Ultrasound of the Urinary System

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Indications

- Renal colic
- Renal mass
- Haematuria
- Renal size
- Poor or non-functioning kidney on IVU
- Recurrent UTI
- Hypertension
- Renal failure
- Trauma
- To guide biopsy and interventional techniques
Advantages

- No radiation
- Non-invasive
- Available
- Portable
- Inexpensive
Limitations

- Training requirements
- Operator dependent
- Patient‘s physical habitués
- Overlying bowel gas
- Does not offer functional information
- Confusing artifacts
Preparation

- **No need for patient to fast**
- **Full Bladder**
  - 3 to 4 glasses of water an hour before examination and not to void
Equipment
Ultrasound transducers

- 3.5 MHz – Adult
- 5.0- 7.5MHz – Pediatrics
- Curvilinear transducer
Adjust frequency and depth

- Newer transducers have multi-frequencies that is adjustable e.g. 2-5 MHz; 7 to 10 MHz

- Adjust to the highest frequency that allows adequate penetration to examine the structures of interest e.g. Higher frequency for anterior bladder walls.

- Depth of ultrasound wave penetration for renal ultrasound must be at least 20cm
Ultrasound probes have a groove on one side that corresponds to the top or on the upper left of the screen.
Orientation of Image

- By convention, Right or cephalic is on the right of the screen/picture; Left or caudal is on the left
- Touching one end of the probe with the finger to get the orientation right
- Superficial structures seen on top and deeper structures at the bottom
Preset scanning programme

- Various scanning settings can affect the final image
- Most machine allows programmed scanning settings to be preset for various body parts (e.g. cardiac, abdomen, superficial, obstetrics etc)
- Choose the proper preset/programme for renal or abdominal scan.
Control panel
Sensitivity and Gain

1. Adjust the overall gain to the correct level
2. TGC allow adjustment of the gain at various depths

Fig. 14c. Longitudinal scan: the gain is incorrectly adjusted, so that the outline of the kidney and the periphery of the liver are not well seen.

Fig. 14d. Longitudinal scan with proper gain: the margins of the kidney and the internal details of the kidney and liver are now well defined.
Focusing

- Focusing improve lateral resolution giving rise to a better image
- Adjust the focus zone to the depth of interest
Terminology

- Echogenic, hyperechoic, high echoes, increased echoes: Bright image [bone, calcium (stone), air, fat, metal, foreign body, specular boundary (diaphragm, vessel wall)]

- Anechoic, no echoes, echo void: Black image [fluid, CSF, urine, bile, blood]

- Hypoechoic, low echoes, reduced echoes: Dark [thick fluid, pus, renal medulla]
Echogenicity

The echogenicity of renal structures as compared to other structures:

- High: Diaphragm, renal sinus, bowel air, bones, spleen, liver, Pancreas, renal cortex, renal medulla
- Low: ovaries, bowel wall, GB, bladder, vessels
Scanning procedure
The patient

- Practice courteous and respectful interaction with patient
- Confirm the patient’s identity and procedure
- Briefly explain the examination and instruct the patient appropriately
- Drape patient properly
Ultrasound gel

Coupling gel ensure good contact (improve transmission of sound) and facilitate probe movement.
1. The ultrasound machine is positioned so the screen is easily visible from the operator’s working position.
2. Ambient lighting is reduced to maximize screen contrast.
Scanning technique

The transducer is held perpendicular to the skin surface with the transducer marker (groove) pointed cephalic and the scanning plane directed to the lie of the kidney.

Apply firm pressure (gradually increased) to improve contact and displaces overlying air.

A depth guide is usually located along the right side of the screen, to enable estimation of the depth of a structure relative to the abdominal wall.
Scanning technique

- The whole kidney should be scanned in at least 2 planes: longitudinal and transverse in relation to the axis of the kidney.
- Other planes as required.
- Real time assessment.
- Arrested respiration if required and for taking picture.
- Use cine play back for reviews.
Right kidney

1. Supine using liver as window
2. Angle Tx obliquely moving posteriorly
3. Left decubitus
Left Kidney

- Supine or left side up position with patient leaning slightly forward
- Over the flank, follow the lie of kidney, lower pole more anterior
- Longitudinal and transverse scan covering whole kidney
- Relax, normal breathing, deep inspiration if upper pole is obscured by ribs
- Arrested respiration for picture taking
- Prone, follow the lie of kidney, lower pole more lateral
Left kidney
Normal Kidney

- **Capsule**
  - Smooth echogenic line around the kidney
  - Fetal lobulation

- **Parenchyma: Cortex & Medulla**
  - Less echogenic than liver
  - Medulla more hypoechoic, more so in infants and is pyramidal in shape

- **Sinus (fat, collecting systems & vessels)**
  - centre, occupies 1/3,
  - highly echogenic

- **Pelvis/Proximal ureter**
  - Near the hilum
  - May not be seen
Renal artery and vein

1. Seen at the hilum
2. Vein anterior to artery
3. Pulsation
Kidney - Measurements

**Bipolar length**
- 9 – 12 cm

**AP diameter**
- 4 - 6 cm

**Parenchymal thickness**
- Measure at lower pole, from capsule to central sinus
- 1 - 2.5 cm

Measure at level of renal hilum
Normal versus Hydronephrosis
Hydronephrosis:
Over distention of bladder

An over distended urinary bladder can produce dilatation of a normal pelvicalyceal system.

Empty the bladder before making a diagnosis of hydrenephrosis
Renal cysts:
Bilateral diseased kidneys
Renal calculi
Ureter

- Normal ureter is not seen on US
- If dilated, can be traced from renal pelvis to level of obstruction
- Decubitus, tracing along the dilated ureter, longitudinally
- Seen as tubular hypoechoic structure with echogenic wall
- Dilated distal ureter can be traced into the bladder
Bilateral dilated ureters
1. Place the transducer sagitally in the midline at approx. 4cm superior to the symphysis pubis

2. Angle transducer downwards into the pelvis to demonstrate the bladder

3. Rotate 90° into the transverse plane to view the bladder.
Normal Bladder

- Ovoid fluid-filled structure
- Smooth echogenic wall
- Wall thickness varies with degree of distension
- Should be uniform all around and not more than 4 mm in a full bladder
- Ureters or jets of urine may be seen entering at the lower end
Bladder

Normal

Wall thickening
Bladder calculi
Bladder: Forley’s catheter

Fig. 125b. Longitudinal scan: the balloon of a Foley catheter next to the bladder wall.
Pitfall: Enlarged prostate

- Smooth margin
- Merged with prostate

Fig. 124c. Longitudinal scan: a markedly enlarged prostate.
Pitfall: Uterine mass

- Irregular margins
- Merged with uterus
- Distort bladder wall

Fig. 124d. Transverse scan: distortion of the bladder wall by pressure from a large uterine myoma
Best lesson of life is listen to everyone and learn from everyone, because no body knows everything and everyone knows something.