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## **ABDOMEN LIMITED PROTOCOL or RUQ, LIVER, GALLBLADDER**

The patient should be NPO as least 6-8 hours prior to the examination.

- Obtain pertinent patient history
- Image documentation
  - Pancreas
    - Transverse images, include long images if pathology is seen
  - Liver
    - Long image to include right liver/right kidney interface
    - Long measurement of right kidney (TCA/ECH only)
    - Long images of right lobe through to left lobe to demonstrate echotexture and any pathology.
    - Long measurement of liver length.
    - Transverse images of superior liver to inferior liver showing echotexture and any pathology.
    - Transverse image of hepatic veins.
    - Transverse image(s) of liver to demonstrate main portal vein. Include right and left portal veins when possible.
    - Images of liver/portal vein with and without color Doppler
    - PW Doppler of portal vein flow
  - Biliary system
    - Common bile duct, with and without measurement.
    - Long gallbladder images with patient in supine and decubitus position
    - Transverse gallbladder images with patient in supine and decubitus position
    - Measurement of gallbladder wall, if it appears thickened
    - Upright position is required if gallbladder is difficult to image supine and/or decub. Or if unable to verify movement of possible gallstones.
    - Image the gallbladder fossa if it is surgically absent.
  - IVC
    - Sagittal images with and without color Doppler.
  - Right Kidney
    - Long and transverse images with measurements.

# ABDOMEN COMPLETE PROTOCOL

The patient should be NPO as least 6-8 hours prior to the examination.

- Obtain patient history
- Image documentation
  - Pancreas
    - Transverse images, long images included if pathology is seen.
  - Liver
    - Long images to include right liver and right kidney interface
    - Long measurement of right kidney (TCA/ECH only)
    - Long images of right lobe through to left lobe to demonstrate echotexture and any pathology.
    - Long measurement of liver length.
    - Transverse images of superior liver to inferior liver showing echotexture and any pathology.
    - Transverse image of hepatic veins.
    - Transverse image(s) of liver to demonstrate main portal vein. Include right and left portal veins when possible.
    - Images of liver/portal vein with and without color Doppler
    - PW Doppler of portal vein flow
  - Biliary system
    - Common bile duct, with and without measurement.
    - Long gallbladder images with patient in supine and decubitus position
    - Transverse gallbladder images with patient in supine and decubitus position
    - Measurement of gallbladder wall, if it appears thickened
    - Upright position is required if gallbladder is difficult to image supine and/or decub. Or if unable to verify movement of possible gallstones.
    - Image the gallbladder fossa if it is surgically absent.
  - Aorta
    - Long images proximal, mid and distal, with and without measurements. Transverse prox, mid, and distal images if dilatation/aneurysm is noted (Include transverse measurements)
  - IVC
    - Long images with and without color Doppler.
  - Spleen
    - Long images with length measurement. If spleen appears enlarged, include all 3 measurements.
    - Long image of spleen/left kidney interface if possible
    - Transverse images
  - Renals
    - Long and transverse images with measurements

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# **CELIAC ARTERY COMPRESSION SYNDROME ULTRASOUND PROTOCOL**

The patient should be NPO as least 6-8 hours prior to the examination

## **Obtain patient history**

### **Image documentation:**

- Record proximal aortic velocity just below the diaphragm proximal to the celiac axis
- Record highest velocity in the proximal celiac axis during maximum inspiration and expiration in supine position.
- Record highest velocity in the proximal celiac axis in erect position.

# TIPS ULTRASOUND PROTOCOL

The patient should be NPO as least 6-8 hours prior to the examination

**Overview:** This exam will include the entire liver, a four quadrant evaluation for ascites, and color and spectral Doppler evaluation of the TIPS, the portal veins, and the hepatic vein that the TIPS communicates with.

## **Gray Scale Images:**

1. Transverse liver with all hepatic veins: Take more than one image if necessary to be sure all three hepatic veins are imaged.
  
2. Transverse image of the liver with the portal vein
  
3. Longitudinal liver with images to include:
  - Left lobe of liver with prox. Aorta
  - Left lobe of liver with left portal vein
  - Liver with IVC labeled
  - Right lobe of liver with right portal vein
  - Right lobe of liver / right kidney interface
  
4. Four quadrant assessment for ascites (RUQ, RLQ, LUQ, LLQ)

**Color and Spectral Doppler Images:** (Determine which portal and hepatic vein the TIPS communicates with)

1. Color and angle-corrected spectral Doppler with PSV measured of the portal vein proximal to its communication with the TIPS
  
2. TIPS at its communication with the portal vein with color and angle-corrected spectral Doppler and PSV measured

3. Proximal TIPS with color and angle-corrected spectral Doppler and PSV measured
4. Mid TIPS with color and angle-corrected spectral Doppler and PSV measured
5. Distal TIPS with color and angle-corrected spectral Doppler and PSV measured
6. TIPS at its communication with the hepatic vein with color and angle-corrected spectral Doppler and PSV measured
7. Hepatic vein just distal to its communication with the TIPS with color and angle-corrected spectral Doppler
8. All portal veins (main, right, left) should be evaluated for flow direction with color and angle-corrected spectral Doppler with the PSV measured.

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# TRANSCRANIAL DOPPLER EXAM

## **Indications:**

- Subarachnoid hemorrhage (SAH)
- To assess for intracranial vasospasm

## **Prior to exam:**

- Obtain patient history.
- Look for prior MRA, CTA, or Cerebral Angiography to assess patient anatomy before start of exam.

## **Exam Documentation:**

1. Peak Systolic (PS), End-diastolic (ED), and Mean velocities (TAMAX on GE system) should be obtained at each site. Enter all velocities into vascular report on system. Capture image of Vessel Worksheet report page.

## **Anterior Circulation:** Scanned through patient's temporal window.

- Scan patient's right circulation first. All Doppler waveforms obtained with ZERO ANGLE CORRECTION.
  1. MCA-- Prox, Mid, and Dist
  2. ACA-- Prox, Mid, and Dist
  3. PCA-- Prox, Mid, and Dist
  4. Terminal ICA
  5. Extracranial ICA. Measured at distal most segment that a good Doppler waveform can be obtained.
- Scan patient's Left circulation. All Doppler waveforms obtained with ZERO ANGLE CORRECTION.
  1. MCA-- Prox, Mid, and Dist
  2. ACA-- Prox, Mid, and Dist
  3. PCA-- Prox, Mid, and Dist
  4. Terminal ICA
  5. Extracranial ICA. Measured at distal most segment that a good Doppler waveform can be obtained.

## **Posterior Circulation:** Scanned through Foramen Magnum, slightly off center to avoid the cervical spine. (Only need to scan if posterior circulation is involved.)

- All Doppler waveforms obtained with ZERO ANGLE CORRECTION.
  1. Intracranial Right Vertebral Artery—Prox, Mid, and Dist
  2. Intracranial Left Vertebral Artery—Prox, Mid, and Dist
  3. Basilar Artery—Prox, Mid, and Dist
  4. Extracranial Distal Right and Left Vertebral arteries. Measured at distal most segment that a good Doppler waveform can be obtained.

## **WORKSHEET:**

2. Fill entire worksheet with values obtained during study.
3. Calculate MCA/Dist extracranial carotid ratio for each side. (Formula on worksheet.)
4. Calculate Basilar/Dist extracranial vertebral ratio for each side, if posterior circulation was scanned. (Formula on worksheet.)

## **CRANIAL (Neonatal Head) ULTRASOUND PROTOCOL**



### Indications:

- Premature, ? Intraventricular Hemorrhage
- Enlarged Head Circumference
- Traumatic Delivery
- Hydrocephalus
- Periventricular leukomalacia

### Prior to exam:

- Obtain gestational age at birth and type of delivery
- Obtain pertinent history

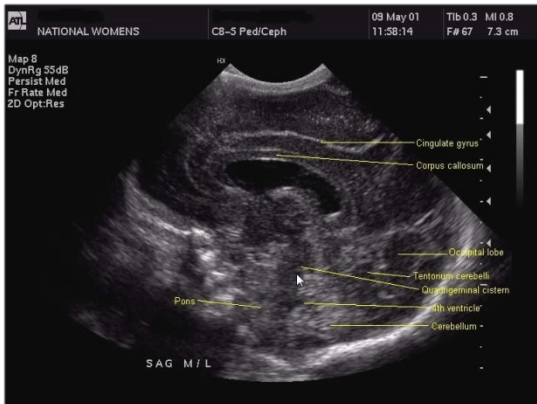
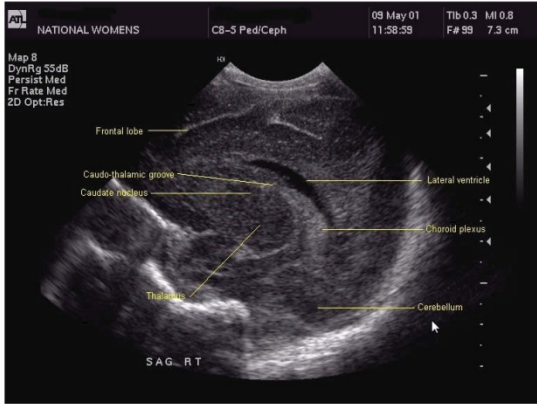
### Image Documentation:

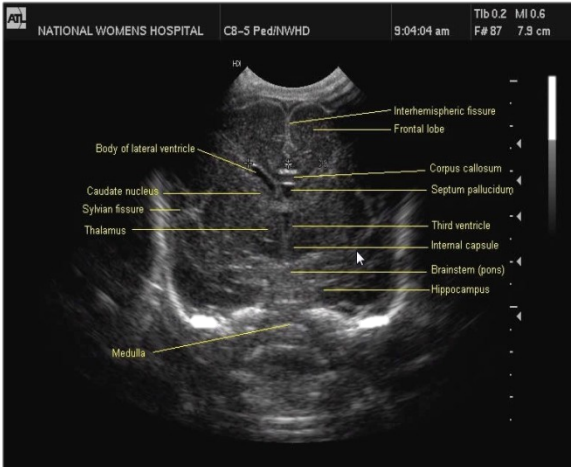
1. Right Brain
  - Obtain right sagittal images, scanning lateral to medial. Approx 6-8 images.
    - Special attention made to Caudothalamic groove
  - Capture cine clip of right brain in sagittal plane, scanning lateral to medial.
  - A true mid-line image should be obtained to demonstrate the following structures:
    - Corpus callosum
    - Cavum septum pellucidum
    - Third and fourth ventricles
    - Cerebellar vermis
2. Left Brain
  - Obtain left sagittal images, scanning lateral to medial. Approx 6-8 images.
    - Special attention made to Caudothalamic groove
  - Capture cine clip of left brain in sagittal plane, scanning lateral to medial.
3. Coronal Brain
  - Obtain coronal images, scanning from anterior to posterior. Approx 12-14 images.
    - Special attention made to Caudothalamic groove
  - Capture cine clip of entire brain in coronal plane, scanning anterior to posterior.
4. Sagittal Sinus
  - Obtain color Doppler and spectral Doppler of sagittal sinus.

\*\*Images should be obtained to demonstrate the choroid plexus and temporal horn of the lateral ventricles bilaterally and the occipital horn of each lateral ventricle. Careful imaging to the watershed zone of the parenchyma, superior to each lateral ventricle should be performed to rule out periventricular leukomalacia.

**\*\*ALWAYS SCAN RIGHT SAGITTAL FIRST, LEFT SAGITTAL SECOND, THEN CORONAL IMAGING. NO EXCEPTIONS! THIS IS DONE FOR STUDY COMPARISON.**

\*\*When scanning, if there is a question of an enlarged subarachnoid space or fluid, be sure to include color Doppler images of the fluid. If the color Doppler spreads throughout the fluid, the fluid is subarachnoid. If the vessels stay by the brain, it is subdural. (RAD:1996, 201:389-392)





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# ARTERIAL EXAMINATION (Segmental Pressures)

## Indications:

- Claudication
- Decreased pedal pulses
- Leg/foot pain
- Non-healing ulcers

## Patient Preparations:

- Explain procedure to patient
- Obtain appropriate history and enter it into computer
- Patient should be in supine position

## Procedure:

- Obtain Doppler waveforms in legs
- Obtain segmental blood pressures and pulse volume recordings (PVR)
- Have patient exercise (if ordered)

## Doppler exam:

- Obtain spectral waveforms and PVR's bilaterally
  - Groin (CFA)
  - Mid-thigh (SFA)
  - Knee (Popliteal)
  - Ankle (PTA)

## Segmental Pressures:

1. Bilateral cuff placement
  - Brachial
  - Thigh—2 thigh cuffs used at TCA if possible, only 1 at TCN
  - Upper calf
  - Ankle
2. Arm pressures are obtained using the brachial arteries.
3. Ankle pressures are initially obtained using the DPA and PTA. The rest of the leg pressures are obtained using the highest pressure (DPA or PTA)
4. Great toe pressure/waveform obtained at TCA or all digits if ordered.

**Post Exercise ABIs:**

- If the patient is unable to stand on their own or unable to walk without assistance, this portion of the exam is not performed. SAFETY FIRST!
- Have the patient walk for 10 minutes with a 10% grade at 2 MPH or until he/she is unable to continue. It is ok to slow treadmill speed or reduce grade to safe walking speed for the patient. If patient is unable to walk for full 10 minutes stop exam. Make note of walking time, speed, and grade.
- Post exercise: record bilateral ankle pressures and unilateral arm pressure (side with highest pressure before at rest) every minute up to 10 minutes.
- Post exercise recordings may be stopped if there is a return to baseline before 10 minutes.

# ANKLE BRACHIAL INDEX (ABI)

## **Indications:**

- Claudication
- Decreased pedal pulses
- Leg/foot pain
- Non-healing ulcers

## **Patient Preparations:**

- Obtain appropriate history and enter it into computer.
- Patient should be in supine position.

## **Exam:**

Choose "Custom Sequence" on the equipment to automatically move through ABI exam or follow steps below.

1. Obtain pulse volume recording (PVR) at ankles.
2. Obtain bilateral arm blood pressures.
3. Record right PTA (Posterior Tibial Artery) Doppler waveform
4. Obtain right PTA pressure.
5. Record right DP (Dorsalis Pedis) Doppler waveform.
6. Obtain right DP pressure.
7. Repeat steps 3-6 on left leg.
8. At TCA only, record PVR and pressures of great toes.

\*\*If digits are ordered record PVR and pressures of all toes.

**If exercise ABI with exercise is ordered, do above plus:**

## **Post Exercise ABIs:**

- If the patient is unable to stand on their own or unable to walk without assistance, this portion of the exam is not performed. SAFETY FIRST!
- Have the patient walk for 10 minutes with a 10% grade at 2 MPH or until he/she is unable to continue. It is ok to slow treadmill speed or reduce grade to safe walking speed for the patient. If patient is unable to walk for full 10 minutes stop exam. Make note of walking time, speed, and grade.
- Post exercise: record bilateral ankle pressures and unilateral arm pressure (side with highest pressure before at rest) every minute up to 10 minutes.
- Post exercise recordings may be stopped if there is a return to baseline before 10 minutes.

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# LIVER DOPPLER EXAMINATION

The patient should be NPO as least 6-8 hours prior to the examination

## Indications:

- Portal hypertension
- Budd-Chiari Syndrome
- ETOH abuse
- Liver failure
- Pre-op/post-op liver transplant

## Patient Preparations:

- Explain procedure to patient
- Obtain appropriate history and enter it into ultrasound system
- Patient should be NPO for 6-8 hours
- Patient may be positioned supine, oblique, or decubitus (right or left)

## Procedure:

- Patient should have complete abdominal ultrasound before starting the Doppler portion of the examination (following the department protocol).
- The abdominal vessels should be imaged with color and spectral Doppler.

## Exam:

- |   |  |
|---|--|
| 1. Main Portal Vein (MPV)                 | Measure vessel diameter in B/W<br>Longitudinal image with/without color<br>Obtain a waveform and measure PV<br>Check direction of flow |
| 2. RPV/LPV                                | Obtain a color image<br>Obtain a waveform to document direction of flow  |
| 3. Hepatic Artery                         | Obtain a waveform and measure to get resistive index (RI), PS and ED velocities  |
| 4. Hepatic Veins<br>(right, middle, left) | Obtain a B/W and color image<br>Obtain waveform in each vessel (make sure you are close to the IVC for optimal waveform)               |
| 5. IVC                                    | Obtain a B/W and color image<br>Obtain a Doppler waveform  |
| 6. Splenic Vein<br>(at midline and hilum) | Obtain a B/W and color image<br>Obtain a Doppler waveform to document flow direction   |

**Helpful Hints:**

1. Try to keep your Doppler angle 60° or less.
2. Allow the patient to continue breathing for Hepatic vein waveforms to demonstrate normal phasicity.
3. Have the patient in LPO position, if necessary.
4. Obtain the Splenic vein images in the Midline
5. Portal vein flow toward the liver is hepatopedal and away from the liver is hepatofugal.
6. Make sure to look for a recanalized umbilical vein in patients with severe liver disease and document if seen.



# 1<sup>ST</sup> TRIMESTER OB EXAMINATION

## (Less than 13 weeks gestation)

### Prep:

- Patient is to drink 40 oz of water within 15 minutes, FINISHING 1 hour before the scheduled appointment time.  
Patient should not void during this time as their bladder needs to be full for this exam.

### Indications:

- The early obstetrical examination is useful for determining accurate gestational age and assessing fetal development. This examination also allows the etiology of pain and/or bleeding during pregnancy.

### Examination tips:

- This examination is performed transabdominally, with a distended urinary bladder. Include transvaginal imaging to further delineate early gestational development/pathology and maternal anatomy, when necessary.

### Imaging techniques:

1. Longitudinal views
  - Images of the uterus should be documented to include right, left and ML uterus. Measurements of the uterus should be made as indicated. Document any pathology noted.
  - Evaluation of the cervix and the lower uterine segment should be included.
  - Attempt should be made to evaluate the maternal adnexa to include images of both ovaries. Measure as needed and Doppler to ensure blood flow is present.
2. Transverse views
  - Images of the cervix, lower uterine segment, body and fundus needed. Measure as needed. Document any pathology noted.
  - Transverse images of both ovaries including measurements, if possible. Document color and Doppler to ensure blood flow is present if not done in longitudinal views.
3. Gestational images
  - Document the gestational sac in longitudinal and transverse planes.
  - Images of all pertinent fetal anatomy should include, but not limited to the following: yolk sac, embryo, heart motion with appropriate Doppler or M-mode correlation, and crown-rump length measurements. If the gestation is over 12 weeks, consider including BPD/HC/AC/FL measurements as appropriate.
  - If no heart beat is detected, capture cine clips with and without color Doppler to document lack of heartbeat.
  - Document any pathology noted.

## **2<sup>ND</sup> AND 3<sup>RD</sup> TRIMESTER OB EXAMINATION (13-40 weeks gestational age)**

### **Prep:**

- Patient is to drink 40 oz of water within 15 minutes, FINISHING 1 hour before the scheduled appointment time.  
Patient should not void during this time as their bladder needs to be full for this exam.

### **Indications:**

- The second and third trimester OB examination is useful in assessing fetal anatomic development as well as fetal growth parameters.

### **Examination tips:**

- The patient should be adequately prepped with a moderately distended urinary bladder. Proper transducer selection may vary dependant upon gestational age and maternal body habitus. Care should be taken to endure the patients comfort during the course of the exam. Frequent change in position may be necessary to accommodate the patient. In some circumstances, it may be necessary to include transvaginal imaging for the proper documentation of maternal and fetal anatomy.

### **Imaging techniques:**

- Uterine walls and adnexal areas should be imaged.
- Document the maternal cervix and lower uterine segment. The placental location, appearance and relationship to the internal cervical os should be documented. Measure the cervical length. Post void images should be included whenever necessary.
- The umbilical cord attachment at the placental site should be imaged. If requested an appropriate cord Doppler ratio recorded. 3 Doppler samples must be recorded. The number of cord vessels should be imaged, preferably in the transverse plane.
- Fetal number, position and cardiac activity should be recorded. M-mode or Doppler are acceptable means for documenting fetal heart rate.
- If no fetal HR is detected, capture cine clips with and without color Doppler to document lack of beartbeat.
- Amniotic fluid index should be assessed by measuring the largest pocket of fluid identified in each of the four quadrants of the uterus. The fluid should be free of umbilical cord and fetal body parts. AFI is more accurate after 24 weeks, prior to this age observation may be sufficient.

### **Fetal Biometry:**

- Fetal biometry is performed to establish gestational age and/or assessment of interval fetal growth. A minimum of 2 measurements of each parameter must be performed in order to achieve an average gestational age. If growth is in question or the measurement ratios are inconsistent with the stated or established gestational age, additional measurements may be included (i.e.: humerus, tibia/fibula, ulna, foot, etc.)
  - **BPD:** measurements should be done in an axial plane at the level of the Thalami.
  - **HC:** measured at the same time as the BPD
  - **AC:** measured in the transverse plane at the level of the branching umbilical vein and stomach.
  - **FL:** Transducer should be lined up along the long axis of the bone so the beam is perpendicular to the shaft. Measured ends should be blunt, not pointed. Measure from blunt end to blunt end, do not include epiphysis.

### **Fetal Anatomic structures:**

- Every reasonable attempt should be made to document fetal anatomy. The following structures should be included.
  - **Fetal Head**
    - Atrium of the lateral ventricles, with measurements when needed
    - Choroid plexus
    - Cerebellum/cisterna magna with and without measurements
    - Mid facial area
    - Nose/lips
    - Facial profile (if fetal position permits)
  - **Fetal abdomen**
    - Diaphragm-to include image of heart in chest and the stomach in the abdomen. This is generally done in the sagittal plane. Additional views to demonstrate the fetal liver/diaphragm interface may be included.
    - Right and left kidneys should be imaged in the transverse plane. Include sagittal images whenever necessary. \*Measure the renal pelvis if the appearance or history suggest enlargement.
    - Distended fetal urinary bladder.
    - Distended fetal stomach.
    - Umbilical cord insertion site with color Doppler image if necessary.
  - **Extremities**
    - Provide documentation of all four extremities.

### ***Fetal anatomy cont.***

- **Spine**
  - Document all levels of the spine in transverse and sagittal planes.
  - Additional coronal images may be included if needed to adequately demonstrate the spine.
- **Heart**
  - Document the heart and its relationship to the stomach. Establish correct situs.
  - 4 chamber view. Show moderator band in the right ventricle, if possible.
  - Ventricular outflow tracts. Label as RVOT and LVOT. Attempt to document 4 chamber view and outflow tracts in succession.
  - If needed, include images of the ductal arch and aortic arch
- **Follow-up studies**
  - For patients who have already had an initial OB ultrasound for routine size, dates and anatomic survey, please note the following guidelines.
    - Fetal biometry may be repeated if requested by the physician.
    - Fetal anatomic structures that may change as the pregnancy progresses must be re-imaged (i.e. stomach, kidneys, etc.) It is not necessary to re-image all four extremities, or the fetal spine and intracranial anatomy, unless they were not well seen on prior study. Correlation should be made with the prior images and report.
    - Please confer with the radiologist if there are any doubts regarding necessary documentation.
    - Proceed with the examination following the appropriate protocol for the gestational age.
    - Some follow up studies are limited to the request of the ordering physician (i.e. follow up previa, to assess a structure not imaged well previously, or fibroid, etc.)

# BIOPHYSICAL PROFILE EXAMINATION

## Indications:

- A biophysical profile (BPP) examination may be indicated to determine fetal well being due to maternal and/or fetal conditions during the course of the pregnancy. It may be used in conjunction with the fetal non-stress test, in cases of non-reactive stress testing. It may be necessary to perform an OB ultrasound to assess fetal growth with the BPP.

## Examination tips:

- It is not necessary for the patient to have a distended urinary bladder, unless the exam is in conjunction with an OB ultrasound.
  - **At our facility, we only assign a value of 2 for each variable that is normal or a value of 0 if abnormal.**
  - A BPP score of 8-8 is considered normal. A score of 4-6 has no immediate significance, but may need to be repeated after several hours. A score of 0-2 indicates either immediate delivery or extending the test.<sup>1</sup>

## Determine the BPP score:

- Patient is scanned for up to but no longer than 30 minutes. If fetus completes all movements before 30 minutes, scan may be stopped. Assign a value of 0 or 2 points to each of the following parameters.
  - **Fetal breathing movement:** One episode of continuous fetal breathing of 30 seconds duration or longer in the 30 minute period = **2 points**.
  - **Gross body movement:** At least three (unprovoked) discrete body or limb movements in the 30 minutes = **2 points**.
  - **Fetal tone:** At least one episode of active flexion and extension of limbs or trunk. Opening and closing of hand is acceptable = **2 points**.
  - **Amniotic fluid index:** Measure the largest fluid pocket. Pocket of at least 2 cm = **2 points**.

**Quantitative 4 quadrant AFI is included on all Biophysical Profiles.**

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1 Reference: Textbook of Diagnostic Sonography 5th edition, Sandra Hagen-Ansert. Pg. 678-679

# FETAL UMBILICAL DOPPLER EXAM

## INDICATIONS:

- IUGR OR SUSPECTED IUGR
- DECREASED FETAL MOVEMENT
- MULTI-FETAL PREGNANCY
- OLIGO OR POLYHYDRAMNIOS
- SUSPECTED PRE-ECLAMPSIA
- MATERNAL HYPERTENSION, DIABETES, KIDNEY DISEASE OR PROTHROMBIC STATE

## EXAM:

- 3 SEPARATE UMBILICAL ARTERY DOPPLER FLOW VELOCITY MEASUREMENTS ARE CAPTURED IN THE MID OR FREE SEGMENT UMBILICAL CORD.
  - IF MULTI-FETAL PREGNANCY, EACH FETAL CORD IS DONE
- CALCULATIONS NEEDED: PSV, EDV, S/D RATIO, RI, AND PI
- MCA (MIDDLE CEREBRAL ARTERY) DOPPLER ONLY DONE IF SPECIFICALLY REQUESTED TO BE DONE WITH UMBILICAL ARTERY DOPPLER.

## CRITERIA:

- >30 WEEKS GESTATION:
  - S/D RATIO >3 IS ABNORMAL
  - RI >0.7 IS ABNORMAL
  - PI >1.5 IS ABNORMAL
- **NEW** FINDING OF ABSENT OR REVERSED DIASTOLIC FLOW IS CONSIDERED AN URGENT/CRITICAL FINDING.
- <30 WEEKS GESTATION WOULD GO TO [www.perinatology.com](http://www.perinatology.com) UNDER CALCULATORS.

## VEIN MAPPING - LOWER EXTREMITY

Obtain appropriate history and enter it into the ultrasound system.

Exam is done for pre-op evaluation of unilateral or bilateral Greater Saphenous Vein or GSV to assess for suitability of vein for bypass grafting.

- Patient is positioned supine with legs in neutral position.

### **Technique:**

- Image/measure GSV at origin, mid thigh, distal thigh, prox calf, distal calf, and near ankle. Measurements done anterior to posterior in transverse plane with little to no pressure to assure accurate vein measurements.
- Document flow in vein with color and spectral Doppler by each measurement.
- Document any thrombus within GSV.

\*\*\*No need to mark on patient's arm unless there is some type of variant anatomy.

## TCA VEIN MAPPING - UPPER EXTREMITY

Obtain appropriate history and enter it into the ultrasound system

- Patient is positioned supine with arm resting on cart or bed OR patient is positioned upright with arm resting by his/her side.

### Forearm:

#### 1. Cephalic Vein

- Image/measure proximal, mid, and distal cephalic vein. Vein is measured in transverse plane with little to no pressure to assure accurate vessel measurements.
- Document flow in vein with color and spectral Doppler by each measurement.

#### 2. Radial Artery

- Image/measure proximal, mid, and distal radial artery.
- Document flow in proximal, mid, and distal artery with color and spectral Doppler.

### Upper arm:

#### 3. Brachial Artery

- Image/measure proximal, mid, and distal brachial artery.
- Document flow in proximal, mid, and distal artery with color and spectral Doppler.

#### 4. Basilic Vein

- Image/measure proximal, mid, and distal basilic vein. (Or as much that can be visualized.) Vein is measured in transverse plane with little to no pressure to assure accurate vessel measurements.
- Document flow in proximal, mid, and distal vein with color and spectral Doppler.

#### 5. Cephalic Vein

- Image/measure proximal, mid, and distal cephalic vein. Vein is measured in transverse plane with little to no pressure to assure accurate vessel measurements.
- Document flow in proximal, mid, and distal vein with color and spectral Doppler.
- Include cephalic vein origin images, when possible.

\*\*\*No need to mark on patient's arm unless there is some type of variant anatomy



## **TCA PROTOCOL FOR VEIN MAPPING (Pre-Op open Heart Surgery)**

### Patient preparations:

- Place patient on the bed in a reverse Trendelenburg position
- Use light but sufficient pressure to visualize the GSV with ultrasound beginning at the origin of the vessel at the CFV
- You will need several markers for this exam, it is helpful to have 2 people if possible

### Procedure:

- Measure the GSV anterior/posterior in a transverse section at the origin. Freeze the image and **mark directly on the leg** at the origin with a dot and write the measurement in millimeters beside it. Use either an ultrasound pen or permanent marker. Take an image of the measurements
- Follow the GSV and take the AP measurements at the proximal, mid and distal thigh. Take an image at each level. Repeat the above instructions at the proximal, mid and very distal calf down to the medial malleolus. At least 7 images should be taken per leg.
- The AP vein diameter useful for harvesting is at least 3mm. If the vein diameter measures below 3mm from one section of the leg to another, a more thorough evaluation is necessary to determine on accurate usable length of the GSV. You will need to mark on the leg the specific point the GSV no longer measures at least 3mm. Bifurcated systems should be drawn on the leg and worksheet with attention to usable components above 3mm. It is not necessary to film these exhaustively.
- Wipe off the ultrasound gel and thoroughly dry the patient's leg. Use a fresh permanent marker to connect the dots illustrating where the GSV lies and where it bifurcates. Rewrite the measurements at each area on the leg after it is dry.

# UPPER EXTREMITY VENOUS ULTRASOUND

## Indications:

- Arm pain of questionable etiology
- Tight, swollen arm
- Recent PICC line placement and/or removal
- Redness/warmth

## Patient Preparations:

- Explain procedure to patient
- Obtain appropriate history and enter it into computer
- Patient is positioned supine with arm resting on cart or bed

## Procedure:

- Vessels require evaluation with transverse compression, where possible, to rule out deep venous thrombosis. Include color and spectral Doppler waveforms in longitudinal with appropriate annotation.

## Exam:

Internal Jugular Vein		Long gray scale with color and Doppler waveform.
Confluence of Jugular and Subclavian		Long gray scale with color and Doppler waveform.
Subclavian Vein	Proximal Mid Distal	Long gray scale with color and Doppler waveform at each level.
Axillary Vein		Long gray scale with color and Doppler waveform.
Brachial Vein	Proximal Mid Distal	Long gray scale with color and Doppler waveform at each level. Transverse with and without compression at each level.
Basilic Vein	Prox upper arm Mid upper arm Distal upper arm	Long gray scale with color and Doppler waveform at each level. Transverse with and without compression at each level.
Cephalic Vein	Prox upper arm Mid upper arm Distal upper arm	Long gray scale with color and Doppler waveform at each level. Transverse with and without compression at each level

Cephalic Vein	Check prox, mid, dist forearm. If no clot is seen only image at one location.	Long gray scale with color. Transverse with and without compression.
Basilic Vein	Check prox, mid, distal forearm. If no clot is seen only image at one location.	Long gray scale with color. Transverse with and without compression.
Radial Vein	Check prox, mid, distal forearm. If no clot is seen only image at one location.	Long gray scale with color. Transverse with and without compression.
Ulnar Vein	Check prox, mid, distal forearm. If no clot is seen only image at one location.	Long gray scale with color. Transverse with and without compression.

### Exam Information

1. The brachial veins are the deep system and they bifurcate into the radial and ulnar veins.
2. The Basilic and Cephalic veins are superficial. They are not paired with an artery.
3. IJV and SCV do not respond well to augmentation, due to close cardiac proximity.
4. When direct compression is not possible (e.g. SVC), careful examination with color and spectral Doppler should be used to look for filling defects and changes in wave forms.

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# TCA - LOWER EXTREMITY VENOUS ULTRASOUND for DVT

## **Indications:**

- Leg pain of questionable etiology (not claudication)
- Tight, swollen leg
- Tenderness in leg
- Feeling of heaviness
- Question of pulmonary embolism/chest pain
- Redness/warmth

## **Patient Preparations:**

- Explain procedure to patient
- Obtain appropriate history and enter it into computer
- Patient is positioned supine on the bed with the hip slightly rotated externally with the knee slightly bent

## **Procedure-general considerations:**

- The vessels must be evaluated first in transverse gray scale with compressions to rule out deep venous thrombosis before color and spectral Doppler with augmentation can be performed.
- After a DVT has been ruled out, color and spectral Doppler should be performed longitudinal to evaluate for spontaneity, phasicity, and distal augmentation.

Note: Evaluate superficial cords or specific area of pain after completing the DVT Study

## **Exam:**

- CFV/GSV:
  - Transverse gray scale image with and without compression.
  - Color and spectral Doppler showing respiratory variation, Valsalva and augmentation.
- Femoral Vein:
  - Distal thigh transverse gray scale images with and without compression.
  - Color and spectral Doppler showing respiratory variation and augmentation
- Popliteal Vein:
  - Prox and Dist transverse gray scale image with and without compression.
  - Mid popliteal color Doppler image
  - Prox and Dist color and spectral Doppler showing respiratory variation and augmentation.
  - Color Doppler image of distal popliteal and prox calf veins showing patency.
- Posterior Tibial Veins:
  - Color image showing patency.

## **If exam is a unilateral study include:**

- Opposite leg CFV/GSV color and spectral Doppler image showing respiratory variation.

# CAROTID DUPLEX ULTRASOUND

## Indications:

- Asymptomatic carotid bruit, TIA, CVA, F/U carotid endarterectomy, Subclavian steal, Peripheral vascular disease, Stroke protocol, pre-open heart surgery

## Exam:

Gray scale images:

- Gray scale images must be taken in both transverse and longitudinal planes to identify vessel anatomy and document plaque and tortuosity of the vessel as necessary. Gray scale images are taken as follows:
  - Transverse
    - CCA Proximal, Mid, and Distal
    - Bulb
    - Bifurcation-ECA/ICA
  - Longitudinal
    - CCA Prox, Mid, and Distal
    - ICA/ECA bifurcation, when possible
    - ECA
    - ICA Proximal, Mid, Distal

\*\*Gray scale transverse cine clip is stored showing bifurcation. Start at distal CCA and move through bifurcation and back to distal CCA.

Color and Spectral Doppler:

- Color Doppler images should be optimized for correct color fill. Spectral waveforms should be measured at the PSV (peak systolic velocity) and EDV (end diastolic velocity). All velocities are to be entered into ultrasound system calculation package and calc report page must be imaged at the end of the study. The preferred Doppler angle is 60° and the Doppler angle should be maintained between 0-60° as possible.
  - CCA Proximal, Mid, and Distal
  - VERT (The vertebral artery should be evaluated and documented for antegrade, retrograde, bidirectional, or absent flow.)
  - ECA Proximal
  - ICA Proximal, Mid, and Distal

\*\*Color video clip is stored showing flow in dist CCA/prox ICA

Note: CCA/ICA ratio is calculated using the mid CCA and the highest ICA

Except in specific instances, all images are to be taken bilaterally. Note and document the amount of plaque present (minimal, moderate, severe, occluded) on worksheet by drawing areas of plaque at TCN or by documenting in study notes in EPIC at TCA.

# SCROTAL ULTRASOUND EXAMINATION

## Indications:

- Torsion, varicocele, hydrocele, inflammatory processes such as orchitis and epididymitis, testicular/scrotal lump(s).

## Exam:

### Gray scale images:

- Long testicle, right and left.
  - Lateral, mid, and medial
- Transverse testicle, right and left.
  - Upper, mid, and lower
- Testicular measurements in long and transverse. Measure any cystic or solid lesions seen.
- Trans bilateral testicles, include as much of each testicle as possible to show any echogenicity differences from each side.
- Epididymis, right and left
  - Long and transverse
- If varicocele suspected, image varicocele with and without measurement of vein to document size of vessel.

### Color Doppler images:

- Identical filter and scale settings should be used to compare flow to each testicle.
- At least one color image in long, each testicle.
- At least one color image in transverse, each testicle.
- At least one color image of transverse bilateral testicles, showing any color differences between testicles.
- At least one color image of transverse epididymis showing any color differences between testicles, if possible.
- If varicocele suspected, color images with normal respiration and Valsalva.

### Spectral Doppler:

- At least one spectral Doppler image documenting flow of each testicle.

\*\*If patient has a lump, have patient find lump and scan over this area to document what patient is feeling.

\*\* The spermatic cord and inguinal areas should be examined using Valsalva maneuver if there is a question of hernia.

\*\*If undescended testicle is suspected, scan inguinal canal areas and lower abd to find testicle.

# THYROID PROTOCOL

Obtain pertinent patient history

## Exam:

- A high resolution, linear transducer should be used
  - 9.0 MHz or higher
- Scan planes
  - Longitudinal plane, right and left thyroid lobes
    - Lateral
    - Mid
      - Longest length without measurements
      - Longest length with measurements
      - Color Doppler image mid and where nodules are identified
    - Medial
  - Transverse plane, right and left thyroid lobes
    - Superior or upper
    - Mid
      - Transverse measurements at widest point
      - Color Doppler at mid-pole and where any nodules are identified
    - Inferior or lower
  - Transverse Isthmus
    - Gray scale, with and without measurement
    - If isthmus nodule(s) are present, sagittal images needed of nodule(s.)
    - All measurements of nodules to be taken split screen in both planes or immediately after each other. Document any abnormal area with color and measurements
- An image of the isthmus and bilateral lobes of the thyroid should be taken.

## Parathyroid Glands

- Normal parathyroid glands are extremely difficult visualize. They are the size of a grain of rice.
- If Parathyroids are visible, they are considered enlarged and should be fully documented with measurements and color Doppler.

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# RENAL AND BLADDER

Obtain pertinent patient history

## Prep:

- Patient can eat and drink as usual. Patient should not empty their bladder 1 hour prior to exam

## Exam:

- Renals
  - Document the following on each kidney
    - Longitudinal mid with measurement
    - Sagittal medial
    - Sagittal lateral
    - Transverse superior pole
    - Transverse mid pole (Transverse measurement at TCN only)
    - Transverse inferior pole
    - Color Doppler of each kidney
    - Measure and Doppler any pathology seen
- Bladder
  - Longitudinal and transverse images of the bladder
  - Attempt to document urinary jets with color Doppler.



# AORTA

The patient should be NPO as least 6-8 hours prior to the examination.

Obtain pertinent patient history

- Review prior scan if it is follow up

**Exam:**

- Longitudinal proximal with and without measurements
- Longitudinal mid with and without measurements
- Longitudinal distal with and without measurements
- Longitudinal iliac arteries with and without measurements
- Longitudinal color and spectral Doppler at proximal, mid and distal Aorta
- Longitudinal color and spectral Doppler of iliacs, if possible.
- Transverse proximal with and without measurements
- Transverse mid with and without measurements
- Transverse distal with and without measurements
- Transverse iliac arteries with and without measurements

\*\*If an aneurysm is present, measure lumen and outer wall in sagittal and transverse. An attempt to document the origin of the renal arteries and aortic bifurcation in relationship to the aneurysm should be made.

\*\*If a stenosis is suspected, take additional spectral Doppler images with PSV measurement proximal to, at and distal to stenosis.

# ARTERIAL DUPLEX

## **Indication:**

Exam is done to evaluate arterial bypass grafts and/or stents. Routine screening of arteries with ultrasound is not recommended. Routine screening should be done with segmental pressure or ABI exam.

## **History:**

Obtain pertinent patient history, i.e. type and location of bypass graft, angioplasty/endarterectomy or stent.

## **Exam:**

Place a tape measure on the extremity being examined. Label images for proper side, vessel being scanned, and distance above or below knee, e.g. Right CFA 30 cm AK or above knee.

If a graft is present, imaging should begin above the proximal anastomosis in the native artery and continue through to the native vessel below the distal anastomosis. Color and Doppler images are obtained at 5-10 cm intervals and include both proximal and distal anastomoses. Measure PSV and EDV at each location.

If a stent is present, imaging should begin above the stent and conclude distal to the stent. Color and Doppler images are obtained at 5-10 cm intervals and include both proximal and distal stent. If any narrowing is seen within the stent, image the area with color and Doppler and label appropriately. Measure PSV and EDV at each location.

If the patient is post angioplasty/endarterectomy imaging should begin proximal to angioplasty/endarterectomy and continue distal to it. Color and Doppler images are obtained at 5-10 cm intervals through surgical area. Measure PSV and EDV at each location. If any narrowing is seen within the surgical site, image the area with color and Doppler and label appropriately.

At TCA this study is read by Surgical Associates.

At TCN this study is read by the interventional radiologist.

# BREAST IMAGING PROTOCOL

Obtain pertinent patient history

## **Exam:**

Patient should be positioned to allow easy and ergonomically correct access to the affected area.

- The patient's comfort should be a consideration.

## **No prior imaging and patient has a lump or pain:**

Ask the patient to localize the affected area.

- Palpate the area.
- This allows an overall evaluation of the size of the area.
- The depth of the area can be determined as well.

Radial and anti-radial images of the area are taken. Annotate correct side, location, and distance from nipple. (e.g. Right Breast, 10:00, 6 cm FN)

## **Patient has prior imaging:**

Scan affected area under direction of the radiologist. Obtain radial and anti-radial images with correct side, location, and distance from nipple annotated on images.

## SUPERFICIAL STRUCTURES PROTOCOL

Obtain pertinent patient history

### **Exam:**

Patient should be positioned to allow easy and ergonomically correct access to the affected area.

- The patient's comfort should be a consideration.

Ask the patient to localize the affected area.

- Palpate the area.
- This allows an overall evaluation of the size of the area.
- The depth of the area can be determined as well.

Use highest frequency transducer that applies to area being scanned.

### **Imaging:**

Image the area in both the transverse and sagittal planes.

- Document any abnormal areas, with and without measurements.
- Take images with color Doppler.

\*\*Scan unaffected side for comparison, if necessary.

# HYPERTROPHIC PYLORIC STENOSIS (HPS)

Obtain pertinent patient history

## Examination tips:

- Ideally the infant should be NPO for a period of 2-4 hours
- It is helpful to keep a pacifier handy to quiet a fussy infant
- Have a bottle of pedialyte or water available for the exam
- Breast fed babies may be fed by the mother

## Exam:

- In the longitudinal plane:
  - Measure the length of the channel. Length is considered abnormal if it is equal to or greater than 19 mm. Be sure not to include antrum of stomach.
  - Measure the pyloric muscle thickness. The thickness is abnormal if it is equal to or greater than 4 mm. Measure total canal thickness. It is abnormal if over 10mm.
  - Watch the area for at least 5 minutes to assess for fluid/air moving through pylorus. Obtain cine, if possible, to document flow through pylorus.
- In the transverse plane:
  - Images of the muscle thickness, with and without measurements should be taken. Thickness is considered abnormal if it is over 4 mm. Thickness between 3 and 4 mm is variable for abnormality. Thickness equal to or less than 2 mm is considered normal.
  - The abnormally thick pylorus will have a “doughnut” or “bullseye” appearance in the transverse views due to contained mucosa.

\*\*If unable to visualize pylorus, feed baby pedialyte, water, or breast feed. Reassess pylorus after feeding.

# PELVIC IMAGING PROTOCOL

## Prep:

- Patient is to drink 40 oz of water within 15 minutes, FINISHING 1 hour before the scheduled appointment time.  
Patient should not void during this time as their bladder needs to be full for this exam.

Obtain pertinent patient history

- A careful patient history, including hormone or birth control use, and menstrual history is a must.

## Exam:

- The patient should have a moderately distended urinary bladder to visualize the pelvic structures and to displace overlying bowel.
- Transvaginal imaging should be utilized under appropriate circumstances. (If the patient is a minor or unable to give consent, is not sexually active, or if the exam is not physically possible due to condition or body habitus, then the exam may be deferred.)

## Imaging:

- Scan the uterus in the longitudinal plane from midline to left and right sides. Measure the longest length of the uterus from the fundus to the cervix. Measure the greatest anterior/posterior dimension.
- Evaluate the endometrial canal and measure the greatest thickness. Document the presence of any focal abnormalities and/or fluid within the canal.
- Evaluate the uterine myometrium for abnormalities in echotexture and contour. Document and measure any masses seen.
- Color Doppler imaging may be helpful in discerning abdominal areas.
- Scan the uterus in the transverse plane from the cervix to fundus (inferior to superior). Measure the greatest transverse measurement of the uterus at the level of the mid-body.
- Scan the posterior cul de sac (Pouch of Douglas).
- Scan both ovaries and adnexa in the longitudinal and transverse planes. An attempt should be made to document the location of both ovaries in relation to the uterus.
- Measure the ovaries in greatest longitudinal, anterior/posterior, and transverse dimensions. Image and measure any cysts or masses. Evaluate with color and spectral Doppler.

\*\*All male technologists **ARE REQUIRED** to have a chaperone present when transvaginal scanning is done. Chaperone must be an employee of the hospital.

## TRANSVAGINAL PELVIC IMAGING PROTOCOL

Obtain pertinent patient history

- A careful patient history, including hormone or birth control use, and menstrual history is a must.
- Proper technique for the cleaning and sterilization of the probe should be followed. High-level disinfection is completed using the Trophon disinfection system.

### Exam:

- Scan the uterus in the sagittal plane from midline to left and right. Measure the greatest anterior/posterior dimension, as well as, the length of the uterus from the fundus to the cervix.
- Document the echotexture of the myometrium and measure any masses.
- Evaluate the endometrial canal. Measure the thickness and evaluate for any focal abnormalities.
- Scan the uterus in the coronal plane from cervix to fundus. Measure the widest dimension at the mid-body.
- Scan the cervix and posterior cul de sac. Note presence of fluid.
- Evaluate the ovaries and adnexal areas bilaterally. Images should be obtained in the sagittal and coronal planes. Measure the ovaries in all three dimensions.
- A color and spectral Doppler should be included for every patient, if possible.

## MESENTERIC DOPPLER EXAMINATION

Obtain pertinent patient history.

The patient should be NPO as least 6-8 hours prior to the examination.

### Patient preparation:

- Patient may be positioned supine, oblique, or decubitus.
- Patient should be NPO.

### Technique:

- Obtain Doppler of the Aorta, Celiac axis, Hepatic artery, Gastroduodenal artery, Superior and Inferior Mesenteric arteries.
- Doppler waveforms should be obtained at the origin, mid, and distal artery (where visualized.)

### Exam:

- Obtain gray scale images of the aorta, CA, Hep art, GDA, SMA and IMA. Include images as distal as possible in each vessel.
- Obtain color and spectral Doppler images of the aorta, prox, mid, and distal.
- Obtain color and spectral Doppler images of the CA, Hep art, GDA, SMA, and IMA. Imaging as distal as possible.
- Measure the peak systolic and end diastolic velocities.

\*\*This is not a protocol for Celiac compression syndrome. There is a separate protocol for that exam.



# RENAL ARTERY DOPPLER EXAMINATION

Obtain pertinent patient history.

The patient should be NPO as least 6-8 hours prior to the examination.

## **Exam:**

Grey scale mages: follow Renal protocol

Doppler images:

- Spectral tracings of:
  - Proximal, Mid, and Distal Renal artery  
Velocity should be recorded at any site of color aliasing or suspected stenosis. If stenosis, a Doppler waveform should be recorded within the stenosis and distal to the stenosis.
  - Arcuates: upper, mid and lower pole bilaterally
  - Aorta, near renal artery origin
  
- Calculate the acceleration index, RI, PI, PSV, and EDV of these tracings and enter into calc's package on ultrasound system.

Diagnostic Criteria for RAS (+ for stenosis)

RAR > 3.5 PSV in renal artery >180cm/s RI > 0.7 AT > 70msec Tardis Parvis waveform dist to RAS

Acceleration index of 1.7 m/sec or less= definitely abnormal ( $A1 = \Delta V / \Delta T$ ). 3m/sec or more= definitely normal.