ULTRASOUND PEARLS
– a compilation of lessons from Meg, DP, MOB and others
Isabel Newton 7/2008 - please email me with any corrections or additions inewton@ucsd.edu

Recommended Reading: Ultrasound, The Requisites by Middleton

**Ultrasound Emergencies: Do Not Send Patient Home**

1. Ectopic pregnancy
2. New deep venous thrombosis
3. New occluded internal carotid artery
4. Torsion of testicle or ovary
5. IUGR in third trimester
6. No flow in hepatic artery of liver transplant

### COMMON SIZES

<table>
<thead>
<tr>
<th>Organ</th>
<th>Normals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spleen</td>
<td>&lt;13 cm</td>
</tr>
<tr>
<td>CBD</td>
<td>≤ 6 mm, then allow 1 mm/ decade of life after 50 yo Also will be larger post cholecystectomy</td>
</tr>
<tr>
<td>Kidney</td>
<td>&lt; 13 cm (normal 8 – 12 cm)</td>
</tr>
<tr>
<td>Liver</td>
<td>&lt; 16.5 cm</td>
</tr>
<tr>
<td>Abdominal aorta</td>
<td>≤ 3 cm</td>
</tr>
<tr>
<td>Iliac artery</td>
<td>≤ 2 cm</td>
</tr>
<tr>
<td>Popliteal artery</td>
<td>≤ 1 cm</td>
</tr>
<tr>
<td>Pancreatic duct</td>
<td>&lt; 3 mm (but can increase with age)</td>
</tr>
<tr>
<td>Thyroid lobes</td>
<td>~ 1.5 – 3 cm</td>
</tr>
<tr>
<td>Thyroid isthmus</td>
<td>~ 3 mm</td>
</tr>
</tbody>
</table>

**Call a DVT when there’s…**

1) Loss of compressibility of the vein (#1 sign)
2) Echoes within the lumen / color void on color Doppler
3) Call it occlusive or non-occlusive

**Acute versus Chronic DVT:**

- A thrombus has an **acute** appearance if it doesn’t compress, the vessel is engorged, and it is anechoic.
- A thrombus has a **chronic** appearance if it compresses slightly, the vessel is not engorged, and the thrombus is echogenic, **often along the wall or linear.**

**Resistive Index**

\[ RI = \frac{\text{peak systolic volume} - \text{end diastolic volume}}{\text{peak systolic volume}} \]

- **High resistive index** – muscular arteries (eg. superficial femoral artery, posterior tibial artery, common femoral artery, external carotid artery)
- **Low resistive index** – arteries feeding organs that need flow even during diastole (internal carotid artery, renal artery, testicular artery, babies, tumors)

- Normal RI = 0.6 – 0.7
- Abnormal RI = 0.8 – 1.0

**Renal Artery**

- normal renal artery waveform
acceleration time < 0.07
• pre-stenosis → high resistive waveform
• post-stenosis → parvus-tardus waveform
  o slowed acceleration time (> 0.07)

CAROTIDS

1. Internal Carotid Artery Velocities:

<table>
<thead>
<tr>
<th>ICA Velocities</th>
<th>PSV</th>
<th>EDV</th>
<th>Ratio ICA/CCA</th>
<th>% Stenosis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>125 cm/s</td>
<td>40-100</td>
<td>2:1</td>
<td>50-69%</td>
</tr>
<tr>
<td></td>
<td>230 cm/s</td>
<td>&gt;100</td>
<td>4:1</td>
<td>&gt;70%</td>
</tr>
</tbody>
</table>

2. Use ratios when…
• CCA velocity < 50: low outflow state (i.e. CHF)
• CCA velocity >100: hyperdynamic (i.e. HTN, young people)

3. Appearance of plaques
• Ulcerated (will see flow within plaque) – very dangerous
• Soft
• Calcified (hyperechoic)
• Hypoechoic (isoechoic to lumen on grayscale, seen only on color doppler)

4. Carotid Doppler Waveforms:

• ICA – low resistance waveform (high diastolic flow), which makes sense, since you want there to be flow to the brain even during diastole
• CCA – waveforms hybrid between ICA and ECA
• ECA – high resistance waveform (low diastolic flow)

Delayed upstroke (slowed acceleration time) → may indicate a proximal stenosis

5. ECA

<table>
<thead>
<tr>
<th>ECA Velocities</th>
<th>PSV</th>
<th>Stenosis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>200 cm/s</td>
<td>Mild</td>
</tr>
<tr>
<td></td>
<td>200-300 cm/s</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>&gt; 300 cm/s</td>
<td>Severe</td>
</tr>
</tbody>
</table>

6. Vertebral Arteries – SUBCLAVIAN STEAL
• subclavian artery steno-occlusive disease proximal to the origin of the vertebral artery
  o associated with flow reversal in the vertebral artery (on color doppler)
• Severe subclavian stenosis or occlusion
- Parvus tardus waveform (prolonged systolic acceleration time with decreased PSV) in the distal subclavian artery and brachial artery
  - Presteal
    - Slowing of midsystolic velocity in vertebral, with flow reversal (above and below axis)
  - Total vertebral artery reversal of flow

**Occult steal** (bunny ears or buffalo pattern):

**Partial Subclavian Steal**, elicited with evocative maneuver (blood pressure cuff insufflation then release or biceps curls)

**Complete subclavian steal**
OBSTETRICS

1. Placenta
   a. Shape
      i. Succenturiate
         1. watch out for vasa previa – where the placental vessels cross the cervix
      ii. Bilobate
   b. Position
      i. Placenta previa – within 2 cm margin of the cervix
         1. sometimes seen in second trimester but resolves – monitor!
   c. Placenta accreta (placenta grows into uterine wall and +/- beyond)

2. Cervix
   a. 3 – 5 cm

3. Placental Cord Insertion (PCI)
   a. Velamentous – Insertion of the umbilical cord on the chorioamniotic membranes rather than on the placental mass
      i. associated with fetal anomalies, intrauterine growth retardation (IUGR)
      ii. risk for vasa previa

4. Health of the Baby
   a. Fluid (AFI in 3rd trimester <8 cm is worrisome, < 5 cm is an emergency)
      i. Polyhydramnios
         1. 60% unknown cause
         2. 20% fetal cause (eg. swallowing/obstruction, abd defects, atresias, dwarfs)
         3. 20% maternal cause (Rh incompatibility, diabetes)
      ii. Oligohydramnios (DRIPPC)
         1. Demise
         2. Renal
3. IUCR (and placental insufficiency)
4. PROM
5. Post-dates
6. Chromosomes (amnion fuses with chorion ~ 16 weeks, so try to do amniocentesis >16 wks because riskier before then)

b. Growth/symmetry
   i. Intrauterine growth retardation (IUGR) – follow-up US interval of 3-4 wks → best to exclude differences attributed to normal variance
   ii. Best dating parameters
      1. first trimester → crown-rump length (best time to date by US)
      2. second trimester → BPD, HC, AC, FL
      3. third trimester → HC, but, if head low, then femur length
   iii. Dating can be off by a standard deviation of the following and be normal
      1. first trimester → 1 week
      2. second trimester → 2 weeks
      3. third trimester → 3 weeks

4. AIUM Dating Guidelines: 2014 Committee Opinion

5. c. Heart rate (changes for different gestational ages)
   d. Systolic/diastolic ratio
      
      | WEEK | Normal S/D Ratio |
      |------|-----------------|
      | 20   | 4.0             |
      | 24   | 3.5             |
      | 28   | 3.0             |
      | >32  | 2.5             |

5. e. Middle cerebral artery (MCA) RI – very resistive waveform

5. Abdominal Cord Insertion (ACI)
   a. Omphalocele (remember the physiologic omphalocele up to 12 weeks)
   b. Gastrochisis

6. Bladder
   a. Extrophy (weakness in anterior muscle)
   b. Keyhole (in males with posterior urethral valves)

7. Heart
   a. 45 degrees, pointing left
   b. size = 1/3 size of the chest
   c. tricuspid valve 1mm higher than mitral valve
d. no VSDs or ASDs
8. Twins
   a. Diamniotic Dichorionic
      i. 1 (fused) or 2 placentas
      ii. 10% mortality
   b. Diamniotic Monochorionic
      i. 1 placenta
      ii. 25% mortality
      iii. risk of twin-twin transfusion syndrome
      iv. risk of stuck twin
   c. Monamniotic Monochorionic
      i. 1 placenta
      ii. 50% mortality
      iii. risk of cord entanglement
   d. Telling amnion from the chorion:
      i. Sex
      ii. Placenta
      iii. Membrane

Yolk sac – involutes around week 12-16
- Provides nutrients
- primary site of hematopoiesis at the beginning
- resorbed into the small intestine → site of Meckel’s diverticulum

**EARLY PREGNANCY** (First trimester = up to week 13 by LMP)

*Memorize this chart!*

<table>
<thead>
<tr>
<th>Week</th>
<th>Mean Sac Diameter (MSD)</th>
<th>US findings in normal pregnancy</th>
<th>Beta HCG (doubles q48 hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>4 mm</td>
<td>Gestational Sac</td>
<td>1,000</td>
</tr>
<tr>
<td>5</td>
<td>8 mm</td>
<td>Yolk Sac</td>
<td>7,000</td>
</tr>
<tr>
<td>6</td>
<td>16 mm</td>
<td>Embryonic pole + Fetal heart motion</td>
<td>11,000</td>
</tr>
</tbody>
</table>

Demise if no heart beat by 7 mm CRL. If less than 7 mm, and no heart beat, return in 7-10 d

What to call the little guy…
Embryo – up to 10 weeks
Fetus – after 10 weeks

Pregnant woman presents +/- bleeding +/- pain, and has an ultrasound:
A. You see a gestational sac (light gray ring is the endometrial decidual reaction)
   a. Normal pregnancy
   b. Anembryonic pregnancy (sac but no pole)
   c. Embryonic/fetal demise
B. You see NO gestational sac
a. Very early normal pregnancy
b. Spontaneous abortion
   Happens to ~30% of all pregnancies <12 wks!
c. Ectopic
   i. BEWARE of pseudogestational sac – endometrial reaction to the hormones of pregnancy – can mimic a normal intrauterine pregnancy, but look in the adnexae for ectopic!!!

C. You see something strange….the MOLE!!!
   a. Enlarged uterus
   b. Hyperemesis
   c. Very high beta HCG (often >100k)
      i. 50% are accompanied by multiseptated cystic ovarian masses (theca lutein cysts) 2° to the severely high beta HCG level!!
   d. On US: multiple hyperechoic and hypoechoic spaces filling the endometrial canal, without an embryo) –like grapes
   e. Risk of malignancy
   f. Not to be confused with a Partial Mole
      i. usually triploid (2 sperm)
      ii. associated with maternal complications
      iii. lower malignant potential than Complete Mole
      iv. symptoms are vaginal bleeding and absence of FHT

1. echotexture – uniform
2. size – should be equivalent bilaterally (make sure the sonographers give you a side-by-side view)
3. flow
   a. should be symmetric (if increased → inflammation, tumor)
   b. RI should be 0.6-0.7
4. testicular masses
   a. solitary
      i. testicular cancer
         1. seminoma (well-defined, focal)
         2. nonseminomatous (ill-defined)
            a. teratoma
            b. embryonal
      ii. metastasis
      iii. focal infection
iv. infarct/ hematoma
v. ectasia of rete testis
vi. epidermoid cyst (benign lesion)
b. bilateral
   i. metastases
      1. adults – NHL
      2. children – leukemia
      3. renal, prostate
   ii. testicular cancer
   iii. ectopic adrenal rests
   iv. congenital torsion

5. epididymal masses
   a. spermatocele / epidydimal cysts
   b. tumor
      i. adult – adenomatoid
      ii. kids – rhabdomyosarcoma
   c. cystadenoma (Von-Hippel Lindau)
   d. lipoma (spermatic cord)
   e. leiomyoma

6. scrotal skin thickness
   a. thickened
      i. trauma
      ii. cellulites and fourniers gangrene (look for gas)
      iii. edema

Ultrasound Patterns:

Portal veins are surrounded by echoes, hepatic veins are not.

Things that can look striated on ultrasound:
  • Tumor
  • Infection
  • Fibrosis

Things that are echogenic on US:
  • Calcifications (sharp flashlight shadow)
  • Air (dirty shadow)
  • Blood
  • Tumor

Normal lymph node
  • Elliptical
  • Fatty hilum

Features of Dermoid (cyst or teratoma) – have 2+ of the following characteristics:
  • Fatty plug (Rokitansky) – “iceberg effect”
- Curvilinear lines
- Echogenic dots (from hair)
- Fat/fluid level
- Chunky, large calcification

**Features of Fatty Deposition in the Liver**
- increased echogenicity
- decreased penetration
- decreased conspicuity of vascularity and diaphragm

**Features of Thyroid Nodules Associated with Malignancy**
- psammomatous calcifications
- indistinct margins
- size > 1 cm

**Differential Diagnoses**

**Ddx of Complex Adnexal Masses**
- corpus leuteal cyst
  - Cystic
  - Echogenic wall
  - Ring of fire pattern of vascular flow on color doppler
  - Low resistive waveform
- hemorrhagic cyst
- ectopic
- endometrioma (diffuse internal echoes)
- tubo-ovarian abscess
- adenoma/ adenocarcinoma
  - (adenocarcinoma more likely if >5 cm, septations, wall > 2mm thick, ascites, nodularity)
- hydrosalpinx (serpentine appearance)

**NOTE!!!** Follow any ovarian cyst measuring ≥ 3 cm → if premenopausal, recommend repeat ultrasound in 6 weeks (another phase in the menstrual cycle)

**Theca lutein cysts are seen in....**
- Ovarian hyperstimulation
- Molar preganancy
- Twins

**Ddx of hydronephrosis** (calyceal separation)
- peripelvic cysts
- papillary necrosis
- extra-renal pelvis
- reflux

- congenital megaureter and calyces
- persistent dilatation post resolution of obstruction
**Always check apparent hydronephrosis post-void to see if it persists.**

**Always turn on doppler to make sure the spaces aren't just vessels!**

Mild hydronephrosis can occur in late pregnancy and post-partum due to the pressure of the fetus on the ureter.