National Rehabilitation Hospital




Renal Ultrasound

(Basic Principles)

BMUS Study Day

Rosie Conlon

Clinical Specialist Sonographer

NATIONAL REHABILITATION HOSPITAL

Dun laoghaire, Dublin **Sat 15th October 2016**

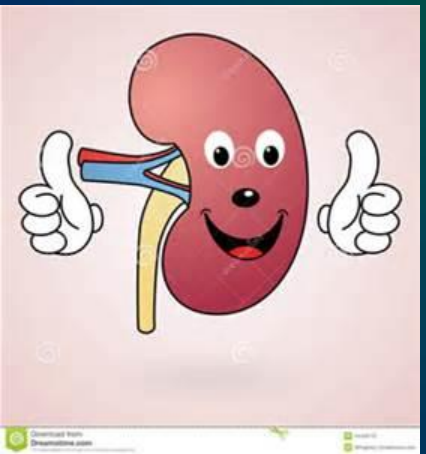
WHY?

"Bones can break, muscles can atrophy, glands can loaf about and even the brain can sleep without immediate danger to survival. BUT when the kidneys fail…. Neither bone, muscle gland nor brain could carry on."

Homer William Smith,
"*The Evolution of the Kidney*", *Lectures on the Kidney* (1943).

Preparation

- 500mls 1 hour before, avoiding micturition.
- Catheter clamped 1.5 hours before.
- Fluids by PEG 1.5 hours before.



- Operator Dependant
- Real Time
- Reproducible
- Non-invasive
- Inspiration

WHAT? - PROTOCOL

- Both Kidneys
- Urinary Bladder
- +/- Residual Volume
- Pelvic Surveillance
- Aorta
- Local protocol pertinent to the population
- Full bladder

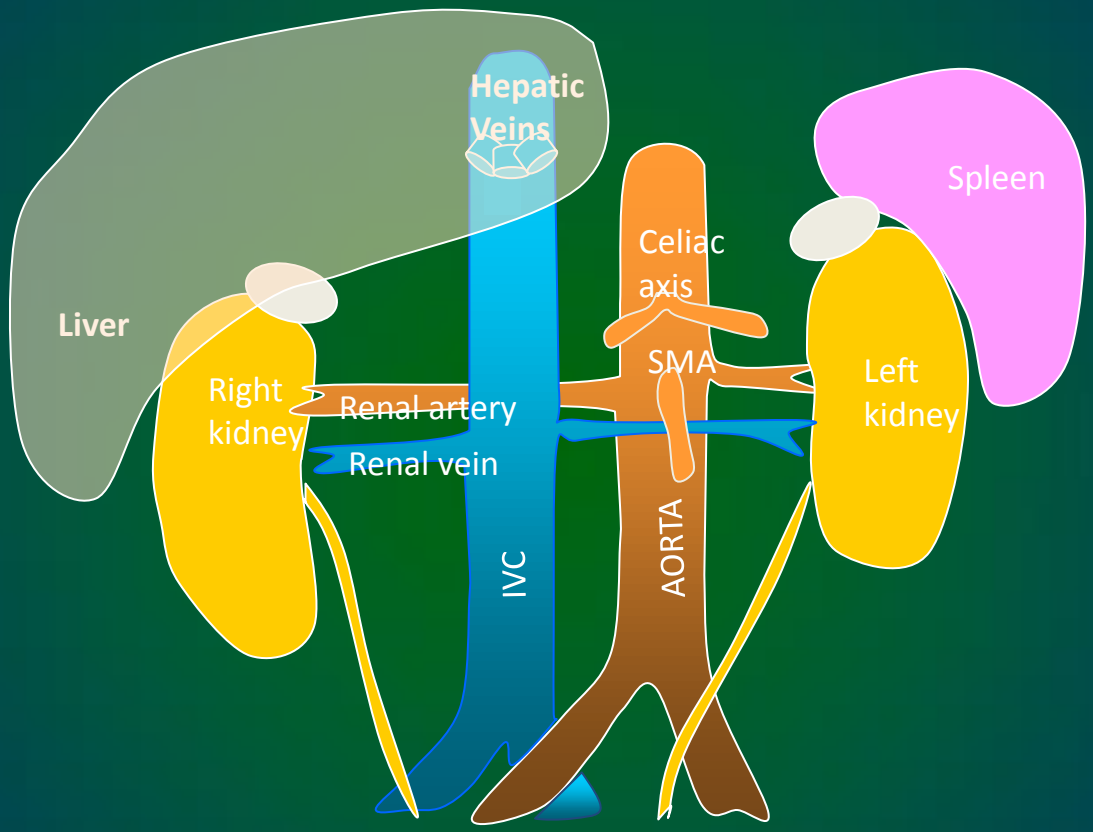
The most important step in diagnosis is realising that it might exist.

Right Kidney-Technique

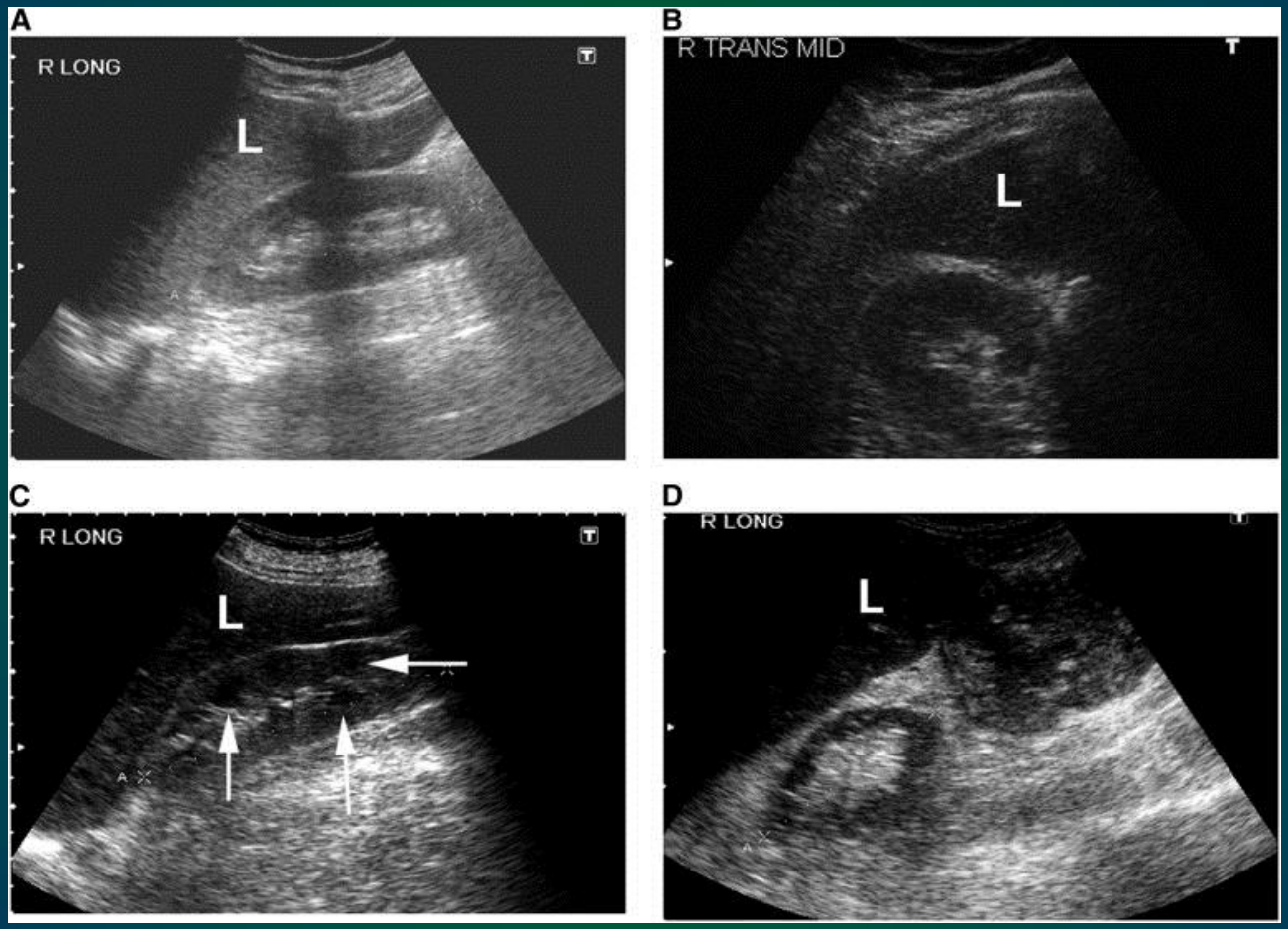
- A 3.5-5 MHz probe is typically used to scan the kidney. For the right kidney, have the patient lie supine and place the probe in the right lower intercostal space in the midaxillary line. Use the liver as your "acoustic window" and aim the probe slightly posteriorly (toward the kidney). Gently rock the probe (up and down or side to side) to scan the entire kidney. If needed, you can have the patient inspire or exhale, which allows for subtle movement of the kidney.

- Obtain longitudinal (long axis) and transverse (short axis) views.

ANATOMY


Hepatic Veins
Spleen
Celiac axis
Liver
SMA
Left kidney
Right kidney
Renal artery
Renal vein
IVC
AORTA

NORMAL

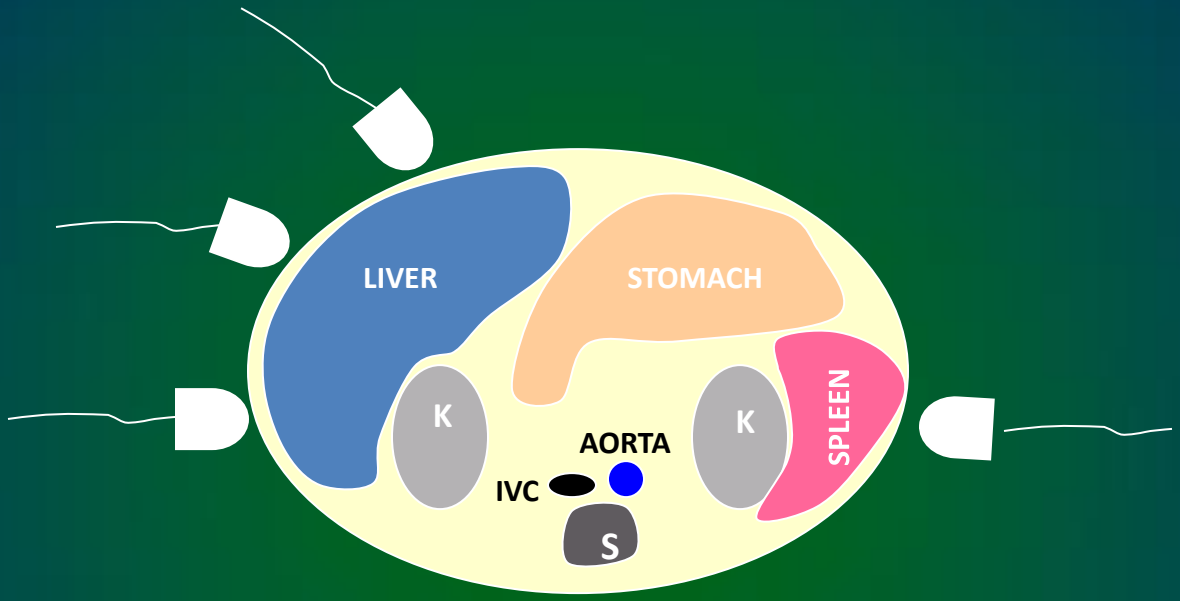


Left Kidney-Technique

- For the left kidney have the patient lie supine or in the right lateral decubitus position. Place the probe in the lower intercostal space on the posterior axillary line. The placement will be more cephalad and posterior than when visualizing the right kidney. Again gently rock the probe to scan the entire kidney.

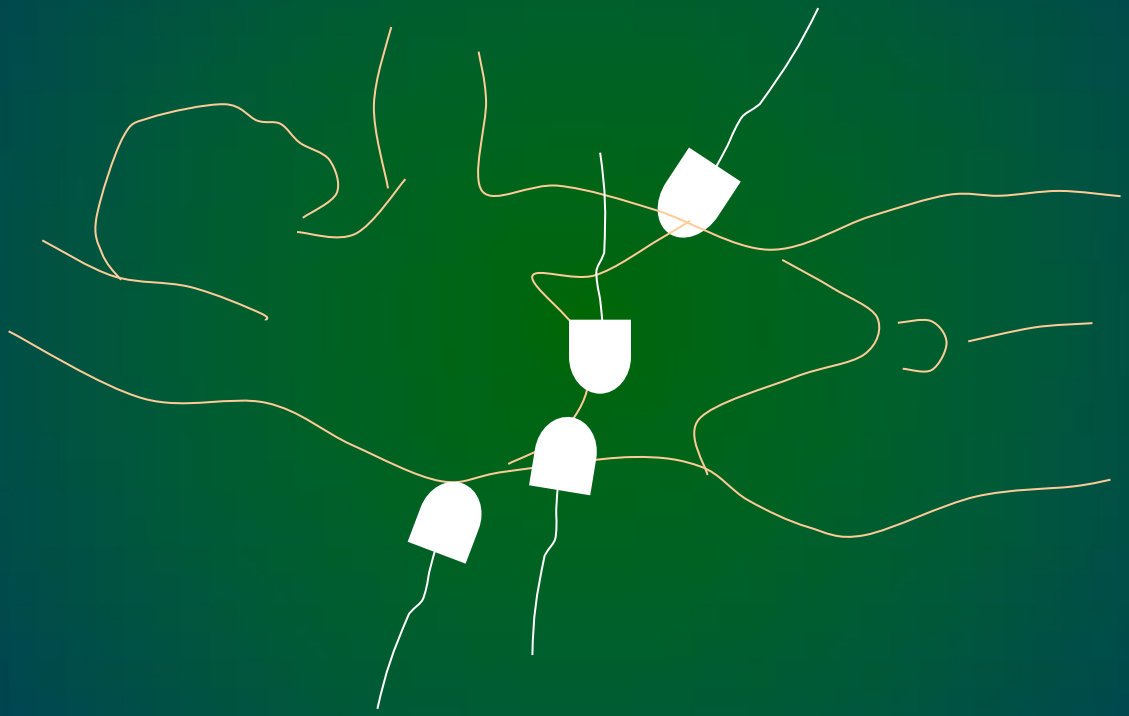
- Obtain longitudinal and transverse views

Approach to Scanning



- Right kidney scanning approach: anterior, lateral, posterior
- Liver is the acoustic window
- Left kidney: requires a posterior approach, through the spleen
- Air-filled bowel impedes anterior scanning

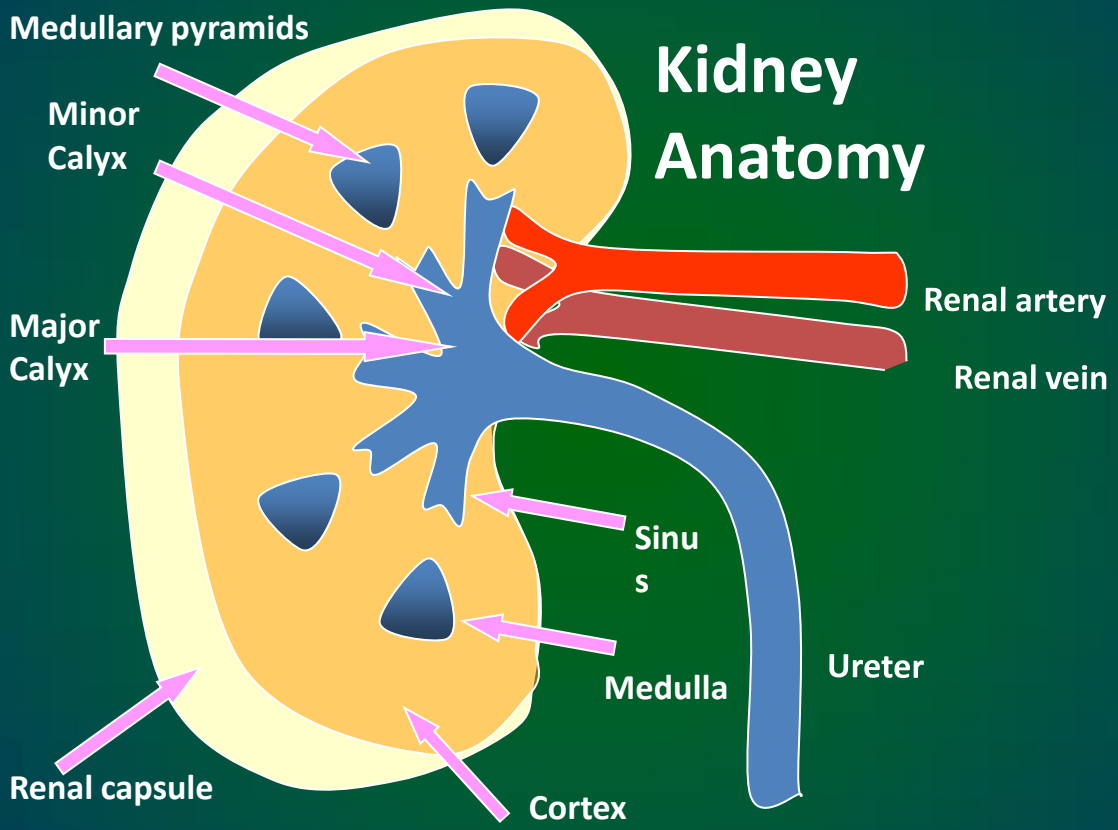
Renal Scanning Approaches



Normal Anatomy

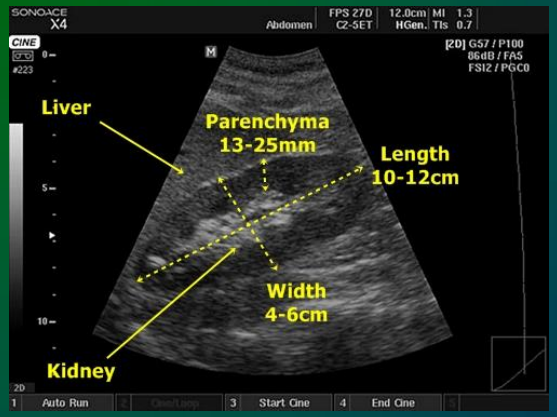
- 9-12 cm long, 4-5 cm wide, 3-4 cm thick
- Gerota's fascia encloses kidney, capsule, perinephric fat
- Sinus
  - Hilum: vessels, nerves, lymphatics, ureter
  - Pelvis: major and minor calyces
- Parenchyma surrounds the sinus
  - Cortex: site of urine formation, contains nephrons
  - Medulla: contains pyramids that pass urine to minor calyces. Columns of Bertin separate pyramids

Normal Anatomy

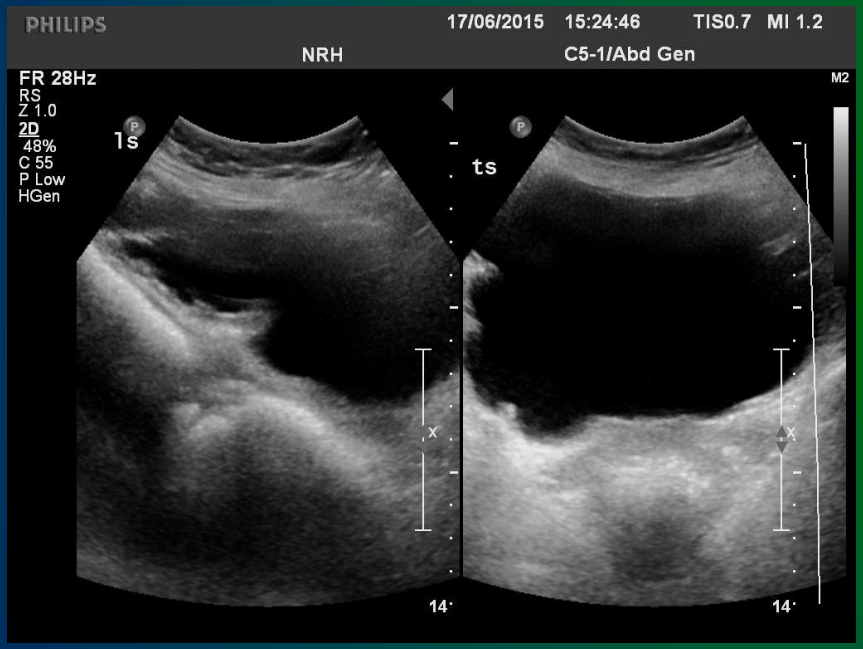


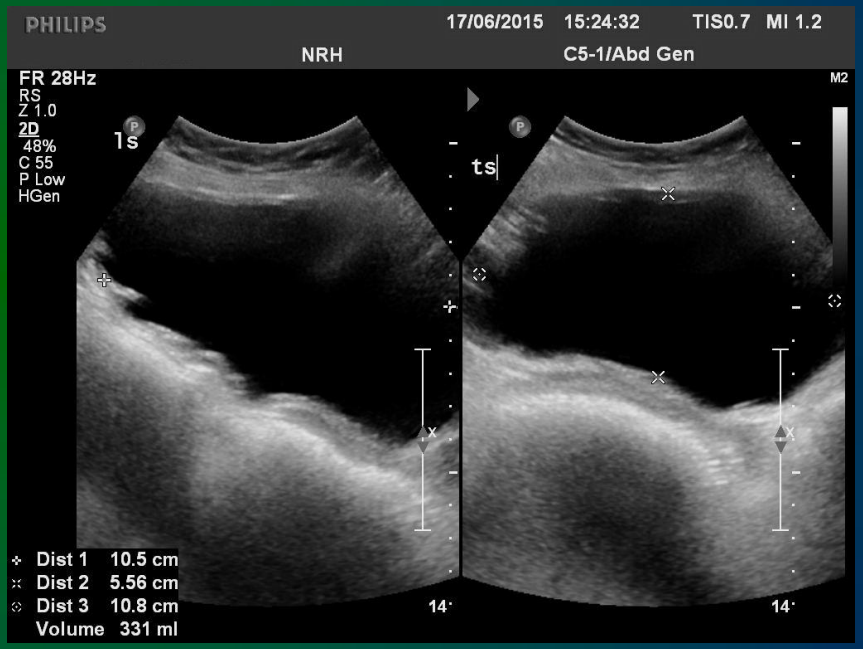
Normal Anatomy

- Kidneys are retroperitoneal, T12 - L4
- Right kidney is lower than the left kidney
- Right kidney is posterio-inferior to liver & gallbladder
- Left kidney is inferior-medial to the spleen
- Adrenal glands are superior, anterior, medial to each kidney

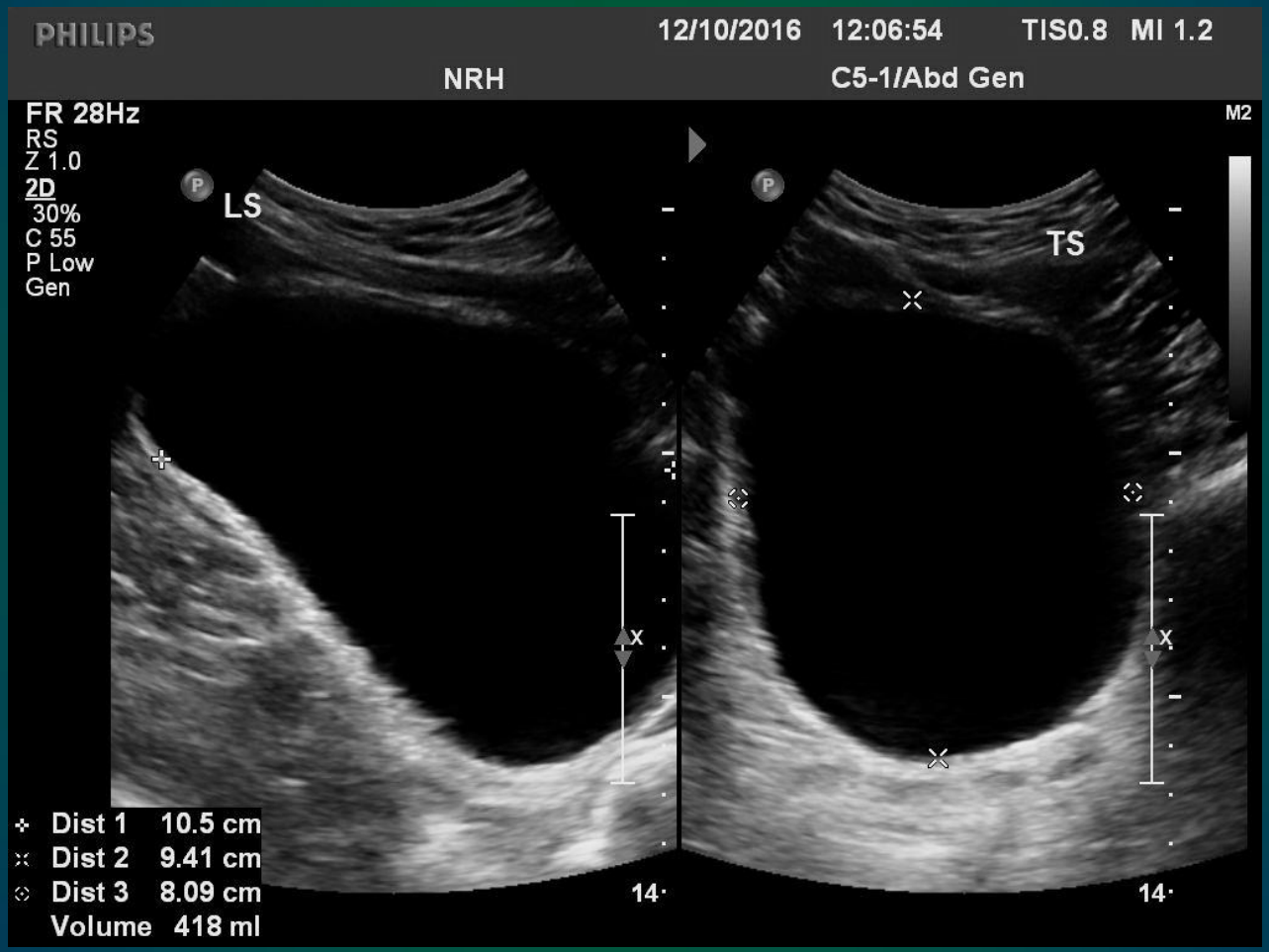


Thickened Bladder Wall

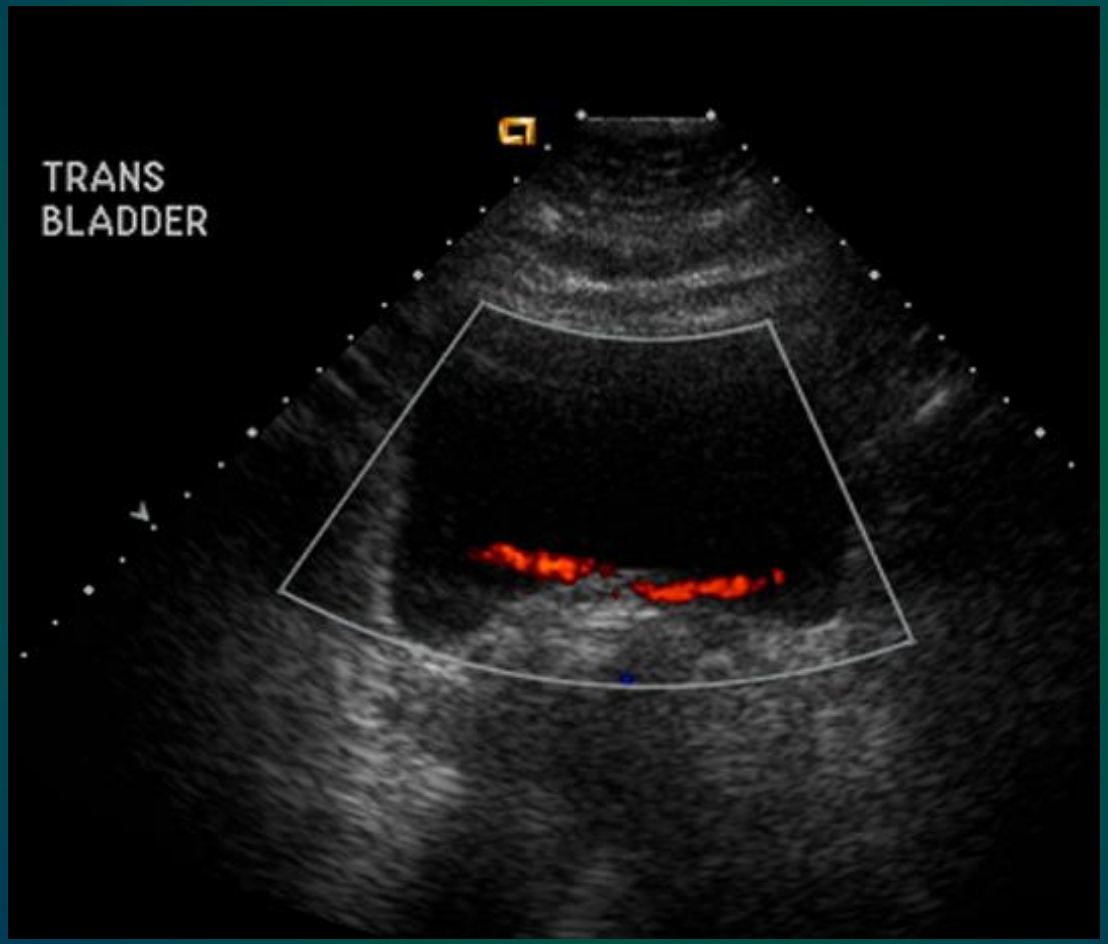




Bladder Volume

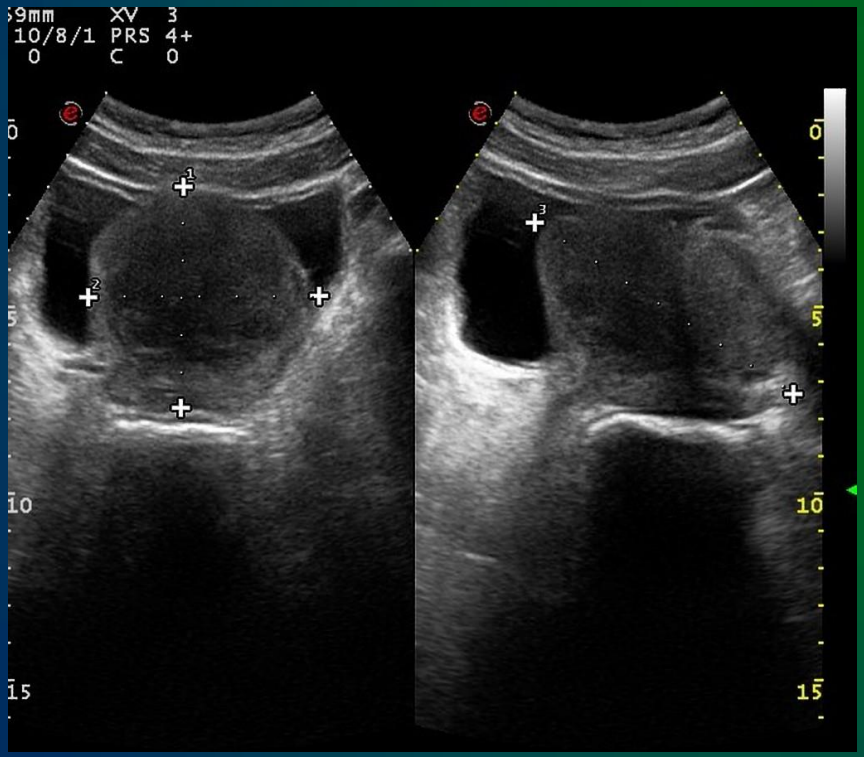


Ureteric Jets

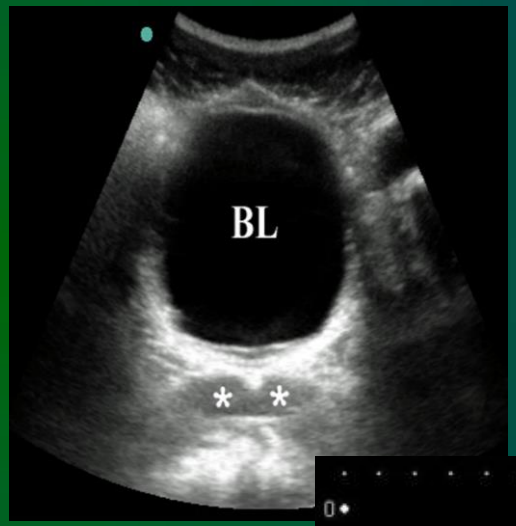


Male Anatomy

Prostate Gland



Seminal Vesicles

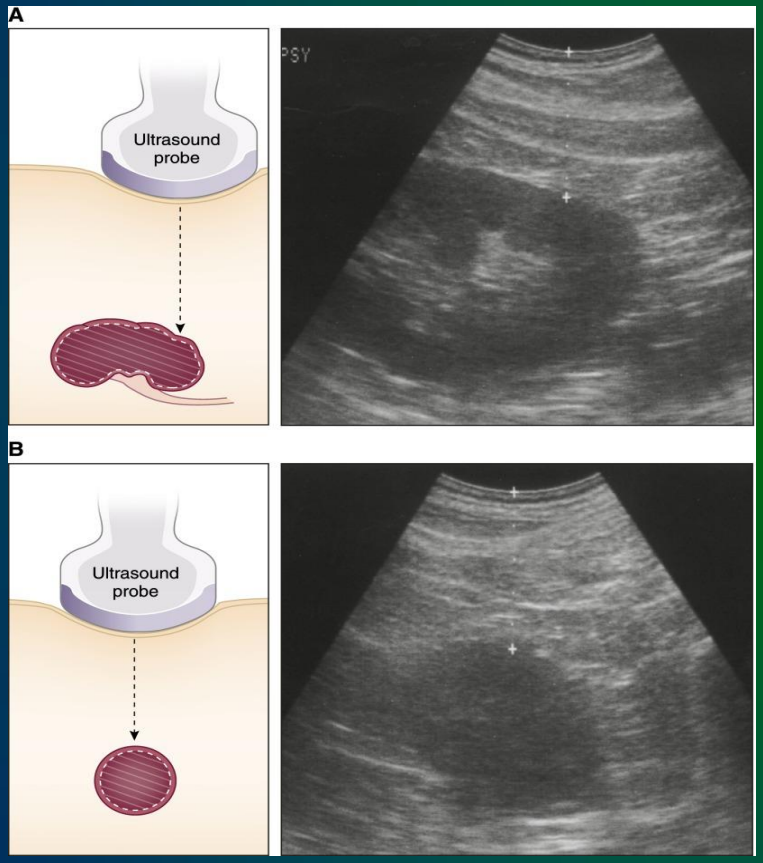


Over-Hydration

Pre-Micturition

Post Micturition

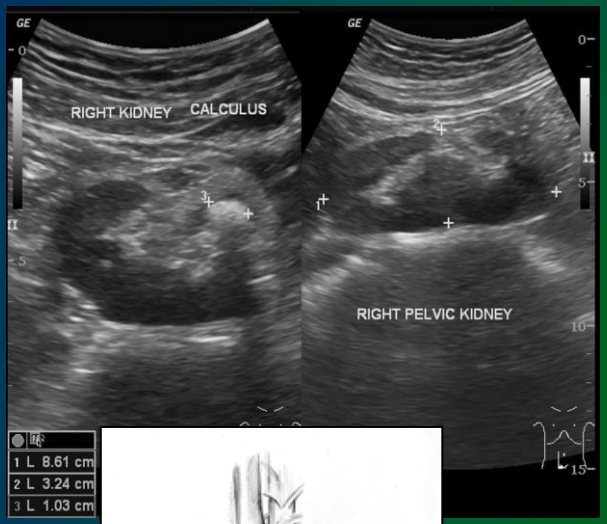
INTERVENTIONAL

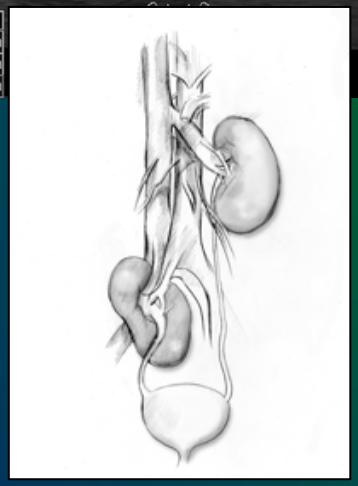


VARIANTS

- **Dromedary humps:**
  - Lateral kidney bulge, same echogenicity as the cortex
- **Hypertrophied column of Bertin:**
  - Cortical tissue indents the renal sinus
- **Double collecting system:**
  - Sinus divided by a hypertrophied column of Bertin
- **Horseshoe kidney:**
  - Kidneys are connected, usually at the lower pole
- **Renal ectopia:**
  - One or both kidneys outside the normal renal fossa

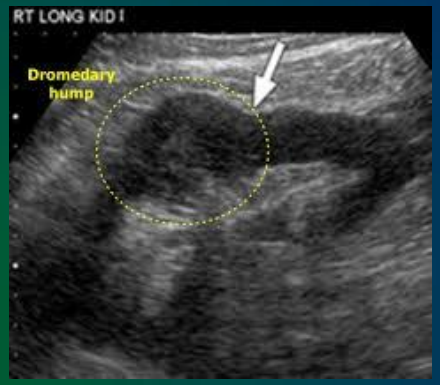
VARIANTS

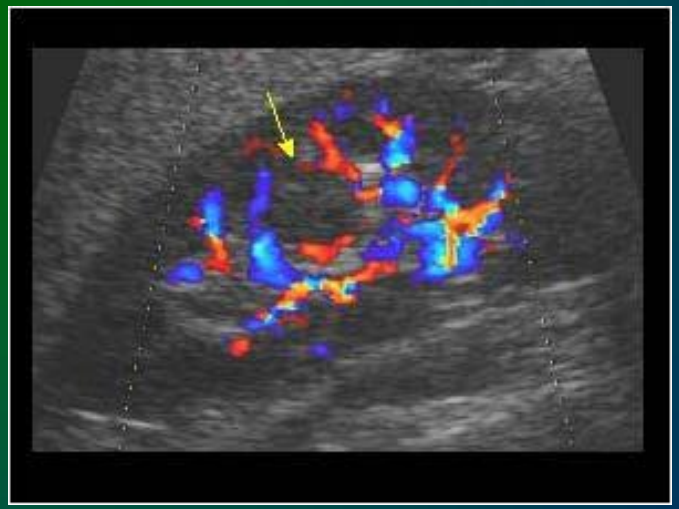




Pelvic Kidney

Dromedary Hump





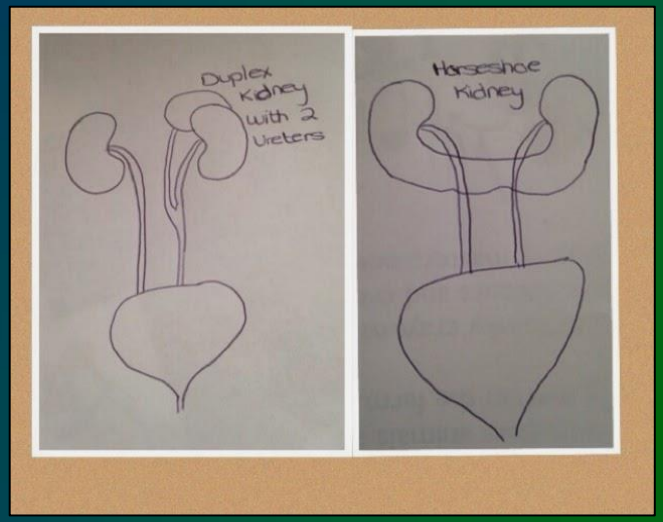
Extra Renal Pelvis

- **Extra Renal Pelvis** refers to the presence of the renal pelvis outside the confines of the renal hilum. It is a normal variant that is found in ~10% of the population .
- The renal pelvis is formed by all the major calyces. An exta-renal pelvis usually appears dilated giving a false indication of an obstructive pathology.

  CT for clarification.
- Avoid confusion with hydroureter

  or PUJ obstruction

VARIANTS CONT..



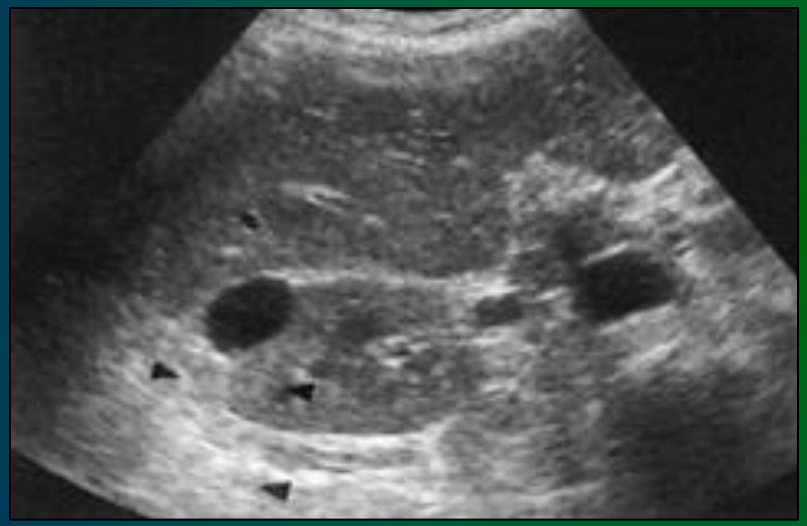
Horseshoe Kidney

Cross Fused Ectopia

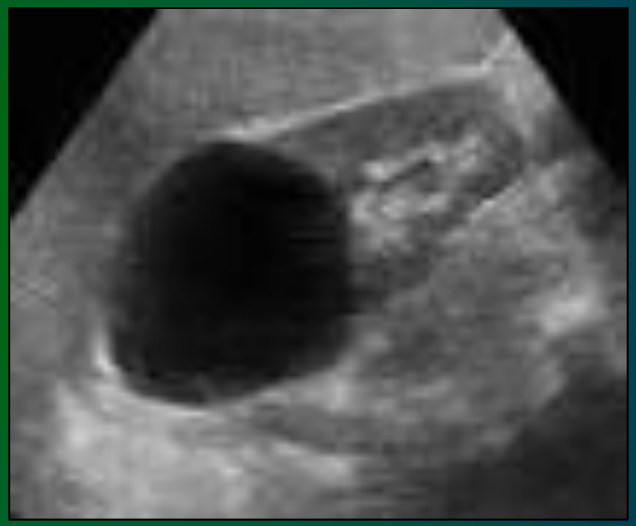
- Cross fused ectopic kidney.
- The left kidney is fused to the lower pole of the right kidney

Renal Cysts

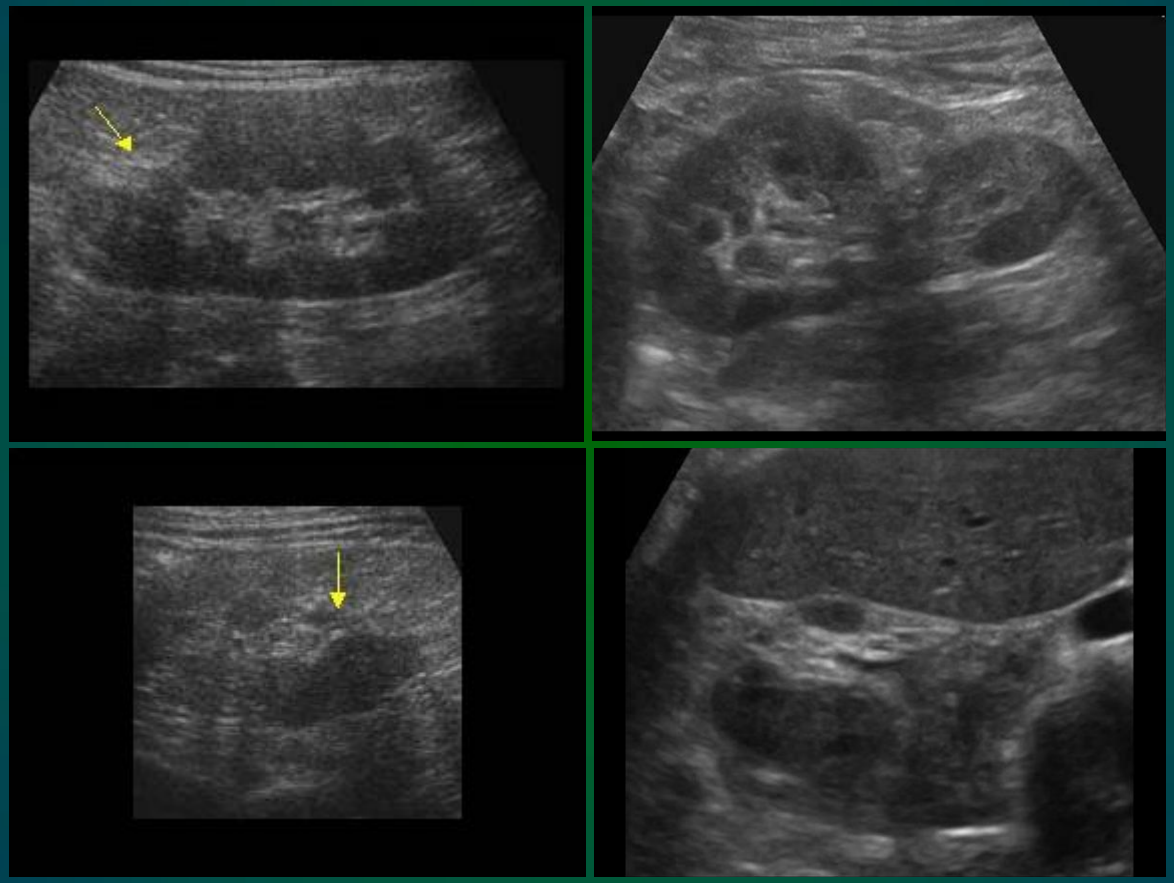
Cyst 1



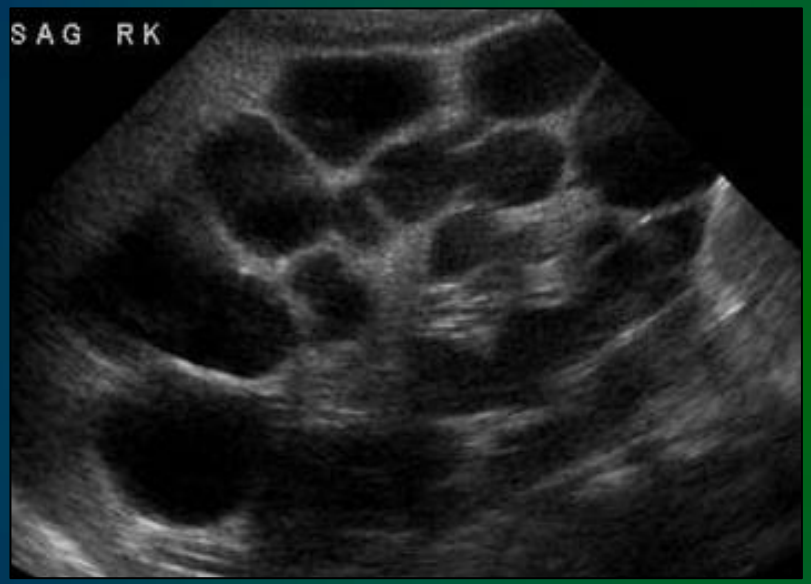
Cyst 2



Renal Scarring

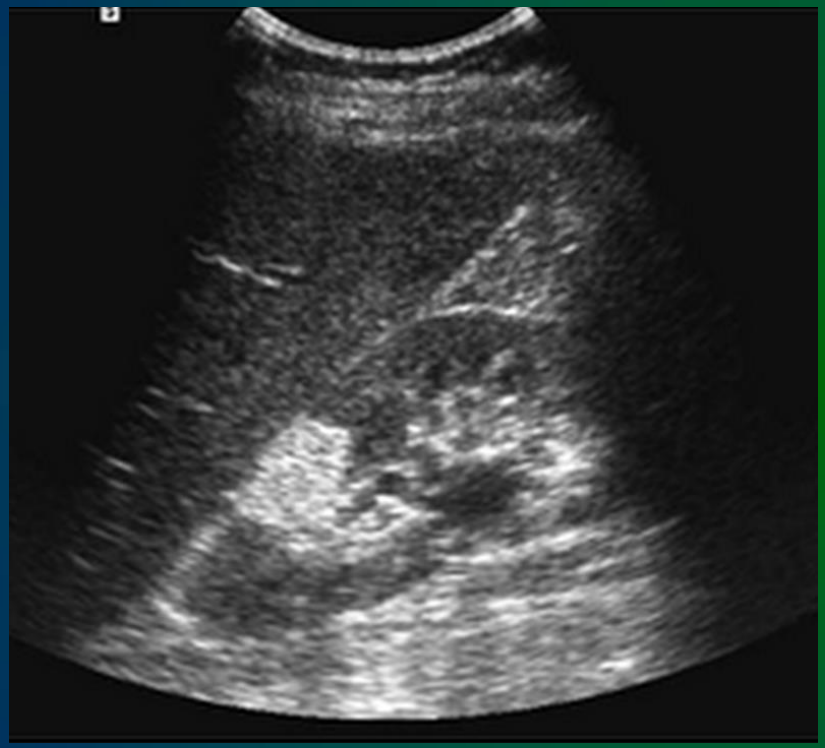


Multicystic Dysplastic Kidney



- Right kidney in a new-born shows no normal renal parenchyma and the right renal fossa filled with multiple simple appearing cystic structures c/w MCDK. The cysts did NOT communicate

ANGIOMYOLIPOMA



- This is a homogeneous, highly echogenic, usually rounded lesion in the renal parenchyma containing blood vessels, muscle tissue and fat, as the name suggests. They are usually solitary, asymptomatic lesions, found incidentally , although larger lesions can haemorrhage causing haematuria and pain.

Multiple Angiomyolipomas

- Also associated with Tuberose sclerosis, they tend to be multiple and bilateral.

Obstructive Uropathy
Grading System - Subjective

- Mild

  Minimal separation of calyces

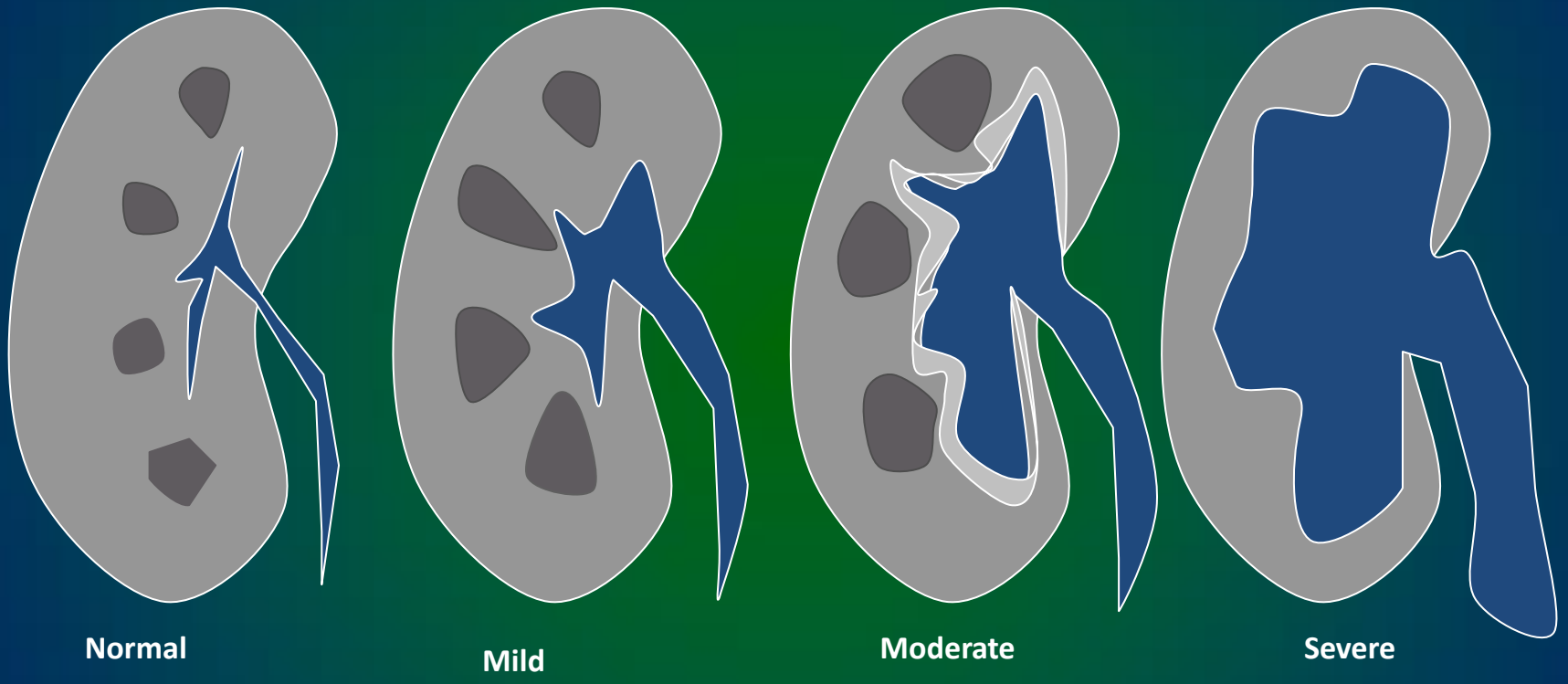
- Moderate

  Dilation of major and minor calyceal system

- **Severe**

  Marked dilation of the renal pelvis and thinning of the renal parenchyma

Range of Hydronephrosis



HYDRONEPHROSIS

Intrinsic acquired

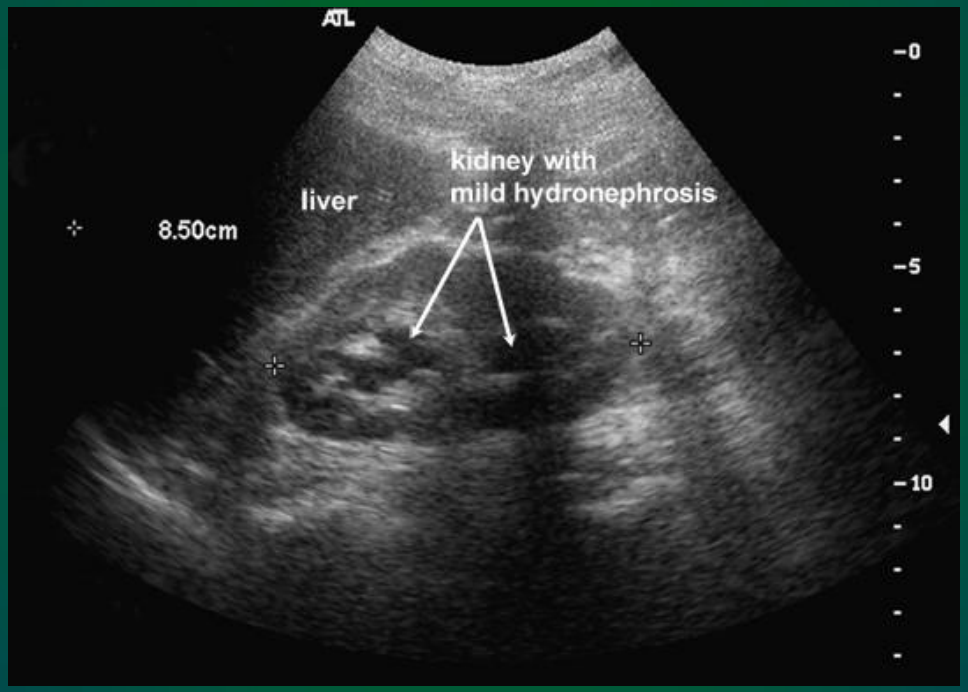
- Renal lithiasis
- Neoplasm (renal, ureteral, bladder)
- Papillary necrosis
- Ureterocele
- Blood clot
- Neurogenic bladder
- Anticholinergics
- Pregnancy, PID, uterine prolapse)
- Diuretics
- Vesico-ureteral reflux
- Diabetes insipidus

Intrinsic congenital

- Stenosis (ureteral, urethral, meatal)
- Adynamic ureter
- Spinal cord defects
- Duplication of the ureter
- Ureterocele

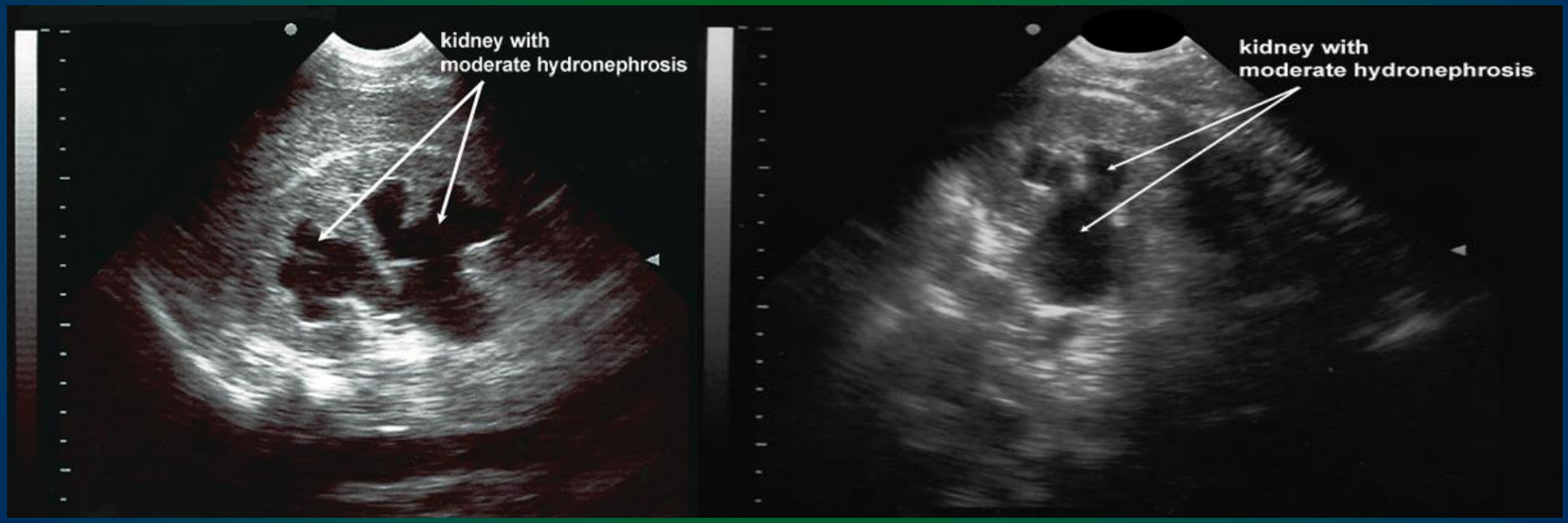
HYDRONEPHROSIS

Mild Hydronephrosis



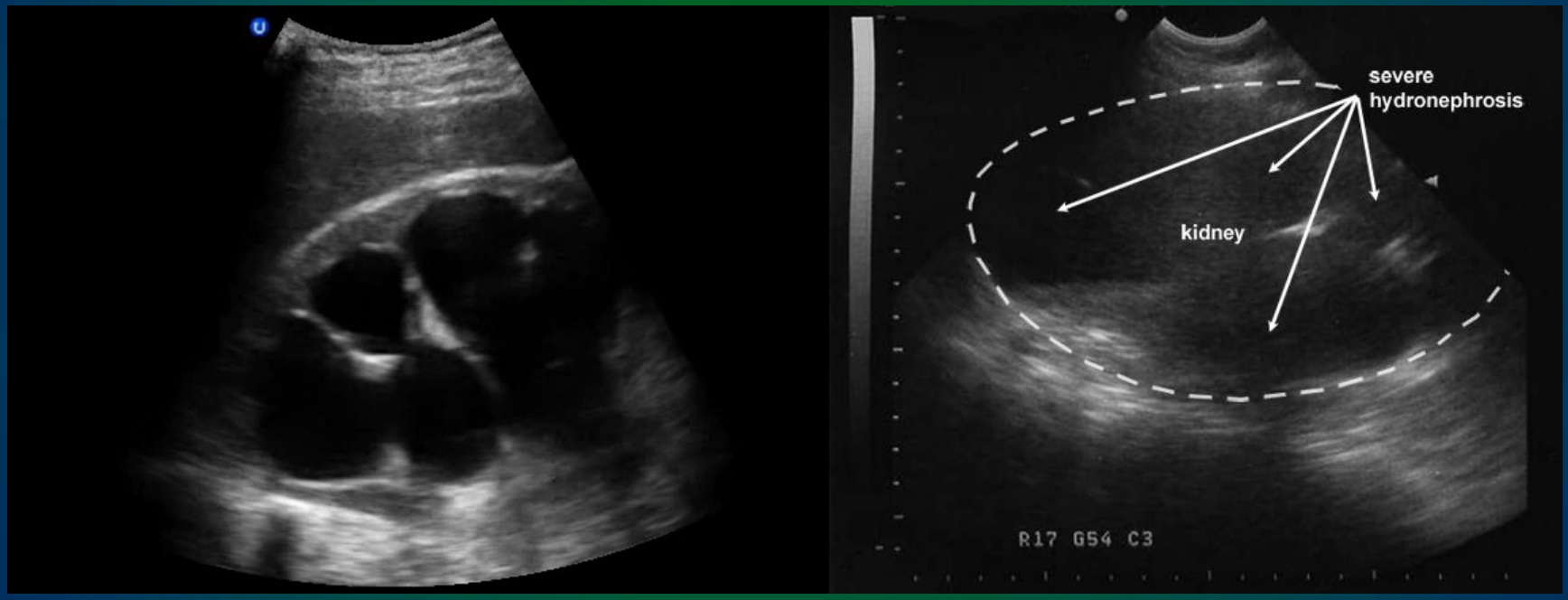
HYDRONEPHROSIS

Moderate Hydronephrosis



Severe Hydronephrosis

Severe Hydronephrosis



Small Kidneys

- Unilateral (may be bilateral)
  - Chronic infections
  - RAS Renal Artery Stenosis
  - Hypoplastic Kidney
  - Always bilateral
    - Chronic glomerulonephritis
    - Hypertensive nephropathy
    - Collagen Vascular Disease

Enlarged Kidneys

Always Unilateral

- Compensatory hypertrophy
- Bilateral or Unilateral
  - Renal Mass
  - Hydronephrosis
  - Renal vein thromboses
  - Lymphoma
  - Amyloidosis

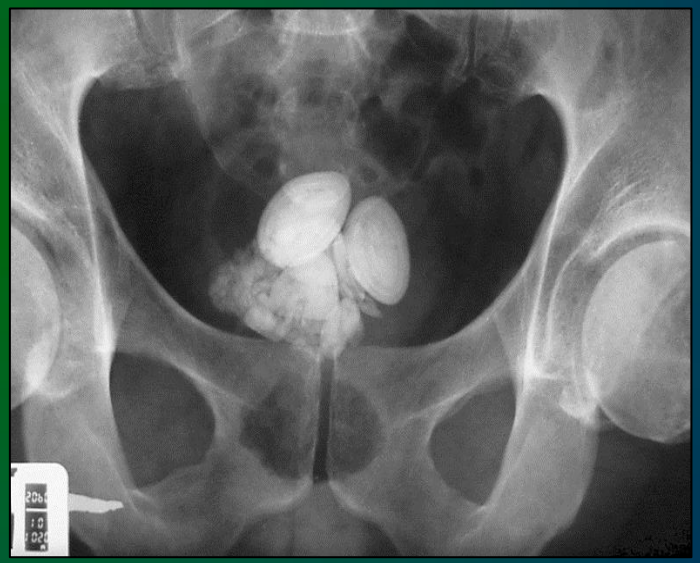
Always Bilateral

- PCK Polycystic Kidney Disease
- AGN Acute glomerulonephritis
- Amyloidosis

Urolithiasis

Renal Calculi-

Bladder Calculi



U/S only

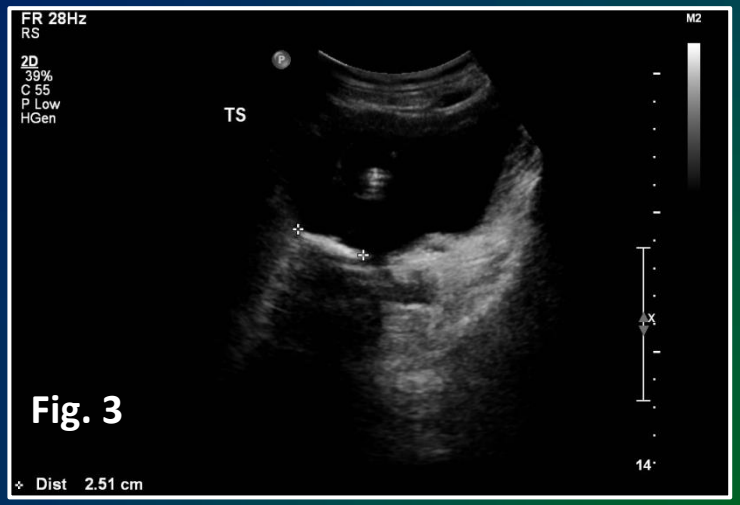


Fig. 3

Fig. 4

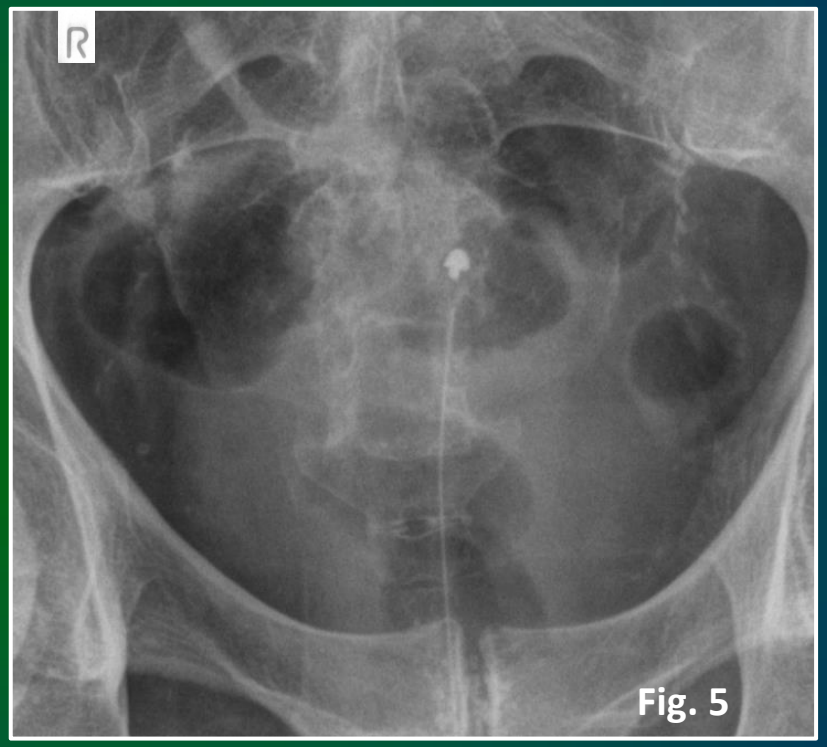
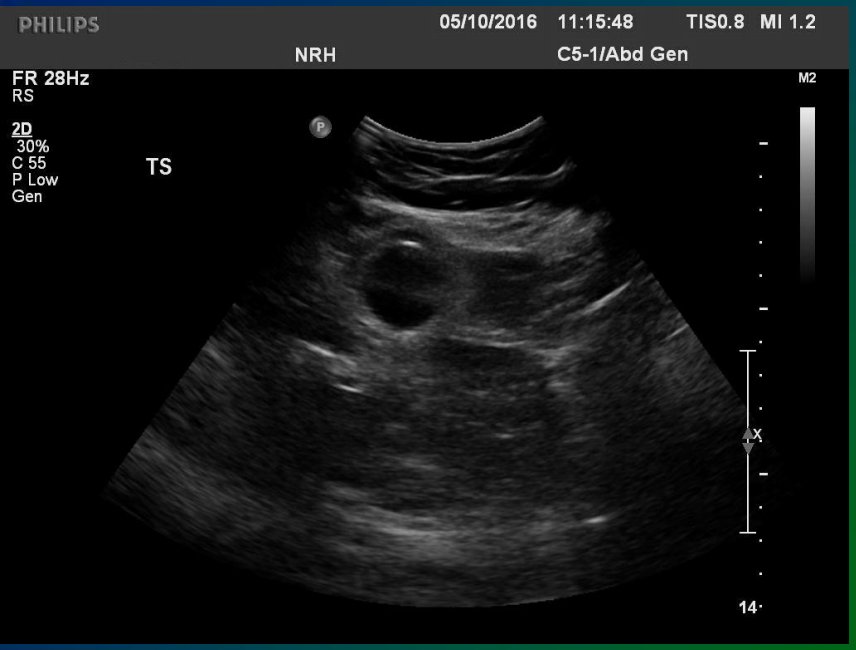


Fig. 5

Fig. 3, 4 & 5 – Bladder stones with posterior shadowing clearly seen at US in distended bladder but not apparent on X-ray.


PHILIPS
05/10/2016 11:15:48 TIS0.8 MI 1.2
NRH
C5-1/Abd Gen
FR 28Hz
RS
2D
30%
C 55
P Low
Gen
M2
TS
14


PHILIPS
05/10/2016 11:16:00 TIS0.8 MI 1.2
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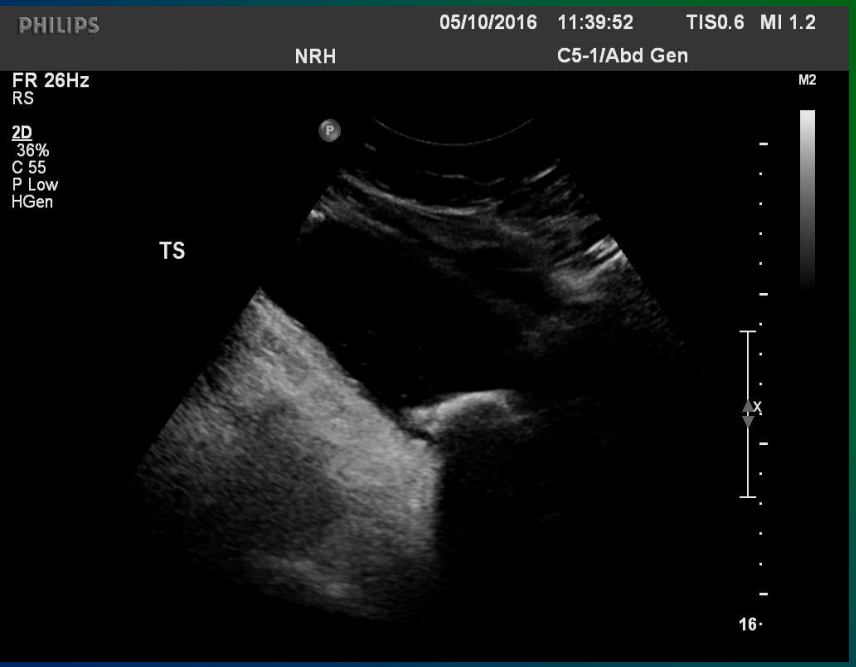
C5-1/Abd Gen
FR 28Hz
RS
2D
30%
C 55
P Low
Gen
M2
LS
14


PHILIPS
05/10/2016 11:39:52 TIS0.6 MI 1.2
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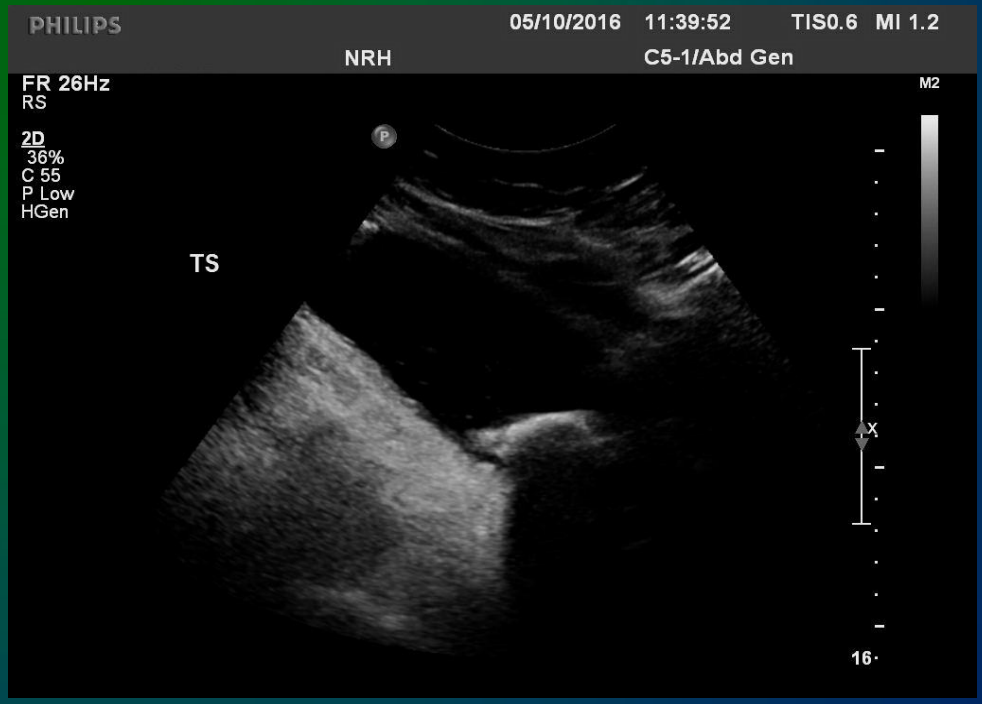
C5-1/Abd Gen
FR 26Hz
RS
2D
36%
C 55
P Low
HGen
M2
TS
16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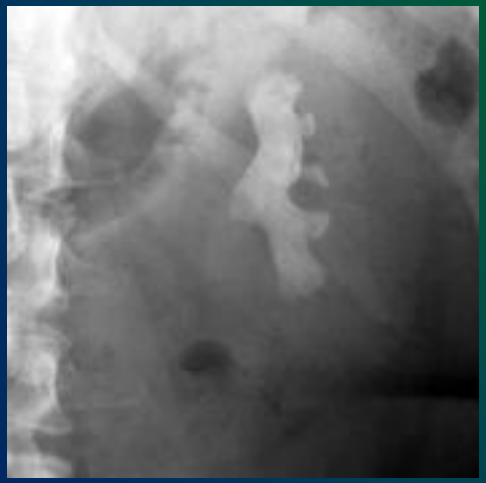
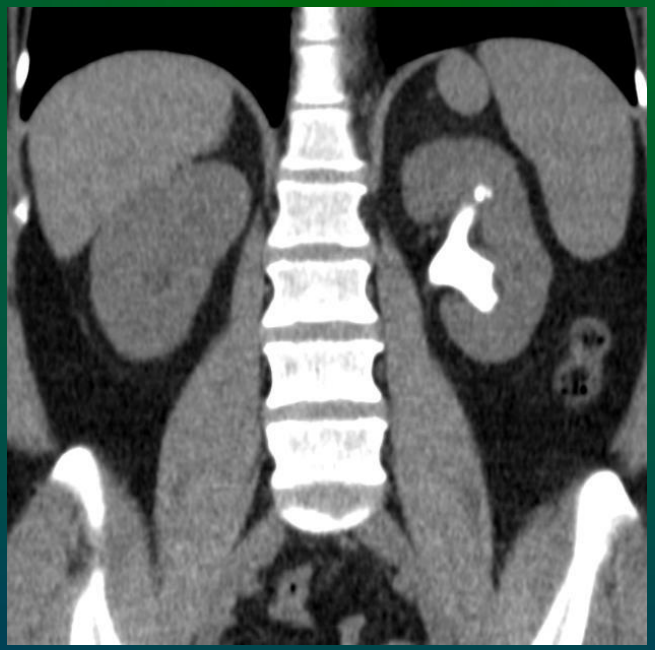
05/10/2016 11:39:52 TIS0.6 MI 1.2
NRH
C5-1/Abd Gen
FR 26Hz
RS
2D
36%
C 55
P Low
HGen
M2
TS
16

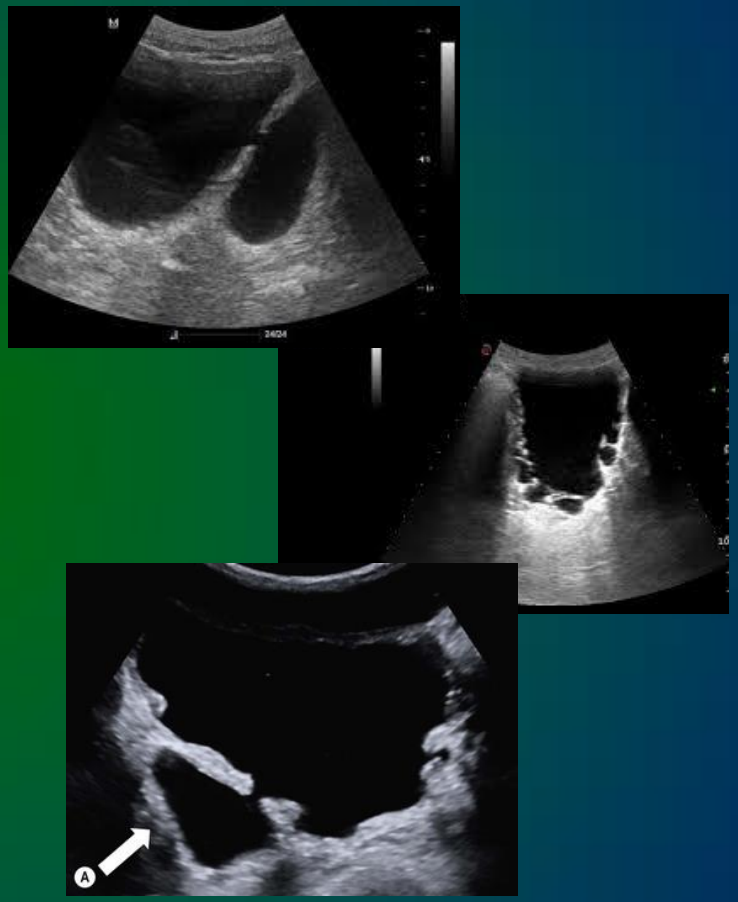
Staghorn Calculus





Bladder Diverticulae

- Diverticula of the bladder in infants and children are common and occur when bladder mucosa protrudes through a congenital defect in the detrusor muscle wall. Most are primary. Those secondary to obstruction or neurogenic dysfunction are less common than previously thought.

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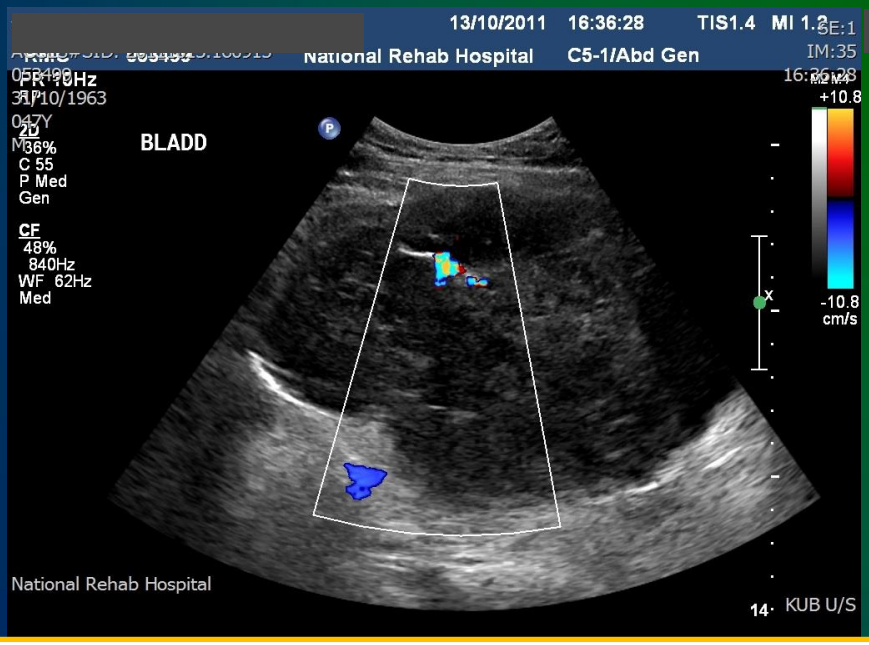
C5-1/Abd Gen
LS LT BLADD
KUB U/S


13/10/2011 16:20:16 TIS0.3 MI 1.2
C5-1/Abd Gen
TS
KUB U/S


13/10/2011 16:20:27 TIS0.3 MI 1.2
National Rehab Hospital
C5-1/Abd Gen
TS
KUB U/S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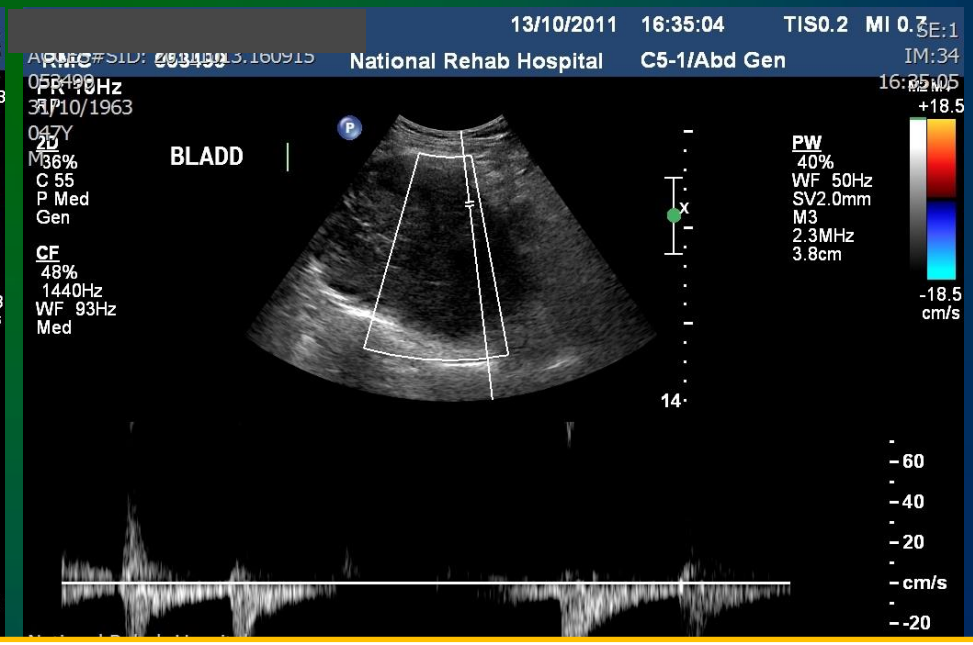
National Rehab Hospital
C5-1/Abd Gen
BLADD
CF
WF 62Hz
Med
+10.8
-10.8
cm/s
KUB U/S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National Rehab Hospital
C5-1/Abd Gen
BLADD
CF
WF 93Hz
Med
PW
WF 50Hz
+18.5
-18.5
cm/s
60
40
20
cm/s
-20


PHILIPS
11/10/2016 10:19:54 TIS0.4 MI 1.2
NRH
C5-1/Abd Gen
FR 28Hz
RS
Z 1.0
2D
35%
C 55
P Low
Gen
M2
BLADD
LS
TS
14
14

Bladder Calculi

Renal Mass

- Pyelonephritis: sonographic appearance is most commonly normal, but you may find hypoechoic cortex and loss of demarcation between the outer cortex and middle pyramids and columns of Bertin.

- Renal mass: may have any echotexture (hyperechoic, anechoic etc.) and appear anywhere within the kidney

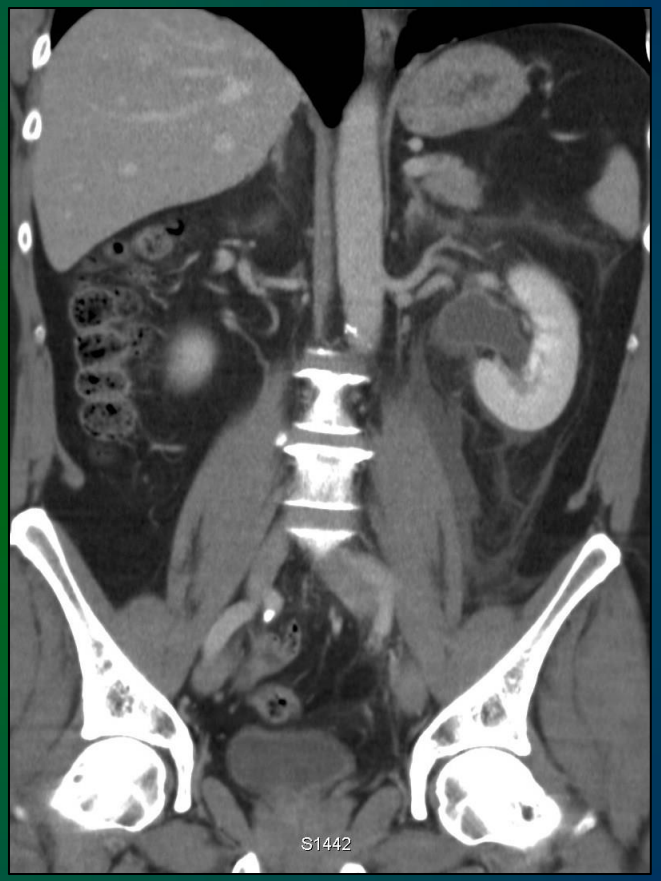
- Transplant kidney: a normal echotexture kidney, typically in a pelvic location

Transitional Cell Carcinoma

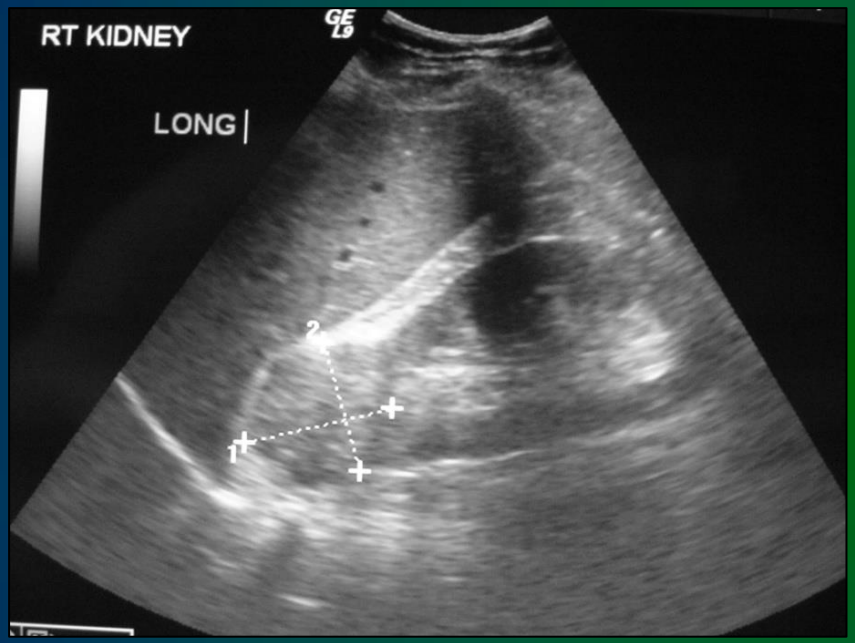
- Ultrasound images Large, transitional cell carcinoma in the upper pole of the RK. The changes are more subtle than those of renal cell carcinoma, and the renal outline remains intact.

- Transitional cell carcinoma is the most common bladder tumour, occurring less frequently in the collecting system of the kidney and the ureter. It usually presents with haematuria while still small. It is best diagnosed with cystoscopy.

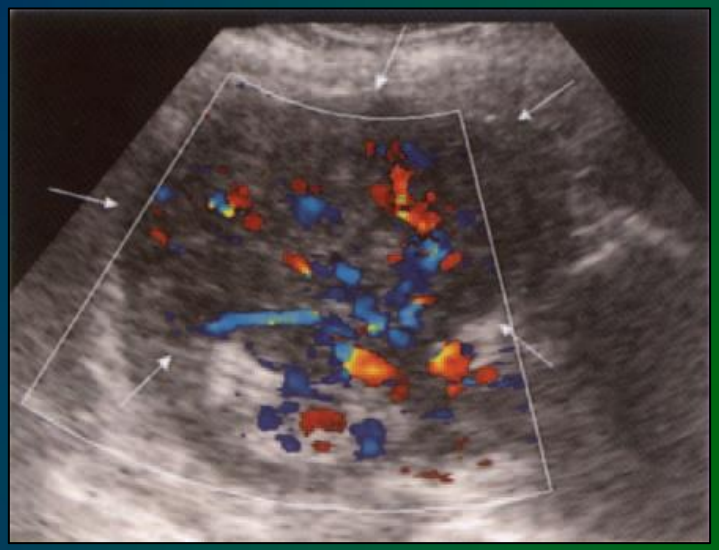
Hydronephrosis due to TCC Ureter



US AND CT RENAL CA



Renal Cell Carcinoma

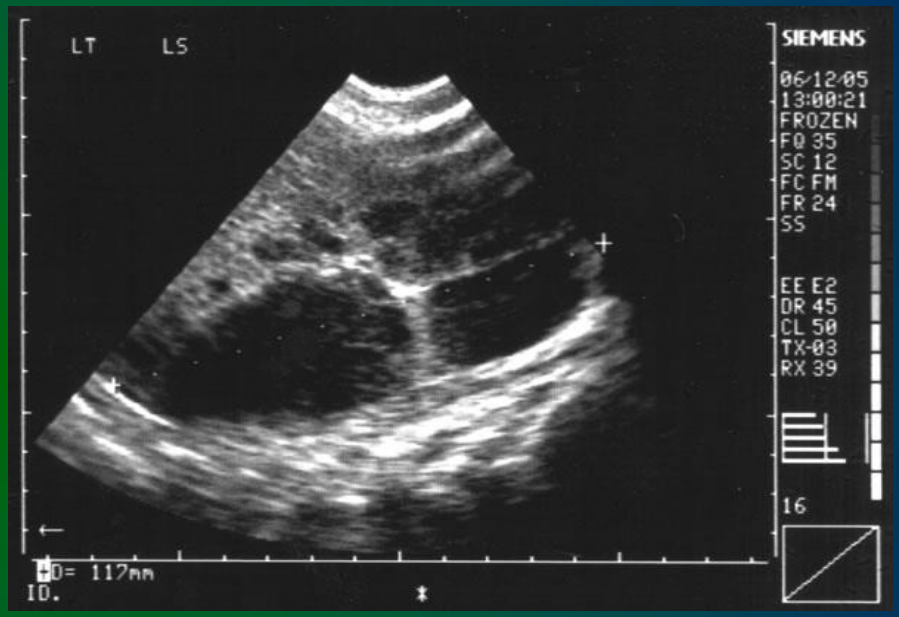


- Large, heterogeneous mass which enlarges and deforms the shape of the kidney (Fig. below). The mass may contain areas of cystic degeneration and/or calcification. It has a predilection to spread into the ipsilateral renal vein and IVC .

- Smaller RCCs can be hyperechoic and may be confused with benign angiomyolipoma. The latter has well-defined borders whilst an RCC is illdefined.

- Colour Doppler usually reveals a disorganized and increased blood flow pattern within the mass with high velocities from the arterioverous shunts within the carcinoma.

BURKITTS LYMPHOMA



NEUROBLASTOMA

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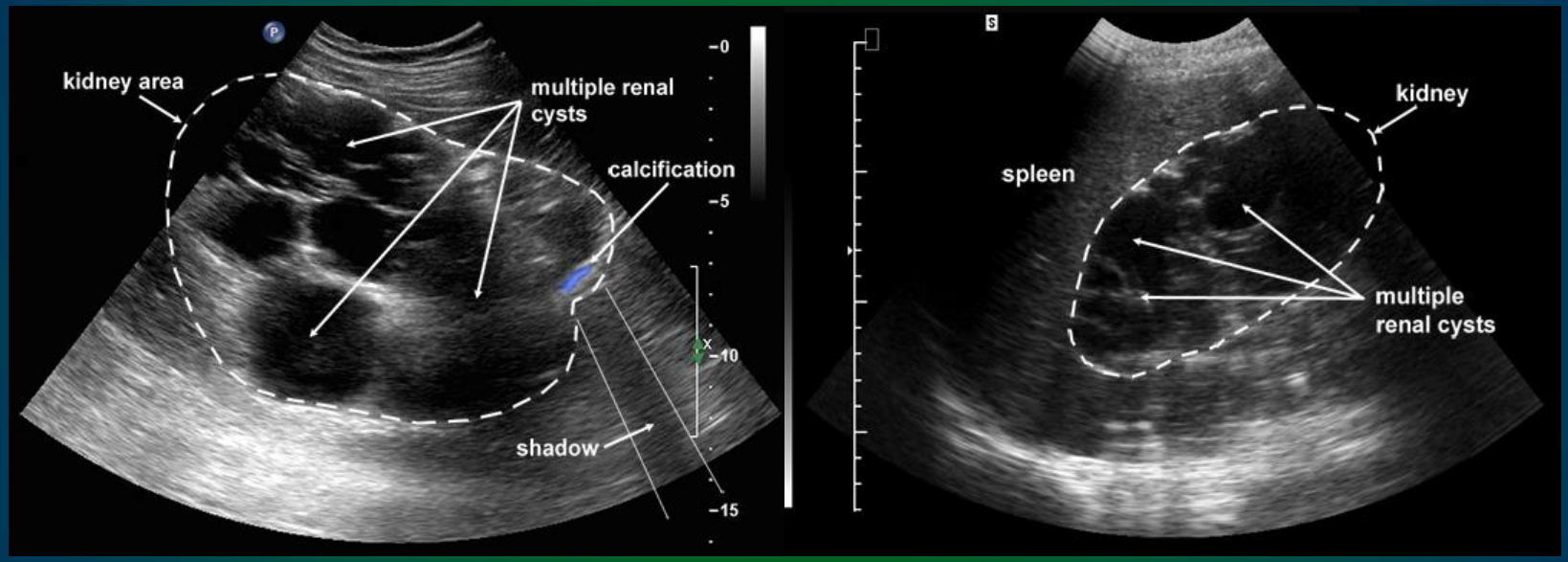
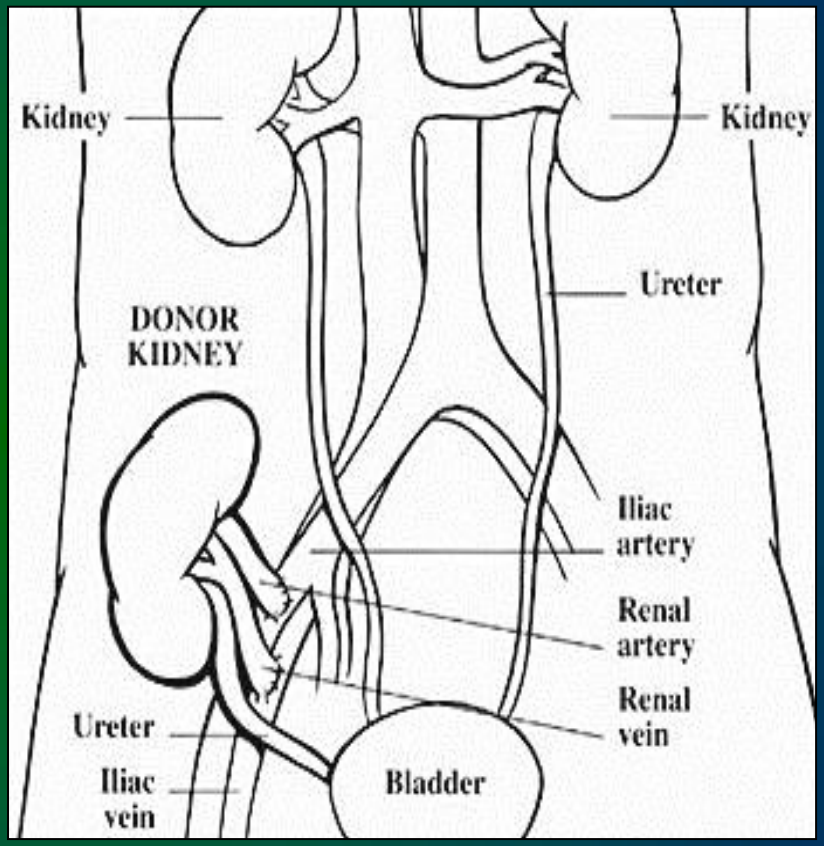
Renal Trauma

POLYCYSTIC KIDNEYS



Renal Transplants-Surgical Technique

- Usually heterotopic (placed in addition to the native diseased kidneys)
- Positioned in the extra-peritoneal pouch in the iliac fossa (usually the right) anterior to the iliacus and psoas muscles.



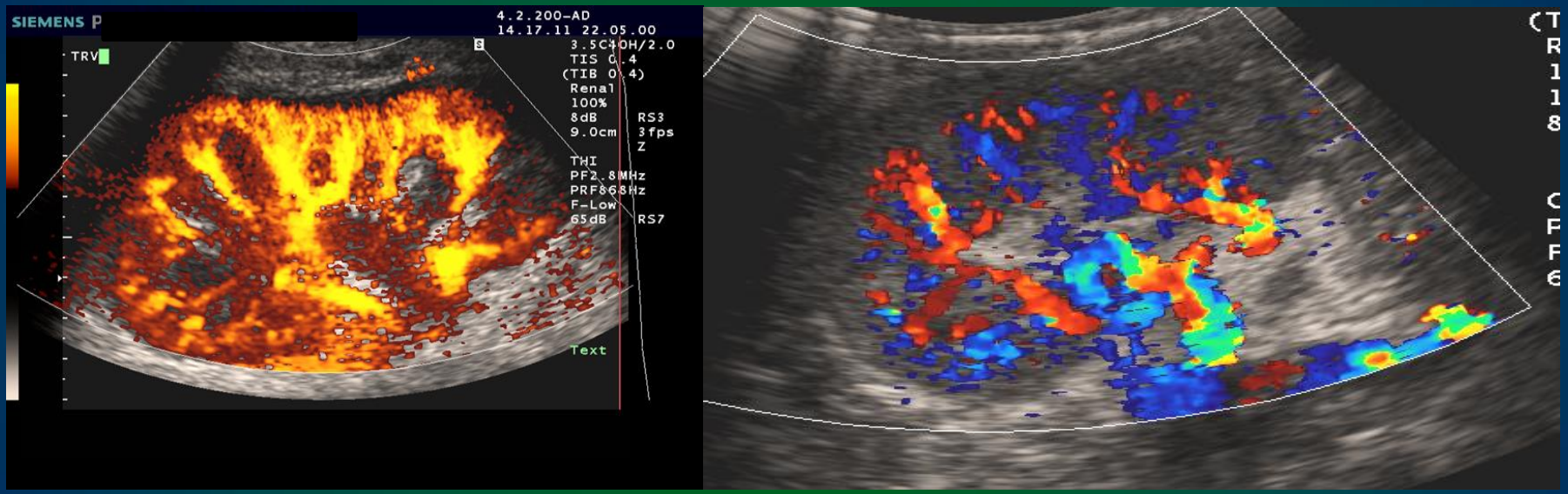
The Role of ultrasound

B Mode imaging

- Morphological appearances:
  - PC dilation
  - Peri-renal fluid collections
- Doppler:
  - Colour /Power Perfusion
  - Spectral Doppler
  - Waveforms
- Intervention:
  - Guide Biopsy Procedures
  - Drain Fluid Collections
  - Placement of Nephrostomy Tubes

LS Renal Transplant (Using Extended Field of View)

Perfusion with power and colour Doppler

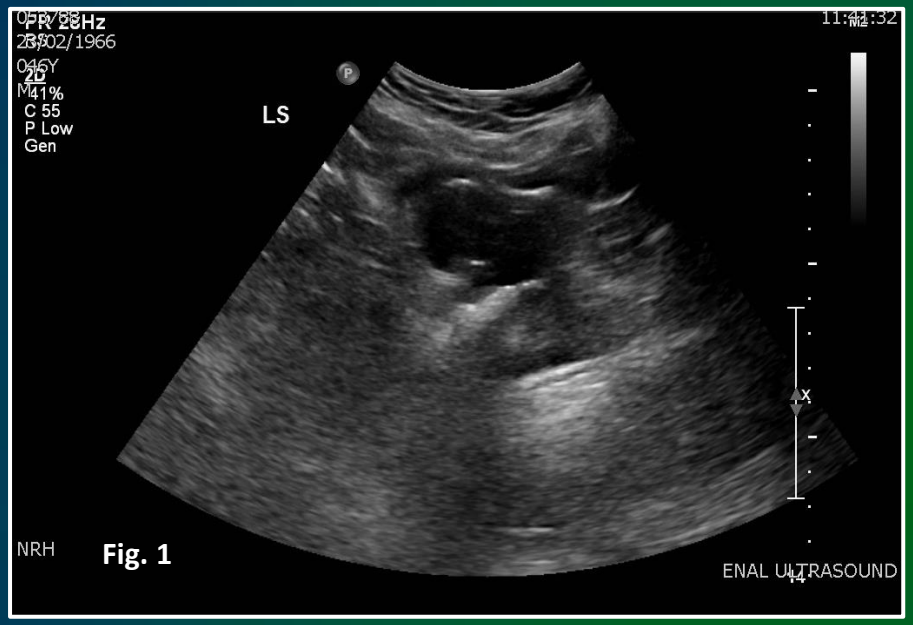


Background

The main purpose of regular urology review is to preserve renal function with the ultimate aim of a non obstructed urinary system.

Urinary Tract Infections (UTI) are the most frequent medical complication in patients with Spinal Cord Injuries (SCI) and a major cause of morbidity.

X-RAY ONLY



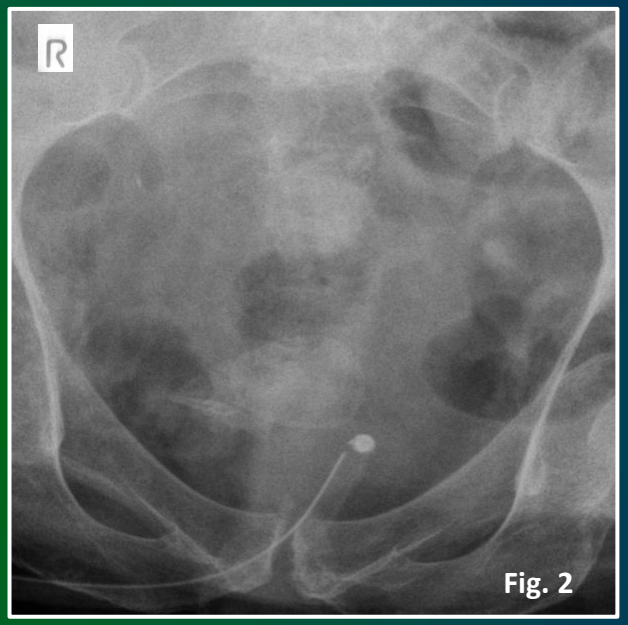
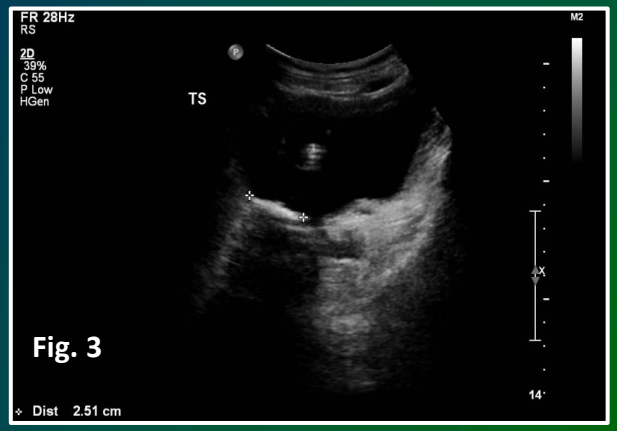


Fig. 1 & 2 - US showing decompressed bladder around IDUC. X-ray in same patient confirming large calculus not visualised on US.

US ONLY



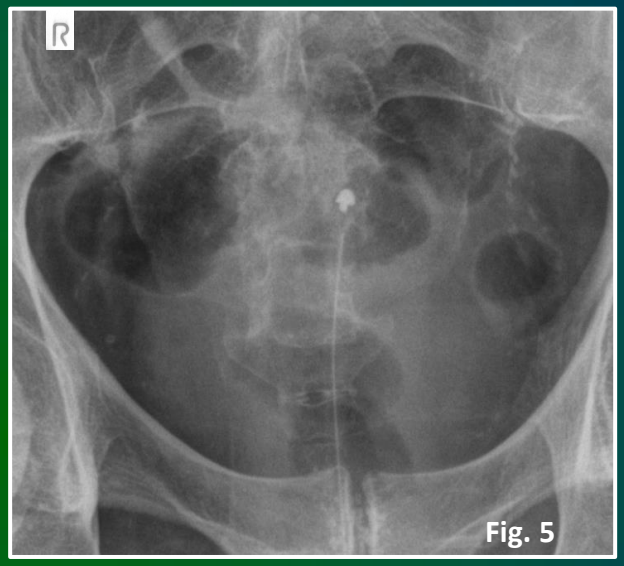


Fig. 3, 4 & 5 – Bladder stones with posterior shadowing clearly seen at US in distended bladder but not apparent on X-ray.

Results

- Bladder ultrasound alone diagnosed 36 % bladder calculi compared to 18% diagnosed by X-ray alone.

- US and X-ray combined diagnosed 46%.

Bladder Mucus

- In one patient, a focal, mobile area of increased reflectivity was demonstrated posteriorly in the bladder. No posterior acoustic shadowing was seen to suggest of calculus formation.

- On flexible cystoscopy no calculus identified, only mucus seen.

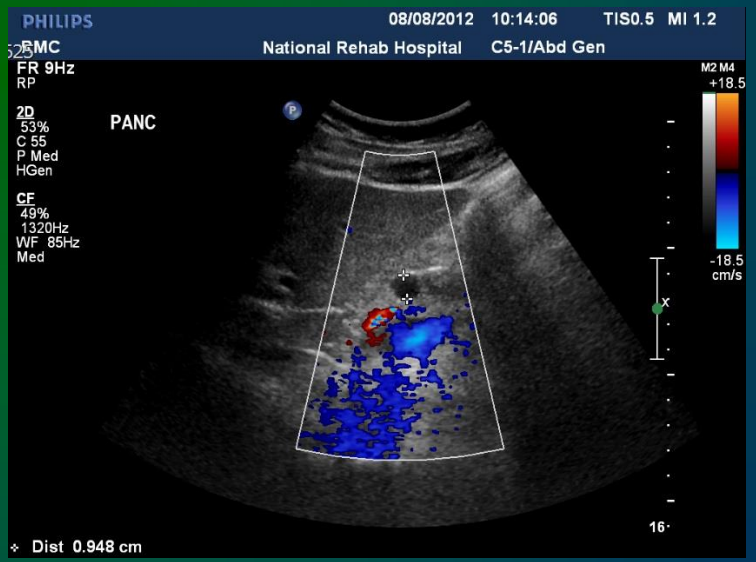
Case Study 1


DELANEY,LINDA
ACCES#SID: 58
064358
04/12/1969
042Y
F
SE:1
IM:1
L
National Rehabilitation Hospital
Bladder
Abdomen

CASE STUDY 2-VHL (VON HIPPEL LINDAU SYNDROME)

- renal lesions
  - renal cell carcinoma(s) (RCCs): usually of the clear cell type
    - 70% lifetime risk
    - RCCs present at an earlier age in those with vHL
  - renal cysts
    - can occur in up to 75% of cases
    - often tend to be bilateral and multiple

- Prognosis is poor, with a median survival of ~50 years, with the most common cause of death being RCC and cerebellar haemangioblastomas .



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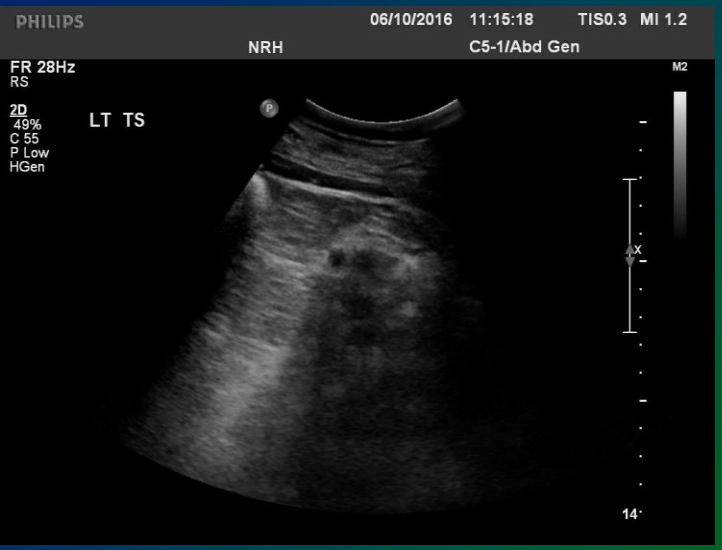
Case Study 3



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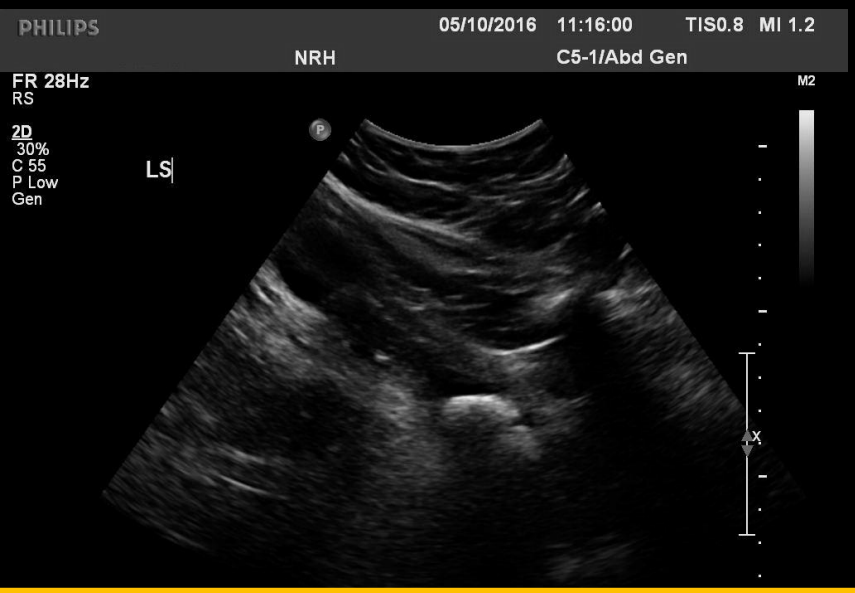

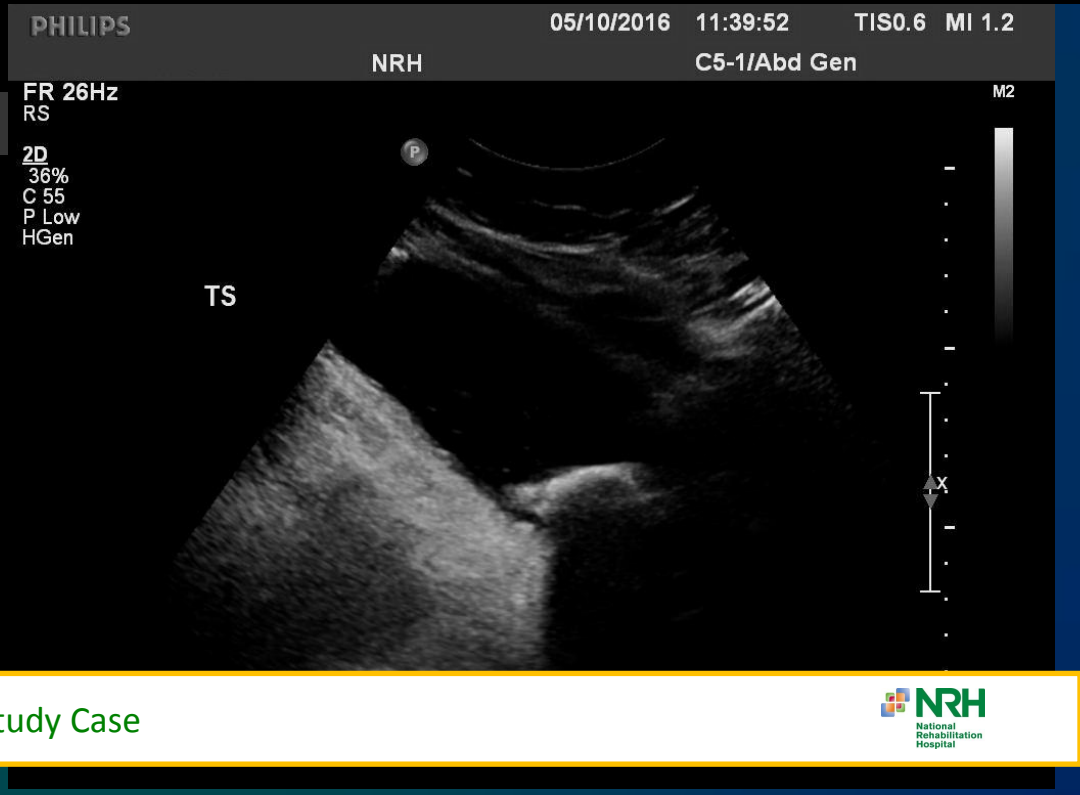

Renal Ultrasound (Basic Principles) and BMUS Study Case

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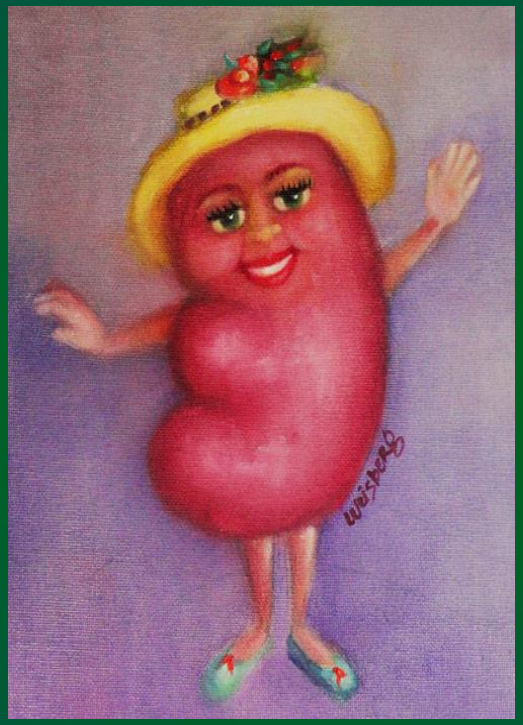
Page Kidney

Thank you for your attention!



Rosie Conlon
rosie.conlon@nrh.ie