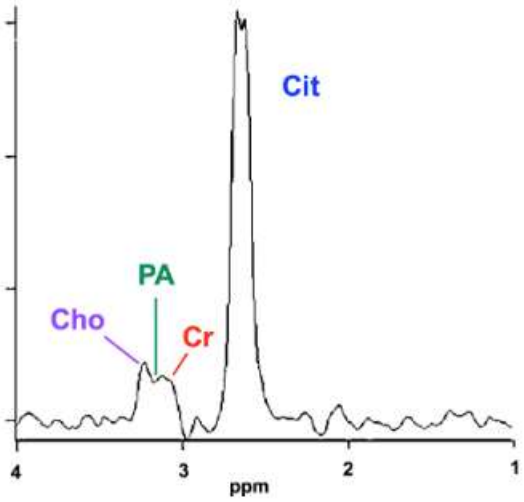
(b) ***Dynamic contrast-enhanced** (DCE) T1W imaging

(c) ***MR spectroscopy**—citrate, creatine, choline

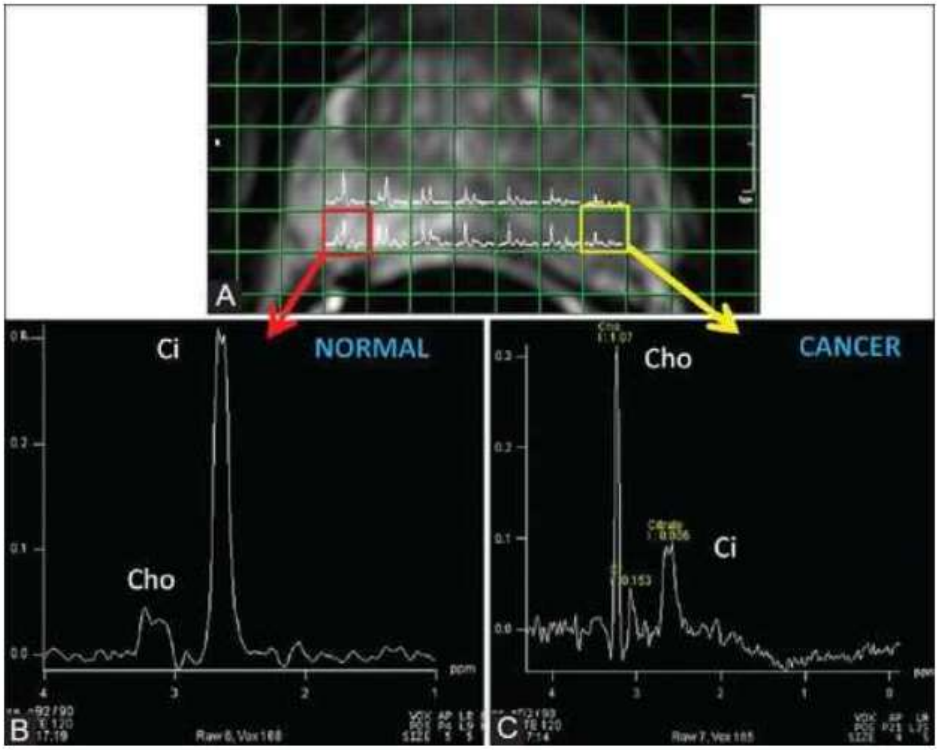


Sig	Sigmoid colon
Rect	Rectum
AC	Anal canal
AM	Anal margin
Pr	Prostate
Bl	Bladder
Pub	Pubis





^{1}H-spectrum of normal prostate at 3.0T. Slight notching of the dominant citrate (Cit) peak at $\delta = 2.6$ ppm is noted. Other resonances include choline (Cho, 3.2 ppm), creatine (Cr, 3.0 ppm), and polyamines (PA, 3.1 ppm)



^{1}H-MRS showing a normal spectrum on the right side of the prostate and cancer on the left. Note the decrease in citrate (Ci) and elevation of choline (Cho) in the cancerous side, with a Jung score = 5. Decrease in polyamines (PA) in cancer also allow better separation of the Cho and Cr peaks to be appreciated. (Modified from Sharma 2014, under CC BY license)

Magnetic Resonance Urography

Indications

1. To demonstrate the collecting system/determine level of obstruction in **a poorly functioning/obstructed kidney**

2. Urinary tract obstruction **unrelated** to urolithiasis. *Suspected renal colic from **underlying calculus** is **better imaged** with CT KUB.

3. Congenital anomalies

4. Renal transplant donor assessment (combined with MR angiography)

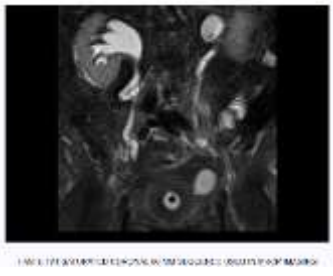
Technique

The two most common MR urographic techniques are:

• **Static fluid-sensitive urography** using heavily T2-weighted MRI techniques to **visualize fluid-filled structures** (**equivalent** to magnetic resonance cholangiopancreatography [MRCP])

• **excretory MR urography** using T1-weighted sequences **post gadolinium** enhancement:

1. *Patient supine *with an **empty bladder for comfort**. *If the bladder is of interest, a moderately full bladder may be preferred.



2. ***Scout views** are obtained.

3. ***Static MR urography** may be performed prior to **excretory urography**. Thick-slab, single-shot, fast-spin echo or a **similar thin-section technique, e.g. half-Fourier rapid acquisition with relaxation enhancement**; single-shot, fast-spin echo; single shot, turbo-spin echo.

*(Breath-hold very fast spin echo (e.g. half Fourier acquisition single shot turbo spin echo [HASTE])

*3D respiratory triggered sequences may be used to obtain thin section data sets that may be further postprocessed.

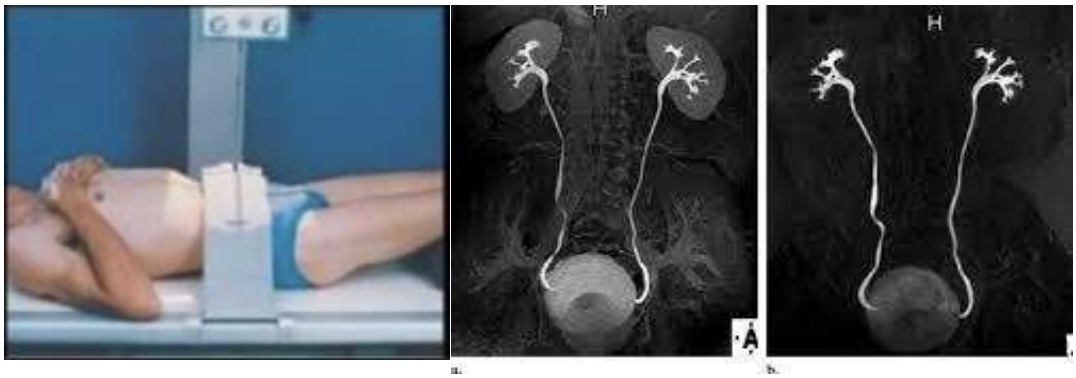
4. ***Oral or i.v. hydration**, **compression** or **diuretics** may be used to enhance collecting system distension.

5. ***Excretory MR urography**: a gadolinium-based contrast agent is **administered** i.v. using a *dose of 0.1 mmol gadolinium kg−1 body weight.

*The **collecting systems** are imaged during the **excretory phase** (10–20 min) using a breath-hold, 3D gradient echo, T1-weighted sequence.

*Fat suppression will improve the **conspicuity** of the ureters.

- T2* **effects** from a high concentration of contrast agent may **reduce** the **signal intensity of urine** and potentially obscure small masses **within the collecting system**. This can be **overcome** by using a lower volume of i.v. contrast **but** may **compromise soft-tissue imaging**.



Magnetic Resonance Imaging of Adrenals

Indications

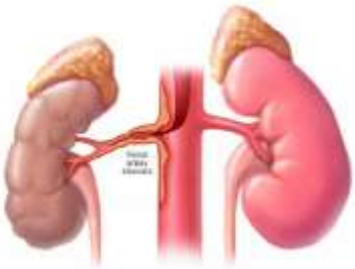
Characterization of adrenal mass.

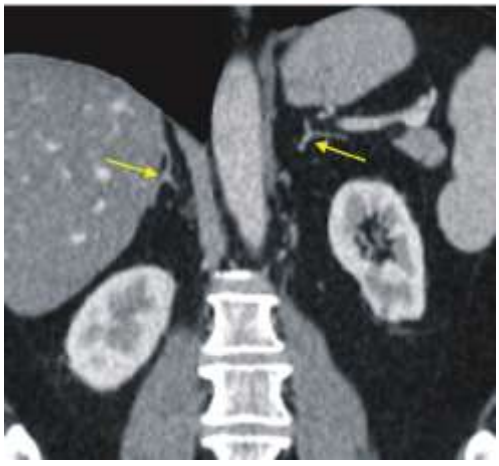
Technique

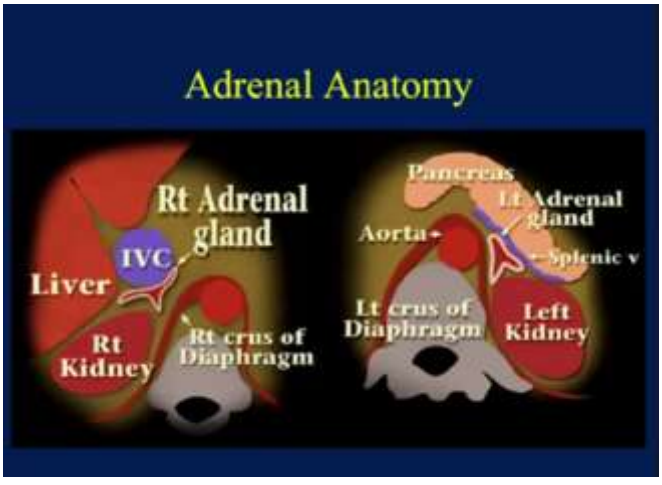
***Chemical shift imaging**: based on a *high proportion of intracellular lipid causing alteration of the local magnetic environment within the **voxel** and hence **resonant frequency of protons**.

Lipid-rich benign adenomas can be shown to lose signal on **opposed phase T1W** imaging compared with **in-phase studies (MRI)**. This is highly specific. **Alternatively**, *unenhanced CT can be **used to characterize an adrenal mass as malignant**, **or

18-F fluorodeoxyglucose positron emission tomography (18-F FDG-PET) can be **used to characterize an adrenal mass as malignant.*







Q1-The imaging technique is commonly used for excretory MR urography to demonstrate the collecting systems is

A. 3D gradient echo, T1-weighted sequence

B. 4D dual-echo, T2-weighted sequence

C. Single-shot, turbo-spin echo

D. Half-Fourier rapid acquisition with relaxation enhancement

E. Diffusion weighted imaging and MR spectroscopy

Q2-If the CT urography contraindicated, ... must be performed

A. Plain film B. IVU C. PET D. MR urography E. None of the above

Q3-Which of the following is a type of magnetic resonance imaging used for

characterization of renal lesions

A. MR prostate B. MR bladder C. MR urography D. MR adrenals E. None above

Q4-In excretory MR urography, which of the following factors most improves the visualization of the ureters using a gadolinium-based contrast agent and a T1-weighted sequence?

A. Administering a higher dose of the contrast agent

B. Extending the scan duration beyond the excretory phase

C. Switching to a fat-suppression technique

D. Employing a breath-hold technique instead of free breathing

E. Switching to a T2-weighted sequence

Q5-What is the optimal timing of pre- and postcontrast T1 weighted imaging in MR urinary tract.

A. Precontrast at 10 s and postcontrast at 50 S B. Precontrast at 20 s and postcontrast at 60 S

C. Precontrast at 30s and postcontrast at 70 S D. Precontrast at 40 s and postcontrast at 80 S

E. Precontrast at 50 s and postcontrast at 90 S

Q6-MRI of the kidneys and upper abdomen generally includes all of the following except.

A. T1 and T2 weighted sequences B. Axial and coronal planes

C. With or without fat saturation D. Pre- and postcontrast T2 weighted

E. At 30 and 70 s

Q7-What is the advantage of using a phased array body coil over an endorectal coil for MRI of the prostate?

A. It provides higher spatial resolution and contrast

B. It provides lower signal-to-noise ratio and artifacts

C. It provides better patient comfort and compliance

D. It provides faster scan time and coverage E. To enhance the contrast and brightness

Q8-The three functional studies that are used in multiparametric MRI of the prostate are

A. Diffusion weighted imaging, dynamic contrast-enhanced imaging, and MR spectroscopy

B. Diffusion tensor imaging, dynamic susceptibility contrast imaging, and MR elastography

C. Diffusion kurtosis imaging, dynamic perfusion imaging, and MR angiography

D. Diffusion spectrum imaging, dynamic phase contrast imaging, and MR thermometry

E. None of the above

Q9-What MRI sequence is typically used to evaluate post-biopsy hemorrhage

A. T1-weighted spin echo (SE) sequence

B. T2-weighted spin echo (SE) sequence

C. Diffusion weighted sequence

D. Dynamic contrast-enhanced (DCE) T1W sequence

E. Heavily T2-weighted sequence

Q10-Which imaging modality is commonly used for assessing retroperitoneal lymphadenopathy in the staging investigations of patients with bladder and prostate cancer ?

A. MRI of the abdomen and pelvis

B. CT scan of the abdomen and pelvis

C. Ultrasound of the abdomen and pelvis

D. PET-CT scan of the abdomen and pelvis

E. X-ray of the abdomen and pelvis

Q11-The indications MR urography include all the following except

A. Urolithiasis B. Urinary tract obstruction

C. demonstrate the collecting system D. Renal transplant donor assessment

E. Congenital anomalies

Q12-In MRI of the prostate, a thin-section ..... small field of view T1-weighted spin echo (SE) scans in axial plane orthogonal to the axis of the prostate is used to evaluate for post biopsy hemorrhage

A. 3-4 mm B. 4-5 mm C. 0.6-1 mm D. 5-6 mm E. 1-2 cm

Q13-The functional study included in multipara metric MRI prostate is

A. T2 B. SPIR C. DWI D. TI E. FLAIR

Q14-What is the purpose of using Antiperistaltic drugs before MRI of the prostate

A. To reduce the bowel motion and distortion

B. To increase the bowel distension and opacification

C. To enhance the bowel contrast and differentiation

D. To improve the bowel function and clearance

E. None of the above

Q15-The MRI sequence that is most commonly used to visualize the fluid-filled structures of the entire urinary tract (kidneys, ureters, bladder) is

A. T2-weighted spin echo (SE) sequence

B. Static fluid-sensitive urography using heavily T2-weighted sequence

C. 3D gradient echo, 3D gradient echo, T1-weighted sequence

D. T1-weighted sequences post gadolinium enhancement

E. T1-weighted sequences post gadolinium enhancement

Q16-What are the alternative imaging modalities that can be used to characterize an adrenal mass as malignant

A. Unenhanced CT and 18-F FDG-PET B. Contrast-enhanced CT and 18-F FDG-PET

C. Unenhanced CT and 18-F DOPA-PET D. Contrast-enhanced CT and 18-F DOPA-PET

E. Unenhanced CT and 18-F FLT-PET

Q17-What is the characteristic finding on opposed phase T1-weighted imaging in chemical shift imaging for lipid-rich benign adenomas

A. Increased signal intensity compared to in-phase studies

B. Decreased signal intensity compared to in-phase studies

C. No change in signal intensity compared to in-phase studies

D. Loss of signal intensity in adjacent tissues

E. Loss of signal intensity in the lipid-rich benign adenoma itself

Q18-In MR urography, the collecting systems are imaged during the excretory phase (10-20 min) using a

A. Breath-hold B. 3D gradient echo C. T1-weighted sequence

D. Fat suppression will improve the conspicuity of the ureters E. All of the above