ABDOMINAL ULTRASOUND

M.A.TAHER

Depending on the clinical indications, an ultrasound examination may include the entire abdomen and retroperitoneum, a single organ, or several organs. A combination of structures may be imaged because of location (e.g. upper abdominal scan, right upper quadrant organs) or function (e.g., biliary system [liver, gallbladder, and bile ducts], both kidneys). For some patients, more focused examinations may be appropriate for evaluation of specific clinical indications or to follow-up a known abnormality. In some cases, additional and/or specialized examinations may be necessary (e.g., spectral, color, or power Doppler). While it is not possible to detect every abnormality using ultrasound examination of the abdomen and retroperitoneum, adherence to the following standards will maximize the probability of detecting abnormalities.

INDICATIONS/CONTRAINDICATIONS

Indications for ultrasound examination of the abdomen and retroperitoneum include, but are not limited to,

A. Abdominal, flank, and/or back pain.
B. Pain that may be referred from the abdominal or retroperitoneal regions.
C. Palpable abnormalities, such as possible abdominal mass or organomegaly.
D. Abnormal laboratory values suggestive of abdominal or retroperitoneal pathology.
E. Follow-up of known or suspected abnormalities in the abdomen or retroperitoneum.
F. Search for metastatic disease or occult primary.
G. Evaluation of suspected congenital abnormalities.
H. Abdominal trauma.
I. Pre-and post-transplantation evaluation.

There is no absolute contraindication.

SPECIFICATIONS FOR INDIVIDUAL EXAMINATIONS

A. Abdomen

1. Liver

The examination of the liver should include long axis and transverse views. The liver parenchyma should be evaluated for local and/or diffuse abnormalities. If possible, the echogenicity of the liver should be compared with that of the right kidney. In addition, the following should be imaged :

a. The major vessels in the region of the liver, including the IVC, the hepatic veins, and the main, right, and left branches of the portal vein.

b. The hepatic lobes (right, left, and caudate) and, if possible, the hepatic fissures, the right hemidiaphragm, and the adjacent pleural space.

2. Gall bladder and biliary tract

The gall bladder evaluation should include long-axis and transverse views obtained in the supine position ; other positions, such as left lateral

[1] Director
[2] Medical Officer, Center for Nuclear Medicineand Ultasound,Post Box # 16 Rangpur 5400,Bangladesh.

decubitus, erect, or prone positions, may be necessary to evaluate the gall bladder and its surrounding area completely, particularly when stones and/or sludge are observed. Wall measurements may aid in the determination of thickening. Tenderness to transducer compression may be assessed.

The intrahepatic ducts can be evaluated by obtaining views of the liver demonstrating the right and left branches of the portal vein. Doppler may be used to differentiate hepatic arteries and portal veins from bile ducts. The intrahepatic and extrahepatic bile ducts should be evaluated for dilatation, wall thickening, filling defects, and other abnormalities. The size of the bile duct in the porta hepatis should be documented. When visualized, the distal common bile duct in the pancreatic head should be evaluated. Routine gall bladder examination should be conducted on a filled gall bladder. Fasting for 8 hours prior to examination will permit adequate distension of a normally functioning gall bladder in adults and children. In infants and some adults, adequate distension may be achieved in less time.

COMMON ERRORS IN GALL BLADDER SCANNING

1. Failure to use the decubitus, "belly out", and erect positions when evaluating possible stones or sludge
2. Misdiagnosis of a hyperechoic spiral value as an impacted stone
3. Failure to identify an impacted stone at the neck of the gallbladder
4. Overdiagnosing gall bladder wall thickness in the post-prandial patient or in the patient with edema
5. Diagnosing artifacts in the gall bladder as sludge
6. Incomplete visualization of the gall bladder fundus from failure to use the intercostal approach
7. Failure to correctly identify the gall bladder when it looks atypically hyperechoic due to multiple stone and little bile
8. Mistaking the normal artifact generated at the gall bladder edges for acoustic shadowing caused by stone
9. Not visualizing the entire gall bladder lumen because it is folded over
10. Missing very small stones when they do not cause shadows

3. Pancreas

Whenever possible, all portions of the pancreas ; head, uncinate process, body, and tail, should be identified in long-axis and transverse projections. Orally administered water or contrast agent may afford better visualization of the pancreas through the stomach. The following should be assessed in the examination of the pancreas :

a. Parenchymal abnormalities.
b. The distal common bile duct in the region of the pancreatic head.
c. The pancreatic duct for dilatation and any other abnormalities, with dilatation confirmed by messurement.
d. The peripancreatic region for adenopathy and/ or fluid.

Doppler may be used to differentiate vascular from nonvascular structures.

4. Spleen

Representative views of the spleen in long -axis and transverse projections including right lateral decubitus should be obtained. Doppler may be used to determine the presence and direction of flow in the splenic vein and artery. Suspicion of splenic enlargement should be documented by measurement. Echogenicity of the left kidney should be compared with splenic echogenicity when possible. An attempt should be made to demonstrate the left hemidiaphragm and the adjacent pleural space.

5. Bowel

The bowel may be evaluated for wall thickening, dilatation, muscular hypertrophy, masses, and other abnormalities. Sonography of the pylorus and surrounding structures may be indicated in the evaluation of the vomiting infant.Graded compression sonography may be necessary to visualize the appendix or other bowel loops and might be combined with pelvic sonography in the evaluation of lower abdominal/pelvic pain. Wall measurements may be helpful in the determination of thickening.

B. Retroperitoneum

1. Kidney

The examination should include the long-axis and the transverse views of the upper pole(s), mid portion(s), and lower pole(s). The cortex and renal pelvic regions should be assessed. A maximum measurement of renal length should be recorded for both kidneys. Decubitus,prone,or upright positioning may provide better images of the kidney. When possible, renal echogenicity should be compared with the adjacent liver and spleen. The kidneys and perirenal regions should be assessed for abnormalities. Doppler may be used to differentiate vascular from nonvascular structures.

Note : For vascular examination of the kidneys, Doppler can be used as follows :

a. To assess renal arterial and venous patency.
b. To evaluated adults, suspected of having renal artery stenosis. For this application, detailed examination of the intra and extra-renal arterial tree should be included. When possible, bilateral, angle-adjusted measurements of the peak systolic velocity in the proximal, mid, and distal main renal arteries should be made. Peak systolic velocity of the adjacent aorta (or iliac artery in transplanted kidneys) should also be documented for calculation of renal aortic ratio. Within the kidney, spectral images of adequate size to allow evaluation of the early systolic peak may be obtained from the upper and lower pole (s) of the kidney.

COMMON ERRORS IN SCANNING THE KIDNEY

1. Failure to scan the contralateral kidney for evidence of obstruction when hydronephrosis is noted on the symptomic side
2. Mistaking prominent renal pyramids for hydronephrosis
3. Mistaking prominent renal pyramids for multiple small cysts
4. Interpreting an extensive extrarenal pelvis as a sign of obstruction
5. Failure to look for perinephric extravasation
6. Confusing normal renal arteries for the not normally visible ureter
7. Overdiagnosing hydronephrosis in the presence of a full bladder
8. Failure to appreciate the renal origin of a large cystic structure due to distortion of the normal anatomy
9. Failure to scan through the urinary bladder for a stone at the uretero-vesicle junction
10. Inability to visualize the left kidney completely because of transducer position anterior to the left posterior axillary line

2. Urinary bladder and adjacent structures

When performing a complete ultrasound evaluation of the urinary tract, images of the prostate gland, distended urinary bladder and its wall should be included, if possible. Bladder lumen or wall abnormalities should be noted. Dilatation or other distal ureteral abnormalities should be documented. Transverse and longitudinal scans may be used to demonstrate any post-void residual, which may be quantitated and reported. The transducer (usually 3.5 to 5 MHz) is placed just superior to the symphysis

pubis and angled caudad to visualize the prostate.

3. Adrenal glands

When possible, usually in the newborn or young infant, long-axis and transverse images of the adrenal glands can be obtained. The adrenal glands are infrequently seen in adults. When visualized, the shape and size of the gland should be documented, as well as the presence of hemorrhage, masses, or other abnormalities.

4. Aorta

Transverse and longitudinal images of the abdominal aorta should be obtained. Dimensions may be documented as appropriate in the proximal, mid, and distal aorta and proximal iliac arteries. Patency/ stenosis may be evaluated with Doppler. If an aneurysm is present, the maximal anteroposterior(AP) and transverse size of the aneurysm should be measured. Measurements should be from outer wall to outer wall. Surrounding solf tissues should be evaluated for any abnormality. If aortic rupture or dissection is clinically suspected, ultrasound may not be the initial examination of choice.

5. Inferior vena cava (IVC)

Transverse and longitudinal images of the IVC should be obtained. Patency and abnormalities may be evaluated with Doppler. Vena cava filters, interruption devices, or catheters may need to be localized with respect to the hepatic and/or renal veins.

ERRORS IN SONOGRAM FOR ABDOMINAL AORTIC ANEURYSM

1. Failure to adequately compress overlying bowel with probe pressure
2. Confusion of the vena cava with the aorta due to transmitted pulsations
3. Overestimating the aneurysmal width due to lack of a true cross section
4. Misinterpreting acoustic enhancement distal to the aorta as evidence of leakage
5. Failure to move the transducer off the sagittal plane while following a tortuous aorta
6. Neglecting to note the take-off of the renal arteries
7. Not measuring external diameter (outer wall to outer wall)
8. Reluctance to move the transducer far laterally in an attempt to visualize an aorta that is obscured by overlying bowel gas
9. Neglecting to visualize the bifurcation of the iliacs
10. Confusing artifact for thrombus

Obstetrics

a. Early pregnancy
   Fetal viability
   Description of the gestational sac, embryo and yolk sac
   Single and multiple gestation (chorionicity)
b. Pathology
   Early pregnancy failure
   Ectopic pregnancy
   Gross fetal abnormalities such as nuchal translucency, hydropic abnormalities
   Hydatidiform mole
   Associated pelvic tumors

Fetal anatomical features from 18 weeks

a. Shape of the skull ; nuchal fold
b. Brain : ventricles and cerebellum, choroid plexus
c. Facial profile
d. spine : Both longitudinally and transversely
e. Heart rate and rhythm, size and position, fourchamber view
f. Size and morphology and of the lungs
g. Shape of the thorax and abdomen
h. Abdomen : Diaphragm, stomach, liver and umbilicus
i. Limbs : Femur, tibia and fibula humerus,

radius and ulna, feet and hands, these to include shape, echogenicity and movement

j. Multiple pregnancy : Monochorionic and dichorionic, twin to twin transfusion syndrome

k. Amount of amniotic fluid : optimum/oligo or poly-hydramnios

l. Placental location

m. Cord and number of vessels

Fetal biometry

a. Crown-rump length, biparietal diameter, femur length, head circumferevce, abdominal circumference, interpretation of growth charts

Activity : recognize and quantify

a. Fetal movement

b. Breathing movements

c. Eye movements

Gynecology

Normal pelvic anatomy
Uterine size and endometrial thickness
Measurement of ovaries
Pelvic tumors e.g. fibroids, cysts, hydrosalpink
Peritoneal fluid
Intrauterine contraceptive devices.

ERRORS IN EMERGENCY PELVIC SONOGRAM

1. Failure to ensure a very full bladder when performing transabdominal scanning
2. Overinterpreting a small amount of fluid in the cul-de-sac as evidence of leakage from an ectopic pregnancy or from an ovarian cyst
3. Identifying a large ovarian cyst as urinary bladder
4. Assuming that a normal-appearing gestational sac with a viable embryo is necessarily intrauterine
5. Misdiagnosing an empty gestational sac of more than 2.5 cm as a normal early pregnancy
6. Mistaking a pseudo gestational sac for an intrauterine pregnancy
7. Misinterpreting the hyperechoic decidual reaction within the uterus as evidence of intrauterine pregnancy
8. Neglecting to obtain a quantitative hCG when the sonographic findings are not consistent with the dates
9. Neglecting to transabdominal scan when transvaginal scan dose not explain symptoms
10. Failure to consider all eight distinct possibilities in a patient with a positive hCG but no intrauterine pregnancy on ultrasound : (a) Confirmed Ectopic Pregnancy, (b) Highly likely Ectopic pregnancy, (c) Very Early Normal Pregnancy, (d) occult Unruptured Ectopic Pregnancy, (e) Complete or Incomplete Spontaneous Abortion (Miscarriage), (f) Dead Embryo, (g) Embryonic Resorption/ Blighted Ovum, (h) Hydatidiform Mole/Tro phoblastic Disease.

PENIS & SCROTUM

Because the penis and scrotal are superficial and of modest size, a high-resolution transducer of 5 to 10 MHz frequency is used. Several sonographic techniques may be used : (1) to place towels between the patient's legs to support the scrotum, or (2) to use one hand to hold the scrotum and the other hand to maneuver the transducer (it requires the presence of a second individual to operate the ultrasound controls). Color Doppler must be done with the instrument set to detect low-velocity flow. One testicle may be used as an acoustic window to bring the other testicle into the focal zone. The epididymis is usually of similar or slightly increased echogenicity to the normal testis. The srotal contents and penis should be scanned in longitudinal and transverse planes.

REFERENCES

1. American Institute of Ultrasound in Medicine, 2003.

2. Heller M, jehle D : Ultrasound in Emergency Medicine, Philadelphia, Saunders, 1995.
3. Zwiebel WJ. The Scrotum. In Zwiebel WJ, Sohaey R : Introduction to Ultrasound, Philadephia, WB Saunders, 1998, pp. 532-543.
4. Goldberg BB (ed.) : Textbook of Abdominal Ultrasound, Baltimore, Williams & Wilkins, 1993.
5. Donald I, Mc Vicar J, Brown TG : Investigation of abdominal masses by pulsed ultrasound. Lancet 1953 ; 1 : 1188-1194.