

DEVELOPED BY
SOCIETY OF RADIOLOGISTS IN ULTRASOUND

DIAGNOSTIC RADIOLOGY RESIDENCY
ULTRASOUND CURRICULUM

Preface:

The following curriculum is intended as a guideline for the training of radiology residents in ultrasound. The resident should be familiar with this material as a result of hands-on clinical experience combined with formal teaching materials such as conferences, teaching files, books, etc. Depending on the organization of the residency program, this material could be covered during a dedicated ultrasound rotation, in a series of organ-based rotations that include more than one imaging modality, or in some combination of the two approaches.

CURRICULUM

BACKGROUND/TECHNICAL CONSIDERATIONS:

A. PHYSICS

- Definition of ultrasound, relationship of sound waves used in imaging to those of higher/lower frequency with other properties
- Working knowledge of frequency, sound speed, wavelength, intensity/decibels
- Interaction of sound waves with tissues: reflection, attenuation, scattering, refraction, absorption, acoustic impedance
- Generation/detection of ultrasound waves
- Doppler phenomenon
- Pulse-echo principles
- Beam formation/focusing

B. BIOEFFECTS/SAFETY

- Thermal/nonthermal effects on tissue
- Relative effects of gray scale, M-Mode, pulsed wave Doppler, color flow imaging, power imaging, harmonics
- Contrast agents

C. IMAGING APPLICATIONS/EQUIPMENT OPERATION

- Transducer choice
 - frequency: gray scale/Doppler (understand tradeoff of penetration/resolution), optimal gray scale probe may not be the optimal Doppler probe

- shape: linear, sector, curved
- approach: external, endocavitary, translabial
- Display: gray scale, M-Mode, pulsed wave Doppler, color/power imaging, 3-D
- Image orientation: standard images in different planes
- Image optimization: power output, gain, time gain compensation
- Image recording options- electronic (digital), film, paper, videocassette
- Endocavitary imaging - vaginal, rectal, endoscopic techniques
- Interventional techniques

D. ARTIFACTS:

- Underlying principles (straight narrow sound beams, simple reflection, constant sound speed)
- Beamwidth artifacts, sidelobes, slice thickness
- Multiple reflection artifacts - mirror image/reverberations
- Tissue characteristics- shadowing/enhancement
- Refractive artifacts
- Doppler artifacts- pulse wave, color imaging(includes aliasing)

E. QUALITY ASSURANCE

- Equipment QA Program
- Phantoms- spatial/ contrast resolution
- Sonographer/physician based QA

II. CLINICAL USES OF ULTRASOUND

A. GENERAL CONSIDERATIONS

-Examination protocols- protocols for each routine examination should be understood. Published protocols/standards from the American College of Radiology (ACR) or American Institute of Ultrasound in Medicine (AIUM) with or without local modification are acceptable frames of reference. Residents should be familiar with the ACR Appropriateness Criteria as a guide for appropriate clinical use of ultrasound and other imaging modalities.

-Basic cross sectional/ultrasound anatomy/range of normal sonographic findings as related to age and sex for each of the anatomic areas included below.

-General diagnostic criteria used to evaluate tissue characteristics and distinguish normal from abnormal, cystic from solid, etc.

-General knowledge of clinical uses/limitations of ultrasound and use of other imaging studies to complement ultrasound

-Techniques for ultrasound guided invasive procedures- aspiration(of tissue masses, fluid collections), biopsy, catheter placement(into pleural, peritoneal, other fluid collections), amniocentesis

-Reporting skills/ requirements

B. SPECIFIC APPLICATIONS

HEAD/SPINE

Neonatal head: hemorrhage, hydrocephalus, shunt evaluation, periventricular leukomalacia, congenital malformations

Neonatal spine: lipoma, tethered cord, sacral skin dimple

Neurosurgical: guidance for intracranial fluid aspiration, mass localization

NECK

Thyroid: size, shape, multinodular goiter, thyroiditis, benign/malignant neoplasm, associated adenopathy, localization of parathyroid mass, biopsy of thyroid/parathyroid mass or adenopathy

CHEST

Pleural fluid (simple vs. loculated/complex) or mass, aspiration/catheter drainage of fluid

Breast: cystic vs solid mass, malignancy, abscess, ultrasound-guided needle localization/biopsy/cyst aspiration

Cardiac: pericardial effusion

ABDOMEN

Liver: normal size, shape, echotexture, diffuse disease, focal mass (cyst, hemangioma, hepatocellular carcinoma, metastatic lesions), cirrhosis/portal hypertension, varices, transplant evaluation

Gallbladder/Bile Ducts: normal gallbladder, intra- and extra-hepatic duct size, gallstones, acute cholecystitis (calculus/acalculus), hyperplastic cholecystoses, sludge, polyps, carcinoma, HIV related biliary disease, biliary obstruction/dilatation, duct stones

Pancreas: normal anatomy/size, duct size, acute/chronic pancreatitis, pseudocyst, calcifications, cysts, masses (benign/malignant), transplant evaluation

Spleen: normal anatomy/size, focal lesions (cystic vs solid), trauma, splenic varices

Kidneys/Ureters: normal anatomy/size, cysts (simple/ complex), cystic diseases, renal cell carcinoma, angiomyolipoma, hydronephrosis/hydroureter, calculi, abscess/pyelonephritis, perinephric fluid, renal transplant evaluation (include Doppler)

Adrenal Glands: focal lesion (cyst/solid), neonatal hemorrhage

Peritoneal Cavity: localization/quantification/aspiration of fluid (free/loculated) – including abscess, blood, omental mass, free air

Gastrointestinal Tract: normal appearance, appendicitis, pyloric stenosis, intussusception, mass

Retroperitoneum: adenopathy, mass

PELVIS (excluding pregnancy)

Urinary Bladder: mass, calculi, obstruction, infection, diverticula, ureterocele, color flow imaging of ureteral jets, volume measurements

Uterus: normal size, shape, echogenicity. Endometrium- normal thickness (premenopausal, postmenopausal, effect of hormone replacement), physiologic variation, carcinoma, hyperplasia, polyps, endometritis, pyometra. Myometrium- leiomyomata, adenomyosis. Cervix- mass, stenosis, obstruction. Saline hysterosonography.

Ovary: normal size, shape, echogenicity, physiologic variation (follicles, corpus luteum). Torsion, infection, abscess, cystic/solid mass- cystadenoma/carcinoma, hemorrhagic cyst, dermoid, endometrioma

Fallopian Tube: hydrosalpinx, pyosalpinx

Prostate: normal size, shape, echogenicity, cystic/solid mass, carcinoma, abscess, biopsy

Scrotum: normal size, shape, echogenicity of testis and epididymis, cystic/solid testicular or extratesticular mass. Testicular carcinoma, torsion, epididymitis/orchitis, varicocele, hydrocele, spermatocele, trauma, testicular calcifications (microlithiasis, granuloma)

EXTREMITIES

Mass (cystic/solid), tendon (tear, inflammation), neonatal hip, foreign body

VASCULAR

Carotid duplex exam(with Doppler spectrum analysis) including normal appearance, arterial occlusion, stenosis, plaque, subclavian steal

Aorta (normal/aneurysm, including proximal and distal extent), inferior vena cava (normal/thrombosis)

Subclavian and jugular vein thrombosis, venous access for catheter placement. Peripheral venous thrombosis evaluation(upper and lower extremity) with compression/Doppler/color imaging, venous insufficiency. Aneurysm, pseudoaneurysm (diagnosis and treatment with compression or thrombin injection), arteriovenous fistula, surgical vascular grafts

Abdominal Doppler, including pulsed Doppler and color imaging of hepatic arteries, veins, and portal veins, intrahepatic portal-systemic shunt Doppler evaluation. Renal arterial Doppler(including use of resistive index). Renal venous Doppler (normal/thrombosis)

OBSTETRICS

EARLY PREGNANCY:

Normal findings: gestational sac appearance, size, growth, yolk sac, embryo, cardiac activity, amnion, chorion, embryology, normal early fetal anatomy/growth, crown rump measurement, multiple gestations, correlation with hCG levels, nuchal translucency

Abnormal findings: spontaneous abortion, embryonic death, failed early pregnancy, bleeding/hematoma, ectopic pregnancy, gestational trophoblastic disease, gross embryonic structural abnormalities

2ND/3RD TRIMESTER:

Normal findings: fetal anatomy/development, placenta, biometry, amniotic fluid, multiple gestations, umbilical cord Doppler, alphafetoprotein testing, perform complete exam according to the AIUM/ACR guidelines. Amniocentesis, chorionic villous sampling guidance.

Nonfetal abnormalities: oligohydramnios, polyhydramnios, placenta previa, placental abruption, placental masses, 2 vessel umbilical cord, cord masses, cervical shortening/dilatation (including translabial and transvaginal imaging).

Fetal abnormalities: intrauterine growth retardation, chromosomal abnormalities/associated syndromes, hydrops, congenital infections, neural tube defects, hydrocephalus, hydranencephaly, chest masses, cardiac malformations and arrhythmias, diaphragmatic hernia, abdominal wall defects, abdominal masses, GI tract obstructions,

urinary tract obstruction/cystic abnormalities, renal agenesis, ascites, limb shortening abnormalities, cleft lip/palate, twin/twin transfusion syndrome.

Understand significance of borderline findings: choroid plexus cyst, echogenic focus in heart, echogenic bowel, borderline hydrocephalus.