

## ULTRASOUND STUDY GUIDE

- **Technical knowledge**
  - Physics and Safety
    - Sound properties and interactions
      - Reflection
      - Attenuation
      - Refraction
      - Acoustic impedance
    - Transducer fundamentals
      - Transmit frequencies
      - Transducer types
    - Beam formation
      - Focusing
      - Steering
      - Other
    - Imaging modes
      - Panoramic imaging
      - Compound imaging
      - Harmonic imaging
      - Elastography
      - Contrast imaging
        - 3D
        - M-mode
        - Doppler
    - System Controls & Quality Assurance
      - Gain
      - Time gain compensation
      - Power output
      - Focal zone
      - Transmit frequency
      - Depth
      - Dynamic range
      - Frame rate

- Doppler
  - Doppler phenomenon
  - Doppler equation
  - Modes
    - Pulsed/Spectral Doppler
    - Duplex Doppler
    - Color Doppler
    - Power Doppler
    - Continuous wave Doppler
    - B-flow
    - Microflow imaging
    - Vector imaging
  - Doppler controls & Quality assurance
    - Color box
    - Gain
    - Doppler angle
    - Pulse repetition frequency / Scale
    - Transmit frequency
    - Wall filter
    - Color write priority
    - Sample volume size
    - Beam steering
  - Doppler measurements
    - Velocity
    - Resistive index
    - Pulsatility index
    - Systolic acceleration time
    - Volume flow
- Artifacts
  - Grayscale
    - Shadowing
    - Increased through transmission
    - Mirror imaging
    - Reverberation
    - Ring-down
    - Comet tail
    - Speed propagation
    - Refraction
    - Side-lobe
    - Slice thickness
    - Anisotropy
    - Noise

- Electrical interference
  - Doppler
    - Aliasing
    - Motion/Tissue vibration
    - Mirror imaging
    - Spectral broadening
    - Blooming
    - Twinkle
    - Acoustic streaming
  - Other
- Safety
  - Mechanical / Cavitation
  - Thermal
  - Mechanical index
  - Thermal index
  - Transducer safety/care – Understand the care and cleaning of transducers.
  - Equipment quality assurance
    - Phantoms
    - Resolution (spatial and contrast)
- **Pathological Diagnosis**
  - Gastrointestinal (nonvascular)
    - Bowel
      - Normal (including congenital anomalies)
      - Appendicitis
      - Diverticulitis
      - Epiploic appendicitis
      - Inflammatory bowel disease
      - Colitis
      - Intussusception
      - Ischemic bowel
      - Small bowel obstruction
      - Cancer (primary, metastases, lymphoma)
      - Benign masses
      - Anal sphincter (normal, tear, fistula)
    - Liver
      - Normal (including congenital anomalies)
      - Focal masses
        - Cystic
          - Simple
          - Complex
        - Hemangiomas

- Biloma
    - Abscess
    - Echinococcus
  - Solid
    - Focal nodular hyperplasia
    - Adenoma
    - Metastases
    - Hepatocellular carcinoma
    - Cholangiocarcinoma - intrahepatic
    - Lymphoma
    - Biliary hamartomas
- Perihepatic collections
- Diffuse disease
  - Steatosis (diffuse and focal)
  - Hepatitis (acute and chronic)
  - Cirrhosis
  - Edema
  - Infarction (diffuse and focal)
  - Infiltrative diseases
  - Elastography
  - Fat quantification
  - Other
- Trauma
- Transplant (nonvascular)
  - Biloma
  - Hematoma
  - Abscess
  - Bile duct abnormalities
  - Post-transplant lymphoproliferative disease
  - Perihepatic collections
- Gallbladder
  - Normal (including congenital anomalies)
  - Gallstones
  - Sludge
  - Acute cholecystitis
    - Calculous
    - Acalculous
    - Gangrenous
    - Perforated
    - Emphysematous
    - Hemorrhagic
  - Chronic cholecystitis

- Wall thickening (nonbiliary related)
- Polyp
- Adenomyomatosis
- Porcelain
- Carcinoma
- Metastases
- Lymphoma
- Bile ducts
  - Normal (including congenital anomalies)
  - Dilatation (extra- and intrahepatic)
  - Choledocholithiasis
  - Cholangitis
    - Primary sclerosing cholangitis
    - Pyogenic cholangitis
    - Recurrent pyogenic cholangitis
    - AIDS cholangitis
  - Caroli disease
  - Choledochal cyst
  - Pneumobilia
  - Cholangiocarcinoma
  - Stents
- Pancreas
  - Normal (including congenital anomalies)
  - Cystic lesions
    - Simple cysts
    - PSAs
    - Pseudocysts
    - Abscess
    - Cystic neoplasms
  - Acute pancreatitis
  - Chronic pancreatitis
  - Pancreatic necrosis
  - Cancer
    - Adenocarcinoma
    - Islet cell neoplasm
    - Metastases
    - Lymphoma
  - Transplant (nonvascular)
    - Pancreatitis
    - Pseudocyst
    - Hematoma
    - Abscess

- Post-transplant lymphoproliferative disease
- Spleen
  - Normal (including congenital anomalies)
  - Splenomegaly
  - Splenosis
  - Infarction
  - Cystic lesions
    - Simple
    - Complex
    - Abscess
    - Necrotic tumor
  - Solid lesions
    - Hemangioma
    - Hamartoma
    - Malignancy (Lymphoma, Metastases, Angiosarcoma)
    -
  - Trauma
    - Hematoma
    - Laceration
- Peritoneum
  - Normal
  - Ascites
  - Abscess/infection/peritonitis
  - Hemorrhage
  - Carcinomatosis
  - Lymphoma
  - Primary peritoneal cancer
  - Mesothelioma
  - Free air
  - Mesenteric lymphadenopathy
- Abdominal wall
  - Normal
  - Hematoma
  - Abscess
  - Endometriosis
  - Hernia
  - Primary neoplasm
  - Metastasis
  - Lymphoma
  - Desmoid
  - Lipoma

- Postsurgical changes
- Genitourinary
  - Kidney (nonvascular: native and transplant) and intrarenal collecting system
    - Normal (including variants and congenital anomalies)
    - Cortical abnormalities
      - Renal parenchymal disease
      - Pyelonephritis
      - Infarction
      - Cortical necrosis
      - Nephrocalcinosis (Medullary and cortical)
    - Cystic lesions and cystic renal disease
      - Simple
      - Complex
      - Polycystic disease – Autosomal dominant
      - Multicystic dysplastic
      - Acquired renal cystic disease
      - Lithium toxicity
    - Masses (solid or with solid components)
      - Angiomyolipoma
      - Oncocytoma
      - Multilocular cystic nephroma
      - Renal cell carcinoma (all types)
      - Metastasis
      - Lymphoma
      - Post transplant lymphoproliferative disease
      - Urothelial carcinoma
    - Infections
      - Pyelonephritis
      - Pyonephrosis
      - Abscess
      - Emphysematous pyelonephritis/pyelitis
      - Xanthogranulomatous pyelonephritis
    - Collecting system abnormalities
      - Hydronephrosis
      - Pyonephrosis
      - Calculi
      - Clot/Fungus ball in collecting system
      - Malignancy
    - Perinephric abnormalities
      - Urinoma
      - Hematoma

- Lymphocele
- Abscess
- Lymphoma
- Ureter
  - Normal (including variants and congenital anomalies)
  - Dilated ureter
  - Ureteral calculus
  - Clot/fungus ball in collecting system
  - Urothelial cancer
  - Stents
- Bladder
  - Normal
  - Calculi
  - Wall thickening
  - Solid masses
    - Urothelial cancer
    - Polyp
    - endometriosis
    - Urachal remnant/CA
    - [heochromocytoma
  - Cystitis
    - Emphysematous cystitis
  - Hemorrhage/clot/fungus ball
  - Bladder outlet obstruction
  - Neurogenic bladder
- Urethra
  - Normal
  - Diverticulum
  - Cyst
  - Abscess
  - Mass
  - Stricture/stenosis
- Scrotum
  - Testes
    - Normal (including variants and congenital anomalies)
    - Orchitis
    - Torsion/detorsion
    - Microlithiasis
    - Masses
      - Germ cell tumor
      - Lymphoma
      - Metastasis



- Stromal tumor
  - Adenomatoid tumor
  - Epidermoid cyst
  - Hematoma
  - Intratesticular varicocele
  - Abscess
  - Cyst – Intratesticular
  - Cyst – Tunica albuginea
  - Adrenal rest
- Focal atrophy/fibrosis
- Sarcoidosis
- Tuberculosis
- Infarct
- Trauma/laceration/hematoma
- Epididymis
  - Normal
  - Epididymitis
  - Abscess
  - Cyst/Spermatocele
  - Adenomatoid tumor
  - Sperm cell granuloma
  - Postvasectomy/Congestion
- Miscellaneous
  - Hydrocele
  - Pyocele
  - Hematocele
  - Varicocele
  - Fournier gangrene
  - Scrotal wall edema
  - Scrotal wall abscess
  - Hernia
  - Scrotolith
  - Vas deferens
  - Appendix testis/epididymis
  - Torsed appendix
  - Spermatic cord
    - Cyst
    - Hematoma
    - Abscess
    - Lipoma/benign tumor
    - Malignant tumor
- Prostate
  - Normal

- Benign prostatic hypertrophy
  - Cancer
  - Prostatitis
  - Abscess
  - Seminal vesicles
    - Normal
    - Cyst/Mass
    - Dilated duct
  - Penis
    - Normal
    - Peyronie disease
    - Masses
    - Doppler
      - Normal
      - Abnormal
  - Adrenal gland
    - Normal
    - Solid mass
      - Adenoma
      - Pheochromocytoma
      - Myelolipoma
      - Metastasis
      - Lymphoma
      - Cancer
    - Hyperplasia
    - Hemorrhage
  - Retroperitoneum
    - Normal
    - Adenopathy
      - Lymphoma
      - Metastatic disease
      - Reactive/Infectious/Inflammatory
    - Primary tumor
      - Location
      - Relationship to blood vessels and surrounding structures
    - Hemorrhage
    - Abscess
    - Fibrosis
- Gynecology
  - Uterus
    - Normal (including congenital anomalies, pre- and post-menopausal)

- Endometrium
      - Effects of hormone replacement
      - Intrauterine device
        - Normal location
        - Migrated/perforated
      - Endometrial fluid/hemorrhage
      - Polyp
      - Hyperplasia
      - Carcinoma
      - Endometritis
    - Myometrium
      - Fibroids
      - Lipoleiomyoma
      - Leiomyosarcoma
      - Adenomyosis
      - C-section scar
      - Vascular lesions
  - Cervix
    - Stenosis
    - Polyp
    - Cancer
    - Adenoma malignum
    - Fibroid
  - Ovary/Adnexa
    - Normal (pre and post-menopausal)
    - Polycystic ovarian disease
    - Ovarian hyperstimulation syndrome
    - Masses/cysts
      - Follicles/Simple cyst
      - Hemorrhagic/ruptured cyst
      - Endometrioma
      - Cystadenoma/carcinoma
      - Dermoid
      - Other germ cell tumors
      - Fibroma/thecoma
      - Other stromal tumors / granulosa cell tumor
      - Metastasis
    - Ovarian torsion
    - Pelvic inflammatory disease
    - Tubo-ovarian abscess/complex
    - Peritoneal inclusion cyst
    -

- Fallopian tube
  - Hydrosalpinx
  - Pyosalpinx
  - Hematosalpinx
  - Torsion
  - Mass
- Vagina
  - Cysts
  - Solid mass
  - Congenital anomalies
- Obstetrics
  - First trimester
    - Normal
      - Gestational Sac
      - Yolk sac
      - Embryo/Fetus
      - Cardiac activity/rate
      - Amnion
      - Chorion
      - hCG levels / menstrual dates
    - Multiple gestations (chorionicity and amnionicity)
    - Failed early pregnancy and embryonic demise
      - Diagnosis
      - Risk factors
    - Miscarriage
    - Retained products of conception
    - Ectopic pregnancy
      - Tubal
      - Interstitial
      - Cervical
      - Ovarian
      - Cesarean scar
      - Abdominal
      - Rudimentary horn
      - Heterotopic
    - Pregnancy of unknown location
    - Gestational trophoblastic disease
    - Nuchal translucency / first trimester screening
    - Chorionic villus sampling (CVS)/Amniocentesis
    - Cell free DNA
    - Embryonic/fetal structures: Normal and abnormal
  - Second and third trimester

- Normal findings
  - Fetus
  - Placenta, cervix
  - Biometry
  - Amniotic fluid
  - Multiple gestations (including chorionicity and amnionity)
- Fetal abnormalities
  - Abnormal growth/well-being
  - Hydrops
  - Fetal death
  - Structural abnormalities
    - CNS
    - Face and Neck
    - GU
    - GI
    - Chest
    - Skeletal
    - Chromosomal abnormalities
      - Down syndrome
      - Turner syndrome
      - Trisomy 18
      - Trisomy 13
    - Syndromes
      - Amniotic band
      - Meckel-Gruber
      - Beckwith-Wiedmann
      - VACTERL
      - Caudal regression
  - Congenital infections
- Aneuploidy markers / Borderline findings
  - Nuchal thickening
  - Choroid plexus cyst
  - Echogenic intracardiac focus (EIF)
  - Echogenic bowel
  - Borderline hydrocephalus
- Oligohydramnios
- Polyhydramnios
- Twins/multiple gestations
  - Types
  - Multiple gestation abnormalities
    - Twin-to-twin transfusion / Stuck twin
    - Acardiac twin (twin reversed arterial perfusion [TRAP])

- Twin demise
  - Monoamniotic twins / cord entanglement
  - Abnormal growth
- Placenta
  - Placenta previa
  - Marginal
  - Succenturiate placenta
  - Circumvallate
  - Vasa previa
  - Abruptio
  - Placenta accreta spectrum
  - Masses
  - Subchorionic bleed
  - Thick placenta
- Cervix
  - Shortening / Dilatation
  - Cerclage
  - Risks for preterm labor
- Umbilical cord
  - Two-vessel umbilical cord
  - Cord masses
  - Placental cord insertion site
  - Velamentous cord insertion
  - Cord prolapse
  - Umbilical cord Doppler
  - Nuchal
- Uterine abnormalities during pregnancy
- Adnexal abnormalities during pregnancy
- Postpartum
  - Retained products of conception
  - Ovarian vein thrombosis
  - Uterine rupture
  - Uterine atony
  - Infection
  - Complications s/p Cesarean section delivery
- Vascular
  - Arterial pathology involving the following beds:
    - Extracranial carotid arteries
    - Vertebral arteries
    - Aorta
    - Mesenteric arteries (Celiac, SMA, IMA)
    - Renal arteries

- Splenic artery
- Hepatic artery
- Peripheral arteries (upper and lower extremities)
- Pelvic arteries

For all the above arterial territories, evaluation of the following:

- Normal grayscale, color Doppler and spectral Doppler waveforms (including variants and congenital anomalies)
- Plaque / Fibrointimal thickening
- Stenosis
- Occlusion
- Dissection
- Arteriovenous fistula
- Aneurysm
- Pseudoaneurysm
- Imaging s/p intervention: arterial bypass grafts, endarterectomy, stent, vascular access
  - Normal
  - Restenosis/occlusion
  - Complications, including infection, PSA, AVF
- Vasculitis/arteritis
- Waveform abnormalities

Additional pathology specific to individual arterial beds:

- Vertebral artery
  - Subclavian steal
- Upper extremity arteries
  - Thoracic outlet syndrome
  - Takayasu arteritis
  - Palmar arch (harvesting)
    - Patency
    - Direction of flow
- Hemodialysis graft/fistula
  - Lack of maturation
  - Steal
  - Fluid collections
  - Flow volume
- Lower extremity arteries
  - s/p arterial bypass grafts
    - Persistent perforators
- Aorta
  - Screening for AAA
  - Stent grafts: normal
  - Endoleak

- Coarctation
- Renal artery
  - Screening for renovascular hypertension
  - Fibromuscular dysplasia
- Venous pathology
  - Extremity venous (including IVC)
    - Normal grayscale, color Doppler and spectral Doppler waveforms (including variants and congenital anomalies)
    - Thrombus
      - IVC filter
      - Tumor in IVC (metastatic or primary)
    - Stenosis
    - Abnormal waveforms
      - Tricuspid regurgitation / Right-sided heart failure
      - cephalad obstruction to flow
    - Venous insufficiency
    - Venous mapping (harvesting and dialysis access creation)
    - Venous thoracic outlet syndrome
  - Portal, coronary, splenic and superior mesenteric veins
    - Normal grayscale, color Doppler and spectral Doppler waveforms (including variants and congenital anomalies)
    - Bland thrombus
    - Tumor in vein
    - Stenosis
    - Cavernous transformation
    - Aneurysm/Varix
    - Portal hypertension
    - Portosystemic collaterals
    - Congestion / heart failure
    - Gas
    - PV to HV fistula
  - Hepatic vein
    - Normal grayscale, color Doppler and spectral Doppler waveforms (including variants and congenital anomalies)
    - Bland thrombus
    - Tumor in vein
    - Budd Chiari syndrome
    - Stenosis
    - Tricuspid regurgitation/congestive heart failure
    - Portohepatic vein fistula (arterial or venous)
  - TIPS
    - Normal



- Stenosis
  - Occlusion
- Renal vein
  - Normal grayscale, color Doppler and spectral Doppler waveforms (including variants and congenital anomalies)
  - Thrombus
  - Tumor in vein
  - Stenosis
  - Nutcracker syndrome
- Kidney Transplant Vasculature
  - Normal
  - Elevated resistive index
    - Rejection
    - Acute tubular necrosis
    - Page kidney
    - Hydronephrosis
    - Pyelonephritis
    - Renal vein thrombosis
    - Compartment syndrome, torquing of pedicle
    - Transducer pressure
  - Arterial stenosis / thrombosis
  - Pseudoaneurysm
  - Arteriovenous fistula
  - Venous stenosis/thrombosis
  - Infarction
  - in flow or outflow pathology
- Liver Transplant Vasculature
  - Normal
  - Arterial stenosis / thrombosis
  - Resistive index abnormalities
  - Vasospasm
  - Portal vein thrombosis / stenosis
  - Hepatic vein thrombosis/stenosis
  - Inferior vena cava stenosis / thrombosis Heart Failure / Congestion
  - Pseudoaneurysm
  - Arteriovenous fistula
- Pancreas Transplant Vasculature
  - Normal
  - Arterial thrombosis / stenosis
  - Venous thrombosis / stenosis
  - Pseudoaneurysm
  - Arteriovenous fistula

- Neck and Head (nonvascular)
  - Thyroid
    - Normal (including variants and congenital anomalies)
    - Hashimoto thyroiditis
    - Graves disease
    - Subacute thyroiditis
    - Benign hyperplastic nodule
    - Adenoma – follicular/Hurthle cell
    - Papillary cancer
    - Follicular cancer
    - Medullary cancer
    - Anaplastic cancer
    - Lymphoma
    - Metastasis
    - Multinodular goiter
    - Cyst
      - Simple
      - Complex
    - Guidelines for fine-needle aspiration
    - Metastatic cervical lymph nodes
  - Parathyroid
    - Normal
    - Adenoma
    - Hyperplasia
    - Carcinoma
    - Cyst
  - Lymph nodes
    - Normal
    - Reactive / inflammatory
    - Infectious
    - Metastatic
    - Lymphoma
  - Salivary glands
    - Normal
    - Infection/inflammation
    - Abscess
    - Stones
    - Dilated duct
    - Pleomorphic adenoma
    - Warthin's neoplasm
    - Mucoepidermoid cancer
    - Adenoid cystic cancer
    - Acinic cell cancer

- Lymphoma
  - Cyst
    - Simple
    - Complex
- Neck Soft tissues
  - Branchial cleft cyst
  - Thyroglossal duct cyst
  - Lymphangioma/Hemangioma
  - Lipoma
  - Keratinous/Epidermal inclusion/Sebaceous cyst
  - Hematoma
  - Abscess
  - Carotid body tumor
  - Hypopharynx cancer
- Musculoskeletal (nonvascular)
  - Normal (including variants & congenital anomalies)
    - Tendon
    - Muscle
    - Ligament
    - Cartilage
    - Bone
    - Nerve
  - Tendons
    - Tear of major tendons (complete or partial)
    - Tendinosis
    - Tenosynovitis
    - Subluxation (pulley injury)
  - Muscle
    - Tear
    - Hematoma
    - Abscess
    - Neoplasm
    - Atrophy
    - Fatty infiltration
    - Myositis
    - Necrosis
  - Nerve
    - Compression
    - Neuroma
    - Neoplasm
    - Neuritis
    - Trauma/laceration
    - Subluxation

- Bone
  - Fracture
  - Osteomyelitis
  - Neoplasm
- Ligaments
  - Tear
  - Plantar fasciitis
  - Plantar fibroma
  - Pulley rupture
- Soft tissues / Joints / General extremity
  - Joint effusion (simple vs complex)
  - Synovitis
  - Cystic lesions
    - Simple
    - Complex
  - Soft tissue edema vs Cellulitis
  - Necrotizing fasciitis
  - Solid lesions
    - Lipoma
    - Desmoid
    - Primary neoplasm
    - Metastasis
    - Lymphoma
    - Giant cell tumor tendon sheath
  - Trauma
    - Foreign body
    - Hematoma
- Thoracic (nonvascular)
  - Lung, Pleura
    - Normal
    - Pleural effusion
    - Empyema
    - Hemothorax
    - Pneumothorax
    - Atelectasis
    - Pneumonia
    - Lung cancer
    - Metastasis
    - Mesothelioma
  - Mediastinum
    - Adenopathy
    - Primary neoplasm

- Hematoma
  - Abscess
- Noninterpretive Clinical applications
  - Protocols
  - Appropriateness
  - Documentation, reporting, communication
  - Clinical quality assurance