OVARIAS
5x3x2cm premen (9cc nulliparous, 15cc multiparous) and 2.5x2x2cm postmen
>18cc abnl for premen and >8 abnl for postmen (vol=LxHxWx0.5)
PEDS: 6yo ~1cc; prepubertal (6-10yo) 1.2-2.3cc; premenarchal (11-12yo) 2.4cc; postmenarchal >2.5-18cc
-Follicles <2.5cm

-Simple cyst
-Premen: OLD GUIDELINES
>3cm → flu 6wk (MRI if bigger or unresolved after two fl/u); >5cm → remove
-if no change in size with fl/u, may be a “non-functional cyst”
NEW GUIDELINES
Cyst ≤3cm physiologic developing/dominant follicle (no fl/u needed and do not have to describe)
Cyst >3 and ≤5cm mention but no fl/u needed
Cyst >5cm and ≤7cm yearly fl/u
Cyst >7cm further eval with MR or consider surgery
-Postmen: OLD GUIDELINES
>1.5 or 3cm → flu 3mo, 6mo, then yearly (MRI if bigger) per Dr Feldstein (UCSF); >5cm → remove
NEW GUIDELINES
Cyst ≤1cm incosequential
Cyst >1cm and ≤7cm almost certainly b9 but yearly fl/u with u/s (at least initially)
Cyst >7cm further eval with MR or consider surgery
-Corpus luteum: thickened or “crowned” wall, small cystic center, ring of fire, size ≤3cm → no fl/u needed
-Para-ovarian or paratubal cyst (use cyst criteria)
-Peritoneal inclusion cyst (prior pelvic surgery/endometriosis/PID)

-Hemorrhagic cyst
-Reticular pattern of internal echoes +/- echogenic clot w/o flow
Cyst ≤3cm no fl/u needed
Cyst >3 and ≤5cm describe but no fl/u needed
Cyst >5cm fl/u in 6-12wks to ensure resolution (image on day 3-10 of cycles)
Homogenous low level internal echoes

-Endometrioma
-Short-term fl/u initially in 6-12wks to exclude hemorrhagic cyst mimickers; then yearly if no surgery removal
Malignancy risk ~1% (endometrioid or clear cell CA) if >9cm (not if <6cm) and age >45yo

-Deroid
-Focal echogenic plug with acoustic shadowing, hyperechoic lines and dot, no internal flow
fl/u in 6-12mos interval regardless of age if no surgical removal
Malignancy risk <2% (SCC) if >10cm and age >50yo

-Complex cyst
-Indeterminate but prob b9 = single cyst but w/ single thin septa<3mm or small wall calc (use same fl/u as simple cyst by size & age)
-Indeterminate but not hemorrhagic/endometrioma/dermoid (multiple septations<3mm; solid nodule w/o flow; focal wall thickening)
Premen (6-12wks fl/u) if persists (not a hemorrh cyst) consider MR w/ gad if not hemorrh/endometri/dermoid, do surgery
Postmen (surgery)
Size>10cm (13% chance of malignancy) → surgery
-Worrisome for malig = thick septa>3mm, solid nodule w/ flow, focal wall thick>3mm (surgery)
-Ovaries are usually hypovascular after menopause
-R.I. on ovarian neoplasm is generally not indicated (not useful!); abnl RI<0.4, abnl PI<1.0
-PCO >10-12 peripheral cysts; hyperechoic/hypervascular central stroma, volume >15cc

UTERUS
(normal 9x5x5cm; postmen 7x2x2cm; neonate 4x2x2cm; pre-pubertal child 3x1x1cm; post-pubertal child 8x3x3cm)
-Menses (day1-5) <4mm; Prolif (day6-10) 4-8mm; Secretory (day14+) upto15mm; "Trilaminar" = preovulatory (disappears 48hrs after ovulation) → do IVF
-Premenopausal EMS upto15mm
-Postmenopausal w/o bleeding (or on HRT) ≤8mm
-If cyclic HRT, do U/S 4-6d after last progesterin pill (anytime if continuous or unopposed estrogen)
-Postmenopausal w/ bleeding ≤5mm
-EMS <3mm (postmen atrophy)
-EMS >3mm (RPOC post-partum); EMS<2mm (no RPOC post-partum)
-EMS thickening and cystic changes w/ Tamoxifen
-Retroverted vs Retroflexed
-Thickened EMS=secretory phase, pregnancy, hyperplasia, RPOC, polyp, CA, tamoxifen
Free Fluid (cul de sac) ~10cc (physiologic but may increase during ovulation)
Pelvic congestion: pelvic veins>4-5mm, slow flow<3cm/s (unilateral or bilateral), dilated tortuous pelvic venousplexuses and arcuate veins

ECTOPIC
Clinically suspect (pain, bleeding, palpable mass) ~15% risk
IUP seen (0% risk); No IUP (55% risk) → adnexal fluid, mass, embryo (75-100% risk); If no fluid, no mass (7-33% risk; some say 15%)
95% tubal; 1.5% peritoneal; 0.5% cervical; 0.03% ovarian
Heterotopic 1:100-1:4000; Methotrexate for tubal/adenexal ring <2.5cm
**ABDOMEN**

Ecogenicity: pancreas>spleen>liver>kidney 
On CT (H.U.): 30(kidney), 40(panc), 50(spleen), 60(liver) 
Fatty liver on CT: <10HU compared to spleen (noncom) and <25HU compared to spleen (post contrast) 

**Liver**<15cm length (midclavicular) 
Peds liver: Inferior tip of liver should be above right costal margin 
Intrahep ducts ≤2mm 
CBD≤6mm (<60yo); Add 1mm per decade over 60yrs; Upto 8-10mm post cholecystectomy; Kids: <4mm 

**GB** wall<3mm; GB dia≤4cm (≥5cm is hydropic); GB length <10cm (think GB should not be more than 5x10cm) 
GB poly≥5mm (F/U); ≥1cm (remove) 
Acute chole=gallstones+Murphy’s+wall thick=99%PPV 

**Spleen**<13cm length (<7cm wide) 
Peds spleen: 5.7cm + (0.3 x age in yrs) 
Splenic artery aneurysm if >2.0cm (operate or coil) 

**Pancreas** width: heads≤3cm, body≤2.5cm, tails≤2.5cm 
Pancreatic duct 3-2-1mm (head-body-tail); upto3mm adult and upto5mm elderly 

**Kidneys** 9-12cm length (asymmetric if size difference >1.5cm) 
Cortical thickness≥1cm 
Renal artery aneurysm 1.0-1.5cm can be followed; consider repair for ≥2cm 

**Adrenal** limb length <5cm and width <7mm 
Consider Adrenal CA if adrenal mass >4cm 

**Bladder**<4mm wall thickness when distended and <8mm wall thickness post-void 
Post-void residual volume >100-150cc may require intervention 

**Misc** 
Appy≥6mm (abnl) incompressible blind-ending tubular structure 
HPS=pyloric muscle thickness>3mm and pyloric channel length>14mm 
Prostate gland upto30cc volume 
Visceral artery aneurysm ≥2cm 
Axillary LN <3mm cortical thickness; preserved fatty hilum; ovoid shape without lobulations
<table>
<thead>
<tr>
<th>Normal Appearance</th>
<th>Follow-up*</th>
<th>Comments</th>
</tr>
</thead>
</table>
| Normal ovary appearance: Reproductive age Follicles<br>• Thin and smooth walls  
• Round or oval  
• Anechoic  
• Size ≤ 3 cm  
• No blood flow               | Not needed | Developing follicles and dominant follicle ≤ 3 cm are normal findings |
| Normal ovary appearance: Reproductive age Corpus luteum<br>• Diffusely thick wall  
• Peripheral blood flow  
• Size ≤ 3 cm  
• +/- internal echoes  
• +/- crenulated appearance    | Not needed | Corpus luteum ≤ 3 cm is a normal finding                                  |
| Normal ovary appearance: Postmenopausal<br>• Small  
• Homogenous                     | Not needed | Normal postmenopausal ovary is atrophic without follicles                |
| Clinically inconsequential: Postmenopausal Simple cyst ≤ 1 cm<br>• Thin wall  
• Anechoic  
• No flow                           | Not needed | Small simple cysts are common; cysts ≤ 1 cm are considered clinically unimportant |
<p>| <strong>Cysts with characteristics worrisome for malignancy</strong> | <strong>Follow-up</strong>* | <strong>Comments</strong>                                                             |
| Thick (&gt; 3 mm) irregular septations | Any age; Consider surgical evaluation |                                                                         |
| Nodule with blood flow             | Any age; Consider surgical evaluation |                                                                         |</p>
<table>
<thead>
<tr>
<th>Cysts with indeterminate, but probably benign, characteristics</th>
<th>Follow-up*</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Findings suggestive of, but not classic for, hemorrhagic cyst, endometrioma or dermoid</td>
<td>Reproductive age: 6-12 week follow-up to ensure resolution. If the lesion is unchanged, then hemorrhagic cyst is unlikely, and continued follow-up with either ultrasound or MRI should then be considered. If these studies do not confirm an endometrioma or dermoid, then surgical evaluation should be considered. Postmenopausal: Consider surgical evaluation</td>
<td></td>
</tr>
<tr>
<td>Thin-walled cyst with single thin septation or focal calcification in the wall of a cyst</td>
<td>Follow-up based on size and menopausal status, same as simple cyst described above</td>
<td></td>
</tr>
<tr>
<td>Multiple thin septations (&lt; 3 mm)</td>
<td>Consider surgical evaluation</td>
<td>Multiple septations suggest a neoplasm, but if thin, the neoplasm is likely benign</td>
</tr>
<tr>
<td>Nodule (non-hyperechoic) without flow</td>
<td>Consider surgical evaluation or MRI</td>
<td>Solid nodule suggests a neoplasm, but if no flow (and not echogenic as would be seen in a dermoid) this is likely a benign lesion such as a cystadenofibroma</td>
</tr>
<tr>
<td>Cysts with benign characteristics</td>
<td>Follow-up*</td>
<td>Comments</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>------------</td>
<td>----------</td>
</tr>
</tbody>
</table>
| Simple cysts (includes ovarian and extracellular cysts)  
  - Round or oval  
  - Anechoic  
  - Smooth, thin walls  
  - No solid component or septation  
  - Posterior acoustic enhancement  
  - No internal flow | Reproductive age:  
  ≤ 5 cm: Not needed  
  > 5 & ≤ 7 cm: Yearly  
  Postmenopausal (PM):  
  > 1 & ≤ 7 cm: Yearly**  
  Any age: > 7 cm: Further imaging (e.g., MRI) or surgical evaluation | Simple cysts, regardless of age of patient, are almost certainly benign  
For cysts ≤ 3 cm in women of reproductive age, it is at discretion of interpreting physician whether to describe them in imaging report |
| Hemorrhagic cyst  
  - Reticular pattern of internal echoes  
  - +/- Solid appearing area with concave margins  
  - No internal flow | Reproductive age:  
  ≤ 5 cm: Not needed  
  > 5 cm: 6-12 week follow-up to ensure resolution  
  Early PM:  
  Any size: Follow-up to ensure resolution  
  Late PM: Consider surgical evaluation | Use Doppler to ensure no solid elements  
For cysts ≤ 3 cm in women of reproductive age, it is at the discretion of interpreting physician whether to describe them in imaging report |
| Endometrioma  
  - Homogeneous low level internal echoes  
  - No solid component  
  - +/- Tiny echogenic foci in wall | Any age:  
  Initial follow-up 6-12 weeks, then if not surgically removed, follow-up yearly | |
| Dermoid  
  - Focal or diffuse hyperechoic component  
  - Hyperechoic lines and dots  
  - Area of acoustic shadowing  
  - No internal flow | Any age:  
  If not surgically removed, follow-up yearly to ensure stability | |
| Hydrosalpinx  
  - Tubular shaped cystic mass  
  - +/- Short round projections  
  "beads on a string"  
  - +/- Waist sign (i.e. indentations on opposite sides).  
  - +/- Seen separate from the ovary | Any age:  
  As clinically indicated | |
| Peritoneal inclusion cyst  
  - Follow the contour of adjacent pelvic organs  
  - Ovary at the edge of the mass or suspended within the mass  
  - +/- Septations | Any age:  
  As clinically indicated | |
THYROID

Normal Lobe Length 4-6cm; Dia 1.3-1.8cm; Vol 19.6 +/-4.7cc (male) and 17.5 +/-4.2cc (female)

Goiter (male>24cc, female>22cc)

Consider FNA >1cm (>5mm is suspicious nodule features or high risk pt)

Suspicious nodule features: size>4cm, microcalcals, internal flow (esp if chaotic), hypoechoic, infiltrative (irreg) margins, taller than wide on trans view (greatest dimension in AP)

High risk pts: h/o neck XRT, family hx of thyroid CA or syndromes (Cowdens, Werner, familial polyposis, Carney complex, MENII), +LAD, high TSH (hashimotos)

Suspicious LN features=size>5mm (other than level II LN), loss of fatty hilum, rounded (rather than oval) shape, hypoechoic, cystic change, hyperechoic calc or colloid, peripheral vascularity

FNA: use 25-22G needle and 9 or 12 MHz, image in trans plane (tx lat to med for R lobe and med to lat for L lobe)

PTC=classic features include solid hypo nodule w/ microcalcals

Follicular CA=classic feature iso or hyperechoic w/ thick irreg halo

B9 nodule=purely cystic; colloid cyst (ring down artifact); colloid clot where clot is spongiform in appearance; spongiform (honeycomb pattern); giraffe spot pattern (hyperechoic round/void spots separated by hypoechoic areas; seen in Hashimotos); homogenously hyperechoic ("white knight")

Preop imaging for thyroidectomy=need to assess for lateral compartment LN (esp levels III, IV and also VI)—suspicious nodes detected in 20-30% of cases

Management of MNG=biopsy most concerning or largest (dominant) nodules bilat lobes and flu all others via serial flu

Management of symptomatic cyst=cyt aspiration with cytology if b9 and recurs, consider perc ethanol bx vs surgical excision

Assessment of nodule growth=increase in volume by 50% or increase in nodule dia by 20% with minimum increase of atleast 2mm in two or more dimensions is considered significant (for mixed solid/cystic nodule, growth assessment is based upon growth of solid component)

Management of nodule after b9 FNA=flu US in 6-12mos (false neg FNA rate of 5%–higher if nodule>4cm) if stable then flu US q3-5yr

Management of malig nodule in pregnancy=ok to wait for after delivery for thyroidectomy but flu US during pregnancy=if sig growth prefer surgery around 24wk gest

AACE/AME/ETA Guidelines for Clinical Practice for the Diagnosis and Management of Thyroid Nodules 2010

FNA all solid and hypoechoic nodules ≥1cm or any nodules with atleast one of the following additional ul/s features:

-irregular margins

-chaotic intranodular vascular spots

-microcalcifications

-taller than wide (greatest dimension is AP)

-extracapsular extension or suggestion of LN mets
- history of neck XRT in childhood/adolescence; PTC/MTC/MEN-2 in 1st degree relatives; increased calcitonin levels

**Simplified TIRADS (thyroid imaging reporting and data system) Kwak et al 2011**

US features: solid; hypoechoic; microlobulated or irreg margins; microcalcifications; taller-than-wide shape; prior surgery for thyroid CA;

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>US FEATURES</th>
<th>RISK OF CA</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIRADS 1</td>
<td>Negative</td>
<td>0%</td>
</tr>
<tr>
<td>TIRADS 2</td>
<td>B9</td>
<td>0%</td>
</tr>
<tr>
<td>TIRADS 3</td>
<td>Probably b9</td>
<td>No suspicious US feature 1.7%</td>
</tr>
<tr>
<td>TIRADS 4a</td>
<td>Low suspicion for malignancy</td>
<td>1 suspicious US features 3.3%</td>
</tr>
<tr>
<td>TIRADS 4b</td>
<td>Intermediate suspicion for malignancy</td>
<td>2 suspicious US features 9.2%</td>
</tr>
<tr>
<td>TIRADS 4c</td>
<td>Moderate suspicion but not classic for malignancy</td>
<td>3-4 suspicious US features 44.4-72.4%</td>
</tr>
<tr>
<td>TIRADS 5</td>
<td>Highly suggestive of malignancy</td>
<td>5 suspicious US features 87.5%</td>
</tr>
</tbody>
</table>

Society of Radiologists in US consensus 2005
<table>
<thead>
<tr>
<th>US Feature</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solitary nodule</td>
<td>Strongly consider US-guided FNA if ( \geq 1 ) cm</td>
</tr>
<tr>
<td>Microcalcifications</td>
<td>Strongly consider US-guided FNA if ( \geq 1.5 ) cm</td>
</tr>
<tr>
<td>Solid (or almost entirely solid) or coarse calcifications</td>
<td>Consider US-guided FNA if ( \geq 2 ) cm</td>
</tr>
<tr>
<td>Mixed solid and cystic or almost entirely cystic with solid mural component</td>
<td>Consider US-guided FNA</td>
</tr>
<tr>
<td>None of the above but substantial growth since prior US examination</td>
<td>US-guided FNA probably unnecessary</td>
</tr>
<tr>
<td>Almost entirely cystic and none of the above and no substantial growth (or no prior US)</td>
<td>Consider US-guided FNA of one or more nodules, with selection prioritized on basis of criteria (in order listed) for solitary nodule*</td>
</tr>
<tr>
<td>Multiple nodules</td>
<td></td>
</tr>
</tbody>
</table>

Management of thyroid nodules consensus statement recommendations

**Resource:**

![Fig. 2. Strength of indication for fine-needle aspiration (FNA) biopsy of thyroid nodules on the basis of ultrasonography (US) findings.](image)
### TABLE 3: SONOGRAPHIC AND CLINICAL FEATURES OF THYROID NODULES AND RECOMMENDATIONS FOR FNA

<table>
<thead>
<tr>
<th>Nodule sonographic or clinical features</th>
<th>Recommended nodule threshold size for FNA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High-risk history</strong>&lt;sup&gt;2&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Nodule WITH suspicious sonographic features&lt;sup&gt;3&lt;/sup&gt;</td>
<td>&gt;5 mm</td>
</tr>
<tr>
<td>Nodule WITHOUT suspicious sonographic features&lt;sup&gt;3&lt;/sup&gt;</td>
<td>&gt;5 mm</td>
</tr>
<tr>
<td>Abnormal cervical lymph nodes&lt;sup&gt;4&lt;/sup&gt;</td>
<td>All</td>
</tr>
<tr>
<td>Microcalcifications present in nodule</td>
<td>&gt;1 cm</td>
</tr>
<tr>
<td><strong>Solid nodule</strong></td>
<td></td>
</tr>
<tr>
<td>AND hypoechoic</td>
<td>&gt;1 cm</td>
</tr>
<tr>
<td>AND iso- or hyperechoic</td>
<td>≥1−1.5 cm</td>
</tr>
<tr>
<td><strong>Mixed cystic-solid nodule</strong></td>
<td></td>
</tr>
<tr>
<td>WITH any suspicious ultrasound features&lt;sup&gt;5&lt;/sup&gt;</td>
<td>≥1.5−2.0 cm</td>
</tr>
<tr>
<td>WITHOUT suspicious ultrasound features</td>
<td>≥2.0 cm</td>
</tr>
<tr>
<td>Spongiform nodule</td>
<td>≥2.0 cm&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Purely cystic nodule</strong></td>
<td>FNA not indicated&lt;sup&gt;6&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>2</sup>High-risk history: History of thyroid cancer in one or more first degree relatives; history of external beam radiation as a child; exposure to ionizing radiation in childhood or adolescence; prior hemithyroidectomy with discovery of thyroid cancer, FDG avidity on PET scanning, MEN2/FMTC-associated RET protooncogene mutation, calcitonin >100 pg/mL, MEN, multiple endocrine neoplasia. FMTC, familial medullary thyroid cancer.

<sup>3</sup>Suspicious features: microcalcifications, hypoechoic, increased nodular vascularity, infiltrative margins, taller than wide on transverse view.

<sup>4</sup>FNA cytology may be obtained from the abnormal lymph node in lieu of the thyroid nodule.

<sup>5</sup>Sonographic monitoring without biopsy may be an acceptable alternative (see text) (40).

<sup>6</sup>Unless indicated as therapeutic modality (see text).
### Table 2: Strength of Panelists' Recommendations Based on Available Evidence

<table>
<thead>
<tr>
<th>Rating</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Strongly recommends. The recommendation is based on good evidence that the service or intervention can improve important health outcomes. Evidence includes consistent results from well-designed, well-conducted studies in representative populations that directly assess effects on health outcomes.</td>
</tr>
<tr>
<td>B</td>
<td>Recommends. The recommendation is based on fair evidence that the service or intervention can improve important health outcomes. The evidence is sufficient to determine effects on health outcomes, but the strength of the evidence is limited by the number, quality, or consistency of the individual studies; generalizability to routine practice; or indirect nature of the evidence on health outcomes.</td>
</tr>
<tr>
<td>C</td>
<td>Recommends. The recommendation is based on expert opinion.</td>
</tr>
<tr>
<td>D</td>
<td>Recommends against. The recommendation is based on expert opinion.</td>
</tr>
<tr>
<td>E</td>
<td>Recommends against. The recommendation is based on fair evidence that the service or intervention does not improve important health outcomes or that harms outweigh benefits.</td>
</tr>
<tr>
<td>F</td>
<td>Strongly recommends against. The recommendation is based on good evidence that the service or intervention does not improve important health outcomes or that harms outweigh benefits.</td>
</tr>
<tr>
<td>I</td>
<td>Recommends neither for nor against. The panel concludes that the evidence is insufficient to recommend for or against providing the service or intervention because evidence is lacking that the service or intervention improves important health outcomes, the evidence is of poor quality, or the evidence is conflicting. As a result, the balance of benefits and harms cannot be determined.</td>
</tr>
</tbody>
</table>

Adapted from the U.S. Preventive Services Task Force, Agency for Healthcare Research and Quality (17).

### Table 6: Sonographic Patterns, Estimated Risk of Malignancy, and Fine-Needle Aspiration Guidance for Thyroid Nodules

<table>
<thead>
<tr>
<th>Sonographic pattern</th>
<th>US features</th>
<th>Estimated risk of malignancy, %</th>
<th>FNA size cutoff (largest dimension)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High suspicion</td>
<td>Solid hypoechoic nodule or solid hypoechoic component of a partially cystic nodule <em>with</em> one or more of the following features: irregular margins (infiltrative, microlobulated), microcalcifications, taller than wide shape, rim calcifications with small extrusive soft tissue component, evidence of ETE</td>
<td>&gt;70–90&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Recommend FNA at ≥1 cm</td>
</tr>
<tr>
<td>Intermediate suspicion</td>
<td>Hypoechoic solid nodule with smooth margins <em>without</em> microcalcifications, ETE, or taller than wide shape</td>
<td>10–20</td>
<td>Recommend FNA at ≥1 cm</td>
</tr>
<tr>
<td>Low suspicion</td>
<td>Isoechoic or hyperechoic solid nodule, or partially cystic nodule with eccentric solid areas, <em>without</em> microcalcification, irregular margin or ETE, or taller than wide shape.</td>
<td>5–10</td>
<td>Recommend FNA at ≥1.5 cm</td>
</tr>
<tr>
<td>Very low suspicion</td>
<td>Spongiform or partially cystic nodules <em>without</em> any of the sonographic features described in low, intermediate, or high suspicion patterns</td>
<td>&lt;3</td>
<td>Consider FNA at ≥2 cm Observation without FNA is also a reasonable option</td>
</tr>
<tr>
<td>Benign</td>
<td>Purely cystic nodules (no solid component)</td>
<td>&lt;1</td>
<td>No biopsy&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>
Practical Approach to Thyroid Nodules
William Charboneau, MD and Carl Reading, MD
Department of Radiology – Mayo Clinic, Rochester, MN

Almost Certainly Benign
- No FNA
  - Cyst with bright echo
  - Cystic nodule
  - Sponge-like nodule
  - Cystic with debris
  - Large cystic nodule with septations
  - Cystic nodule with debris
  - Multiple isoechoic similar nodules (multinodular goiter)
  - Multiple discrete solid hypoechogenic nodules with coarse paracortical septations (Hashimoto's Thyroiditis)

Indeterminate
- FNA
  - Solid with cystic component
  - Cystic with mural nodule
  - Solid, homogenous with thin halo
  - Solid, homogenous

Worrisome for Malignant
  - Solid with irregular margins
  - Solid with micro Ca++
  - Solid with micro Ca++
  - Solid with micro Ca++
  - Fine and coarse Ca++
  - Solid with Coarse Ca++
  - Cystic with solid elements and Ca++
  - Solid with micro and peripheral Ca++

Most are benign, uncommonly follicular or papillary carcinoma

For Indeterminate Nodules
Additional Relevant Factors That Would Encourage FNA
- Family history of thyroid CA
- Previous radiation exposure
- Younger age
- Larger size of nodule

This approach has been effective for majority of patients with thyroid nodules in our practice. Color Doppler may be helpful in selected cases.

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Fig. 1—Sonographic criteria for benign thyroid nodules described by Bonavita et al. [8].
A. Pattern 1. Ultrasound scan of 21-year-old man with multinodular goiter shows spongiform nodule. Similarity of nodule to water-filled sponge or puff pastry is evident.
B. Pattern 2. Ultrasound scan of 49-year-old man with colloid cyst shows cyst with colloid clot. When cystic portion of nodule is subtracted, spongiform nodule, or type 1 nodule, remains.
C. Pattern 3. Ultrasound scan of 28-year-old woman with Hashimoto thyroiditis shows nodule with hyperechoic areas separated by hypoechoic bands, much like pattern of a giraffe’s hide.
D. Pattern 4. Ultrasound scan of 27-year-old woman with Hashimoto thyroiditis shows homogeneous hyperechoic nodule, which Bonavita et al. referred to as “white knight.”
HIGH Suspicion Pattern 70-90%

- hypoechoic, microcalcs, Irreg margin
- hypoechoic, irreg (microlobulated)
- hypoechoic, irreg margin taller than wide
- hypoechoic, irreg margin, extrathyroidal extension
- hypoechoic, interrupted lateral lymph node rim calcification with soft tissue extrusion

Micro calcification: Specificity for diagnosing cancer is 85.8% to 95.0%
LOW Suspicion Pattern 5-10%

hyperechoic solid reg margins

isoechoic solid reg margins

partially cystic with eccentric solid areas

Spongiform (<3%)
# Neck lymph node characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Benign</th>
<th>Malignant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short/Long Axis</td>
<td>&lt;0.5</td>
<td>&gt;0.5</td>
</tr>
<tr>
<td>Hilar line</td>
<td>Present</td>
<td>Absent</td>
</tr>
<tr>
<td>Jugular Deviation or Compression</td>
<td>Absent</td>
<td>Present</td>
</tr>
<tr>
<td>Microcalcifications</td>
<td>Absent</td>
<td>Present</td>
</tr>
<tr>
<td>Cystic Necrosis</td>
<td>Absent</td>
<td>Present</td>
</tr>
<tr>
<td>Vascularity</td>
<td>Central</td>
<td>Chaotic/peripheral</td>
</tr>
</tbody>
</table>
Interval US

- Worrisome features, even if maximum size unchanged

Interval US

- Substantial (>20%) rapid growth
<table>
<thead>
<tr>
<th>Diagnostic Category</th>
<th>Risk of Malignancy %</th>
<th>Usual management</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Non-diagnostic</td>
<td>1-4</td>
<td>Repeat FNA with ultrasound</td>
</tr>
<tr>
<td>II. Benign</td>
<td>0-3</td>
<td>Clinical follow up</td>
</tr>
<tr>
<td></td>
<td></td>
<td>LT4 suppression in selective cases</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sx – If pressure symptom</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US guided minimally invasive procedures – PEIT, Thermal ablation (LASER or RF)</td>
</tr>
<tr>
<td>III. Atypical follicular lesion of undetermined significance</td>
<td>5-15</td>
<td>Repeat FNA</td>
</tr>
<tr>
<td>IV. Follicular Neoplasm/“Suspicious” for follicular neoplasm</td>
<td>15-30</td>
<td>Surgical lobectomy</td>
</tr>
<tr>
<td>V. Suspicious for malignancy</td>
<td>60-75</td>
<td>Near- total thyroidectomy or surgical lobectomy</td>
</tr>
<tr>
<td>VI. Malignant</td>
<td>97-99</td>
<td>Near- total thyroidectomy</td>
</tr>
</tbody>
</table>
TESTIS

Normal Testis: upto 5cm in length and upto 4cm in width
Normal Epididymis: head 1.0-1.2cm and body/tail 2mm
Epididymal cyst vs spermatocele
Varicocele (pampiniform plexus dilation) >3mm
DDX epididymis nodule=sperm granuloma vs adenomatoid tumor
Microliths: >5 on a single image (yearly F/U ultrasound + routine self-exam + yearly physician exam); increased risk of intratubular germ cell tumor if unilateral and then develops contralateral microlithiasis
Scrotal mass ddx: adenomatoid tumor, fibrous pseudotumor, scrotal pearl, hernia, hematoma, abscess
Undescended vs partially descended vs retractile (hypermobile) testis
Mediastinum testis: posterior and superior (just like the epididymis) which means it is on the left on the long view and lateral on trans view
Torsion: decreased or absent color flow; edematous enlarged tests; paratesticular mass (twisted spermatic cord which may be hyperemic); transverse lie (oriented horizontally on longitudinal view); after manual/spontaneous de-torsion will see testicular hyperemia which mimics orchitis but patient is pain-free
Appendix testis torsion: most common in pre-pubertal males; absent flow within appendix testis which is located superiorly near epididymal head (should be ecogenic other consider torsion); there is hyperemia of surrounding epididymis which mimics epididymitis
RENAL ARTERY STENOSIS

Direct renal: normal PSV <200cm/s (no post-stenotic turbulence) (EDV >150cm/s suggest >80% stenosis), normal RI=0.5-0.7 (used to predict response of BP and renal func to revascularization), normal renal/aortic PSV ratio <2.5-3.0 [OTHERS: normal RI 0.5-0.7, normal PI 0.7-1.4, normal PSV 60-180 cm/s, D/S ratio 0.26-0.4]
Indirect intrarenal (interlobar/segmental oriented perpendicular to cortex—not interlobular/arcuate arteries oriented parallel to cortex): normal deltaT (systolic rise or accel time) <0.07s (<70ms), normal systolic accel index>3m/s² (need angle corr), no parvus tardus; increased RI (normal 0.5-0.7) may suggest parenchymal dz; decreased RI suggest RAS

<table>
<thead>
<tr>
<th>STENOSIS</th>
<th>Main renal PSV</th>
<th>RAR (renal to aortic PSV ratio)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;60%</td>
<td>&lt;180cm/s</td>
<td>&lt;3.5</td>
</tr>
<tr>
<td>≥60%*</td>
<td>≥180cm/s</td>
<td>≥3.5</td>
</tr>
</tbody>
</table>

*only one of the two listed criteria needs to be met

Figure 3: Five-step grading system for qualitative waveform analysis. (a) Grade 1 demonstrates a clearly defined early systolic peak with a velocity that is greater than any post-stenotic turbulence. (b) Grade 2 demonstrates an early systolic peak with a lower velocity peak in late systole. (c) Grade 3 demonstrates an early systolic peak with no second systolic peak. (d) Grade 1 demonstrates an obvious systolic acceleration in early systolic. (e) Grade 0 demonstrates the slow diastolic waveform of pulsus tardus.

TIPS EVALUATION (usually btwn right HV and right PV; flow from MPV + intrahep PV branches→TIPS→HV→IVC)

-Perform pre-TIPS, 24hr after TIPS, 4-6wks, 3mos, and then at 6mos intervals
-Normal TIPS: mean PSV 60-200cm/s (prefer 135-200cm/s), hi vel turbulent flow, hepatopedal in MPV, hepatofugal (towards TIPS) in intrahepatic PV branches, PSV in MPV>30cm/s
-TIPS stenosis: PSV <60 or >200cm/s; Gradient>50cm/s along stent; change in PSV +/-50cm/s from baseline (or PSV < 2/3 velocity at baseline); PSV in main PV<30cm/s (portal stenosis); Reversal of flow in HV away from IVC (HV stenosis); hepatopedal flow (away from TIPS) in intrahep PV branches; increasing ascites; recanalized collaterals (portosystemic shunts)
ANAL SPHINCTER
- IS = dark; ES = bright
- Look for hypoechoic ES defect (define by clock face)
- Normal thickness ~4mm

CAROTIDS
- Q.C.: look at gray scale for plaque burden and stenosis; look at spectral analysis for turbulent flow vs aliasing color flow, angle < 60°, beam steering box and corresponding curve above or below the baseline to ensure antegrade flow (check for “inverted” curve), look at calipers for PS and ED velocities, record PSV should be < 125 cm/s
- ICA PSV < 125 cm/s is normal (125-230=50-69% stenosis; >230=>70% stenosis) and EDV < 40 cm/s is normal (>100=>70% stenosis)
- CCA > 45-50 and < 100-135 cm/s is normal
- ICA PSV < 125 cm/s is normal
- CCA > 45-50 and < 100-135 cm/s is normal
- Difference between the two CCA of no more than 20 cm/s
- Unilateral CCA (<50)=proximal stenosis, distal severe stenosis or occlusion, wide diameter artery
- Bilateral CCA (>50)=low cardiac output (CHF, CM etc), pericardial effusion, wide diameter vessels
- Vertebral PSV > 100 cm/s is suggestive of vertebral artery stenosis
- ICA occlusion: low amplitude “thumping” (brief systolic forward flow followed by reversal) proximal to occlusion, externalization (hi-resistance) or internalization (low resistance if there are well developed collaterals from ECA and ipsilateral ICA) of CCA
- Tandem lesions (distal intracranial ICA stenosis may result in low prox ICA velocity with absent diastolic flow; proximal CCA stenosis may result in low ICA velocity with increased diastolic flow; in either case PSV velocity is underestimated)
- Plaque characterization: intimal hyperplasia; heterogenous plaque with focal central hypoechoic intra-plaque hemorrhage; irregular hypoechoic plaque with ulceration

1. Keep angle of insonation < 60°
2. Is the CCA flow normal (50 to 100 cm/s)?
3. Is CCA velocity normal and symmetric, use the PSV to grade stenosis
4. If CCA velocities abnormal or asymmetric, use ICA/CCA ratio and search for cause
5. Use the EDV to help identify very high-grade stenosis, > 100 cm/s suggests > 80% diameter stenosis
6. Confirm all findings on grayscale and color Doppler, measure diameter stenosis/residual lumen
7. Assess direction of flow in vertebral arteries.

<table>
<thead>
<tr>
<th>Degree Stenosis (%)</th>
<th>ICA PSV (cm/s)</th>
<th>Plaque Estimate (%)</th>
<th>ICA/CCA (PSV Ratio)</th>
<th>ICA EDV (cm/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>&lt; 125</td>
<td>None</td>
<td>&lt; 2.0</td>
<td>&lt; 40</td>
</tr>
<tr>
<td>&lt; 50</td>
<td>&lt; 125</td>
<td>&lt; 50</td>
<td>&lt; 2.0</td>
<td>&lt; 40</td>
</tr>
<tr>
<td>50–69</td>
<td>125–230</td>
<td>≥ 50</td>
<td>2.0–4.0</td>
<td>40–100</td>
</tr>
<tr>
<td>≥ 70 but &lt; near occlusion</td>
<td>&gt; 230</td>
<td>≥ 50</td>
<td>&gt; 4.0</td>
<td>&gt; 100</td>
</tr>
<tr>
<td>Near occlusion</td>
<td>High, low, or undetectable</td>
<td>Visible</td>
<td>Variable</td>
<td>Variable</td>
</tr>
<tr>
<td>Total occlusion</td>
<td>Undetectable</td>
<td>Visible, no detectable lumen</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>

VASCULAR
- Abd aorta prox 2.5 cm, mid 2.0 cm, distal 1.8 cm
- AAA > 3 cm; measure AP dimension in both trans (overestimates) and long (underestimates); > 5 cm operate; intraluminal thrombus is usually hypoechoic
- KP guidelines for AAA: ≤ 2.4 cm is normal; 2.5–2.9 cm is ectasia; ≥ 3.0 cm is aneurysm (3.0–3.9 cm annual flu; 4.0–5.9 cm vasc surg consult; ≥ 6.0 cm urgent vasc surg consult)
- CIA 1.0 cm (1.5–2.4 cm = ectasia; aneurysm ≥ 2.5 cm); Pop 7 mm (1.0–1.9 mm = ectasia; aneurysm ≥ 2 cm; 1/3 assoc with AAA; repair pop aneurysm if thrombus or symptomatic or > 2 cm)
- Normal Portal V < 13 mm hepatopedal (velocity < 21 cm/s ~ 80% predictive of portal HTN)
- Normal Splenic/SMV < 10 mm
- Splenic aneurysm if ≥ 2.5 cm (operate or coil)
- MCA > than 1.5x the mean = indicated anemia (due to isoimmunization); Multiple of means 1.29 cm/s = mild anemia, 1.50 cm/s = mod-severe, 1.55 cm/s = severe

DVT:
- Eval: CFV, saphenofemoral jct (drainage of GSV), profunda, SFV prox/mid/distal, pop, trifurcation; CFV and pop augmentation; contralateral CFV
- Incompressible, distended vein w/ acute clot; color void if occlusive thrombus; loss or resp variability/phasicity and loss of augmentation w/ release or valsalva suggest more cephalic clot
- Chronic thrombus (more ecogenic, heterogeneous, irreg surface, collaterals, recanalization, decreased vein dia)
**UE DVT:**
- Cephalic lateral and basilic medial
- Cephalic and basilic vein assessment is optional (superficial vein)
- Assess brachial, axillary, subclavian, and IJ
- Cant compress subclavian IJ; do sniff test for evaluation of subclavian vein (often collapses w/ sniffing and increases in dia w/ valsalva )
- Normal cardiac pulsatility and resp phasicity/variability in subclavian and IJ
- Loss of resp variability and pulsatility (monophasic) w/in central veins w/ clot
- Subclavian and IJ may have valve near confluence
- Technique: ultrasound notch up and to the right use this orientation to assess direction of flow within subclavian which depends on which side of body and orientation of vein segment being imaged
**Venous insufficiency:**
- "proximal" and "distal" vein segments refer to distance from the heart (not direction of flow)
#1 r/o DVT
#2 Assess superficial venous system for size and reflux (incompetent valves or incompetent perforators)
- Exam is generally performed with patient standing on a ledge
- Assess: saphenofemoral jct, GSV, saphenopop jct, LSV, perforator veins (mid thigh perforator, lateral thigh perforator, medial calf perforator)
- Perforators connect superficial veins to deep veins (perforator veins >4mm are usually incompetent while <3mm are usually competent)
- GSV medial/anterior (empties into CFV) and LSV lateral/posterior (empties into pop)
- Seated GSV should be 3-4mm and ≥1cm Upright GSV is abnormal (after augmentation by compression of thigh, venous flow should return to baseline in ≤1sec; >1sec is positive for valvular incompetence suggestive of chronic venous insufficiency)
- "GSV steal" if CFV regurgitation due to sig GSV reflux

**Mapping for dialysis access:**
- basilic ulnar aspect forearm and medial upper arm and continues as axillary vein
- cephalic radial forearm, lateral upper arm and lateral shoulder until it joins axillary under clavicle
- Fistula vs shunt (created by immobilizing superficial vein and connecting to artery)
  - Prefere AVF over graft; non-dominant; forearm>upperarm; assess superficial veins (cephalic/basilic) size with tourniquet/BP cuff on and also depth from skin surface; assess artery (brachial/radial/ulnar) dia and calc (also report high brachial bifurcation); assess central vein (axillary/subclavian) for patency (no stenosis or thrombosis)
  - Normal: inflow artery ≥2mm with sharp systolic upstroke, high resistance flow, and PSV equal to contralateral extremity; draining vein (distended with distal tourniquet) ≥2.5-3mm; no central venous DVT or stenosis; no prox arterial stenosis (no parvus-tradus within distal arteries)

**Dialysis shunt assessment**
- AVF vs straight/loop graft: arterial inflow (afferent limb), anastamosis (1 if AVF, 2 if graft), graft conduit (not if AVF), venous outflow (efferent limb), early venous branches (competitive), central veins (brachial, axillary, subclavian); measure fistula/graft dia at 3 levels
- Graft types: forearm loop (brachial a to AC vein), upper arm straight (brachial a to basilica vein), deep vein transposition (brachial a to basilica vein)
- Normal: arterial PSV 150-300cm/s (30-100cm/s in effrent limb) with low resistance flow and marked spectral broadening, EDV 60-200cm/s, some also do volume flow (normal >800cc/min, early stenosis 500-800, severe stenosis <500), Remember=2x increase in PSV is normal (esp 1st 6mos) so don’t call stenosis unless see narrowing on gray scale;
- Stenosis = increased PSV 2-3x normal ~50% and increased PSV 3-4x normal >75% (also look for aliasing at stenosis and change in waveform aka decreased PSV and diastolic flow distal to stenosis), bruit on exam if tight stenosis
- Additional: r/o central vein stenosis/thrombosis; pseudoaneurysm at anastamosis; perigraft hematoma/abscess; intimal flap at access site; radial steal (reversal of flow within radial artery distal to shunt)

**Vein mapping LE:**
GSV >3mm (mark the course and label branch points)

**PVD evaluation:**
- PSV<200 cm/s: triphasic high resistance flow (antegrade systolic → reversal early dia → small antegrade mid dia → no flow late dia)
- Normal 110 cm/s femoral artery and 70 cm/s popliteal artery (CFA 114+/−20 cm/s with turbulence at bifurc; SFA 94+/−14 cm/s; Pop 69+/−14 cm/s)
- Normal 110 cm/s prox subclavian artery and 85 cm/s axillary artery
- PSV to normal proximal segment ratio >2:1 indicates >50%; >4:1 indicates >75%; and >7:1 indicates >90% stenosis
- Normal CFA dia 8.2+/−0.14 mm with length 2-5 cm (CFV is located medial to CFA)
- Normal prox SFA=6.0+/−0.12 mm and distal SFA=5.4+/−0.11 mm with length 15-20 cm (SFV is located medial to prox SFA; posterior to middle SFA; and finally posterolateral to distal SFA)
- Normal Pop dia 5.4+/−0.11 mm proxPop is distal to adductor magnus canal & above knee; distalPop is just before bifurcation (>1 cm is aneurysm) with length 6-8 cm (pop vein is ant)
- Note: CFA and Pop dia vary with age/gender/body habitus (larger in men)

<table>
<thead>
<tr>
<th>STENOSIS</th>
<th>PSV ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;50%</td>
<td>&lt;2.0</td>
</tr>
<tr>
<td>≥50%</td>
<td>≥2.0</td>
</tr>
</tbody>
</table>

**Bypass graft evaluation:**
- Venous (reversed saphenous or in-situ w/ lysis of valves) vs Synthetic graft
- PSV ratio evaluation at graft anastomosis should be made with PSV distally (w/in distal graft for prox anast and w/in distal native artery for distal anastomosis
- PSV ratio eval w/in body of graft should be made w/ PSV just proximal to it (PSV >180 cm/s or doubling of velocity at stenosis site ie ratio>2 corresponds to 50% stenosis
- Intervention necessary when velocity triples
- Velocity w/in graft <45 cm/s suggest impending graft failure
- Change of waveform from triphasic to monophasic suggest prox or distal stenosis

**Mesenteric Ischemia:**
- PSV >200 cm/s in celiac axis or PSV >275 cm/s in SMA suggest >70% stenosis

Embryo < 11 wks (some say < 9 wks), Fet > 11 wks
Term infant 37-42 wks (> 36 wks)
Dating Scan b/w 7-12 wks (do CRL if < 12 wks)
Anatomy Scan 18-22 wks
G-sac/Embryo grows 1 mm per day during 1st trimester
GSD = 1/2 + MSD
Gestational Age (days) = MSD (mm) + 30
GA (days) - CRL (mm) + 42
EDC (estimated date of confinement) is 40 wks
Advanced maternal age is ≥ 35 yo
1st trimester screening result 1/400 or greater is significant

<table>
<thead>
<tr>
<th>Gestational age (wks)</th>
<th>Mean Yolk-sac Dia (mm +/- SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>3.01 +/- 0.75</td>
</tr>
<tr>
<td>6</td>
<td>2.99 +/- 0.73</td>
</tr>
<tr>
<td>7</td>
<td>3.99 +/- 0.86</td>
</tr>
<tr>
<td>8</td>
<td>4.72 +/- 0.64</td>
</tr>
<tr>
<td>9</td>
<td>5.22 +/- 0.63</td>
</tr>
<tr>
<td>10</td>
<td>5.69 +/- 0.56</td>
</tr>
<tr>
<td>11</td>
<td>5.35 +/- 0.87</td>
</tr>
<tr>
<td>12</td>
<td>4.34 +/- 0.62</td>
</tr>
</tbody>
</table>

HCG LEVELS IN NORMAL PREGNANCY

<table>
<thead>
<tr>
<th>Weeks Of Pregnancy</th>
<th>HCG level mIU/ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5-50 (Average = 14)</td>
</tr>
<tr>
<td>2</td>
<td>5-50 (Average = 21)</td>
</tr>
<tr>
<td>3</td>
<td>5-50 (Average = 42)</td>
</tr>
<tr>
<td>4</td>
<td>10-425</td>
</tr>
<tr>
<td>5</td>
<td>19-7340</td>
</tr>
<tr>
<td>6</td>
<td>10-80-56500</td>
</tr>
<tr>
<td>7-8</td>
<td>750-229000</td>
</tr>
<tr>
<td>9-10</td>
<td>25700-268000</td>
</tr>
<tr>
<td>13-16</td>
<td>13300-254000</td>
</tr>
<tr>
<td>17-24</td>
<td>4000-165400</td>
</tr>
<tr>
<td>24-40</td>
<td>3640-117000</td>
</tr>
</tbody>
</table>

Gestation | HCG (mIU/mL) |
--- | --- |
Negative | 0-8.1 |
4 weeks | 10.2-708 |
5 weeks | 217-6245 |
6 weeks | 152-32177 |
7 weeks | 4059-153767 |
8 weeks | 31366-149094 |
9 weeks | 59105-139901 |
10 weeks | 44186-179409 |
12 weeks | 27107-201615 |
14 weeks | 24302-93646 |
15 weeks | 12540-69747 |
16 weeks | 8904-55332 |
17 weeks | 8240-51793 |
18 weeks | 9649-55271 |

**1st TRIMETER DATING AND EDD**

If expected GA by LMP is but off by U/S by (then re-date)

- < 7 wks ≥ 5 days
- 8-12 wks ≥ 7 days
- 12-18 wks ≥ 10 days
- 18-30 wks ≥ 14 days
- > 30 wks > 3 wks (consider IUGR)

-SLIUP in x position at x wks, y days based on EDD estab by (1st tri U/S which was concord/discord w/ LMP).
-U/S today shows normal/abnormal growth. EFW is x% based on Hadlock.
-Normal fetal anatomy. No anomalies detected.
-Mention cervical length, placental position, AFI etc.

**Transvaginal**

**Should see**

MSD 8 mm 25 mm Yolk Sac
MSD 16 mm 25 mm Embryo
CRL 5 mm 7 mm Heart Rate
VIABILITY

- HCG > 25 mIU/ml is positive (<5 mIU/ml is negative)
- HCG > 2000 mIU/ml or IRP should see an IUP (1-7-11 rule) (1000->G sac, 7000->Y sac, 11,000->Embryo); HCG doubling time~48-72hrs; peak 8-11wks; then plateaus
- If HCG > 3000 and no IUP, consider ectopic (if HCG btw 2001-3000 and no IUP, consider preg of unknown location)
- Valid range for CRL dating: 9.5 – 84.5 mm

OLD CRITERIA:
- MSD > 8 mm EV or > 20 mm TA, should have Y sac (EGA 5.5wks)
- MSD > 16 mm EV or > 25 mm TA, should have fetal pole (EGA 6.5wks)
- FCA (B-mode) must be seen in embryo CRL 5 mm or greater (*alive by 5*); check x3min → if not detected do EV u/s → last resort, use color mode

NEW CRITERIA 2012:
- MSD > 25 mm EV, should have Y sac
- MSD > 25 mm EV, should also have fetal pole
- FCA (B-mode) must be seen in embryo CRL 7 mm or greater by EV (*alive by 7*) or ≥ 15 mm by TA
- Round/oval fluid collection in endometrium even w/o double decidual sign is still likely a G-sac (double decidual sign absent in 35%)
- Generally speaking: at 5wks gestation see G-sac; at 5.5wks gestation see YS (3-5mm); at 6wks gestation see embryo w/ heartbeat

- Poor prognosis: sustained brady<80 bpm, small MSD (should be greater than CRL by atleast 5mm or MSD-CRL < 5mm), abnormal Y sac (foregut)>7mm, thin poorly ecogenic decidua, low-lying G sac; UT anomaly, subchorionic hemorrhage (esp if 40% of G sac volume)
- Perigestational hemorrhage: acute (ecogenic), subacute (hypo), chronic (anechoic); small=<20% of sac circumference; large=50% of sac circumference
- No anembryonic (empty G-sac) or embryonic demise (aka failed pregnancy; no FCA; non-viable IUP) or stillbirth (death at >20wks GA or >350g EFW)
- Spontaneous abortion or threatened abortion (bleeding) or inevitable/imminent abortion (bleeding + open cervix) or incomplete abortion (RPOC)

**TABLE 1: Intrauterine Pregnancy of Unknown Viability: Ultrasound Findings Suspicious but Not Diagnostic of Intrauterine Pregnancy Failure**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crown-rump length &lt; 7 mm and no fetal heartbeat (the rule of “5-alive” is no longer valid)</td>
<td></td>
</tr>
<tr>
<td>Mean sac diameter 16 – 24 mm and no embryo</td>
<td></td>
</tr>
<tr>
<td>Absence of embryo with heartbeat 1 – 2 weeks after an ultrasound showing a gestational sac without a yolk sac</td>
<td></td>
</tr>
<tr>
<td>Absence of embryo with heartbeat 7 – 10 days after an ultrasound showing a gestational sac with a yolk sac</td>
<td></td>
</tr>
<tr>
<td>Empty amnion (visible yolk sac with no visible embryo)</td>
<td></td>
</tr>
<tr>
<td>Absence of embryo 6 weeks after last menstrual period</td>
<td></td>
</tr>
<tr>
<td>Large yolk sac (&gt; 7 mm)</td>
<td></td>
</tr>
<tr>
<td>Sustained bradycardia of less than 80 beats per minute</td>
<td></td>
</tr>
<tr>
<td>Small sac size (mean sac diameter – crown-rump length &lt; 5 mm)</td>
<td></td>
</tr>
</tbody>
</table>

**TABLE 2: Intrauterine Pregnancy of Unknown Viability: Ultrasound Findings Diagnostic of Pregnancy Failure**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crown-rump length ≥ 7 mm and no fetal heartbeat</td>
<td></td>
</tr>
<tr>
<td>Mean sac diameter ≥ 25 mm and no embryo</td>
<td></td>
</tr>
<tr>
<td>No yolk sac or embryo ≥ 2 weeks after an ultrasound that showed a gestational sac without a yolk sac</td>
<td></td>
</tr>
<tr>
<td>No embryo ≥ 11 days after an ultrasound that showed a gestational sac with a yolk sac</td>
<td></td>
</tr>
</tbody>
</table>

**TABLE 3: Pregnancy of Unknown Location**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>An intratuterine sac-like structure with no yolk sac or embryo and normal adnexa</td>
<td></td>
</tr>
<tr>
<td>No intratuterine fluid collection with normal adnexa</td>
<td></td>
</tr>
<tr>
<td>1 – If single hCG level is ≥ 3,000 and “empty uterus”: Viable intrauterine pregnancy is unlikely; however, a single hCG level should not be used as the basis for exclusion of a potentially normal intrauterine pregnancy</td>
<td></td>
</tr>
<tr>
<td>2 – In a hemodynamically stable patient, a single hCG level should not be used as a basis for distinguishing ectopic pregnancy from intrauterine pregnancy, or for determining treatment with methotrexate</td>
<td></td>
</tr>
<tr>
<td>3 – hCG and sonographic follow-up, as appropriate, until definitive diagnosis</td>
<td></td>
</tr>
<tr>
<td>4 – Most ectopic pregnancies have hCG levels &lt; 5,000; often &lt; 1,000; however, hCG level is variable in ectopic pregnancy, and its value does not predict rupture</td>
<td></td>
</tr>
</tbody>
</table>

For all tables: Recommended follow-up: Ultrasound is the best follow-up method (not hCG levels); in a hemodynamically stable patient, a follow-up examination in 7 – 10 days is appropriate [18].
### Table 1: Timeline of Normal Early Pregnancy Development

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Developmental Milestone (Threshold)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 0</td>
<td>Patient has last menstrual period</td>
</tr>
<tr>
<td>Week 2</td>
<td>Conception occurs</td>
</tr>
<tr>
<td>Week 4.5–5.0</td>
<td>Gestational sac appears</td>
</tr>
<tr>
<td>Week 5.0–5.5</td>
<td>Yolk sac appears</td>
</tr>
<tr>
<td>Week 6.0</td>
<td>Embryo appears; cardiac pulsation begins, with a lower limit of 100 beats/min</td>
</tr>
<tr>
<td>Week 6.5–7.0</td>
<td>Amniotic membrane appears; cardiac pulsation lower limit is 120 beats/min</td>
</tr>
<tr>
<td>Week 7–8</td>
<td>Spine develops</td>
</tr>
<tr>
<td>Week 8</td>
<td>Head curvature separates from the body; four limb buds appear</td>
</tr>
<tr>
<td>Week 8.0–8.5</td>
<td>Intrinsic motion of the embryo occurs</td>
</tr>
<tr>
<td>Weeks 8–10</td>
<td>Rhombencephalon develops</td>
</tr>
</tbody>
</table>

### Table 2: US Findings Diagnostic of Pregnancy Failure

<table>
<thead>
<tr>
<th>Finding</th>
<th>Imaging Appearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absent cardiac activity by the time the CRL is a certain size</td>
<td>CRL $\geq$ 7 mm with no heartbeat</td>
</tr>
<tr>
<td>Absent embryo by the time the gestational sac is a certain size</td>
<td>MSD $\geq$ 25 mm with no embryo</td>
</tr>
<tr>
<td>Absent embryo by a certain point in time; requires two US examinations</td>
<td>Absence of embryo with a heartbeat 2 or more weeks after US showed gestational sac without yolk sac</td>
</tr>
<tr>
<td></td>
<td>Absence of embryo with a heartbeat 11 or more days after US showed gestational sac with yolk sac</td>
</tr>
</tbody>
</table>

Note.—Adapted and reprinted, with permission, from reference 6.

### Table 3: US Findings Suspicious for, but Not Diagnostic of, Pregnancy Failure

<table>
<thead>
<tr>
<th>Finding</th>
<th>Imaging Appearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absent cardiac activity by the time the CRL is a certain size</td>
<td>CRL $&lt; 7$ mm with no heartbeat</td>
</tr>
<tr>
<td>Absent embryo by the time the gestational sac is a certain size</td>
<td>MSD of 16–24 mm with no embryo</td>
</tr>
<tr>
<td>Absent embryo by a certain point in time</td>
<td>Absence of embryo with a heartbeat 7–13 days after US showed gestational sac without yolk sac</td>
</tr>
<tr>
<td></td>
<td>Absence of embryo with a heartbeat 7–10 days after US showed gestational sac with yolk sac</td>
</tr>
<tr>
<td></td>
<td>Absence of embryo 6 or more weeks after last menstrual period</td>
</tr>
<tr>
<td>Morphology of gestational sac, amnion, and yolk sac</td>
<td>Empty amnion (amnion seen adjacent to yolk sac, with no visible embryo), enlarged yolk sac ($&gt; 7$ mm), small gestational sac in relation to size of embryo ($&lt; 5$-mm difference between MSD and CRL)</td>
</tr>
</tbody>
</table>

Note.—Adapted and reprinted, with permission, from reference 6.
**ANATOMY SCAN**

- >16th wks, all normal variants are gone!
- Stomach seen by 14wks; spleen by 18wks; GB by 20wks; kidneys/bladder by 16wks
- Rhombencephalon (rhombencephalic cavity is cystic posterior fossa aka future cerebellum) ~6-8wks
- Physiologic gut herniation ~9-11wks (<12wks)
- Chorioamnion fusion by 16wks
- Detectable abnl during 1st trimester scan:
  1. Acrania (initially excencephaly=exposed disorganized brain without cranium)
  2. Alobar holoprosencephaly (identifying 2 lateral vents containing choroids rules this out; assoc with proboscis and cleft lip)
  3. Omphalocele/Gastroschisis (look for herniating mass >7mm and/or containing liver after 12wks gestation to avoid physiologic gut herniation)
  4. Megacystis (enlarged bladder with bladder length ≥7mm; 7-15mm may resolve by 20wks; >15mm may progress to severe obstructive uropathy)
  5. Body stalk anomaly (seen as distorted fetus; wall defect with herniation; scoliosis; short umbilical cord)

**HEAD/NECK**

- HC measured at level of thalami, CSP, and 3rd vent (no cerebellum, orbits or ears in picture; measured using ellipse around outside of skull); BPD from inner to outer table of skull at same level (unlike BPD, HC independent of head shape; also HC is most accurate for GA in 2nd trimester)
- HC <3SD from mean suggest Microcephaly
- Skull bone should be more ecogenic than falx (frontal skull develops first)
- CSP (caum septum pellucidum) seen bttwn 16-37wks (nl CSP excludes forebrain abnl like holoprosencephaly spectrum)—just anterior to CSP look for U-shaped anterior corpus callosum; CSP may not be seen <18wks or >37wks (usually fuses by 6mos to life). If absent CSP, look for partial/complete agenesis of CC.
- Choroids and veins are seen on transventricular view at level of atrium of lateral vents
- Choroid Plexus cysts ≥3mm (usually regress by 24wks)—Assoc w/ T18

---

**Table 4: US Indicators of Poor Prognosis in Early Pregnancy**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Imaging Appearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gestational sac</td>
<td>Irregular contour, low-lying position</td>
</tr>
<tr>
<td>Yolk sac</td>
<td>Calcified, larger than 7 mm</td>
</tr>
<tr>
<td>Amnion</td>
<td>Empty, enlarged, or expanded</td>
</tr>
<tr>
<td>Embryo</td>
<td>Amorphous shape</td>
</tr>
<tr>
<td>Cardiac activity</td>
<td>Bradycardia of 85 beats/min or less</td>
</tr>
<tr>
<td>Chorionic villi</td>
<td>Hydropic change</td>
</tr>
<tr>
<td>Subchorionic hemorrhage</td>
<td>Large, particularly if it encircles at least two-thirds of the gestational sac circumference</td>
</tr>
</tbody>
</table>

---

**Figure 19.** Diagram outlines various early-pregnancy US impressions.
- Vents <1cm (measured from inner wall to inner wall at level of glomus of CP; some measure on both near and far field ventricle; <3mm separation of choroid from medial wall of vent; choroid angle 16-22deg w/o dangling)—ventriculomegaly if ≥1cm
- Posterior fossa imaging on cerebellar plane (angled back so see CSP/thalamus and posterior fossa on same image)
- Cerebellum (trans-cerebellar dia) concordant with dates upto 20wks (ie 20mm at 20wks; usually larger than GA after 20wks; should not be less than 2mm of GA)
- Cisterna Magna 2-10mm (posterior vermis to inner table; small cisterna magnas<2mm=concern for Chiari II; >11mm DW vs arachnoid cyst vs MCM)
- Cisterna magna septa (blake’s pouch fenestrations) rules Chiari out;
- Tonsils <3mm (>5mm=ectopia)
- Nuchal translucency (in to in) <3.5mm 1st trimester 11-13wk6d (upto14wks); obtained on trans-abd view but do trans-vag view of hi maternal BMI or retroverted uterus; increased thickness of NT correlated with increasing prevalence of abnormalities (chr abnl/str defects/genetic syn) or adverse outcome; NT along with serum testing (B-HCG and PAPP-A) detects 90% of T13, T18, T21, Turner’s, and triploidy (with 5% FP rate)
- Nuchal fold thickness (from outer skull to outer skin surface) <6mm 2nd trimester (15-21wks; not performed after 21wks)
- Nasal bone on profile ≥4mm (2.5% percentile is 4.4mm at 18wks and 5mm at 20wks; others use 0.75th MOM being 3.6mm at 18wks and 4mm at 20wks)—hypoplastic nasal bone assoc w/ trisomy21
- No frontal bossing (aka no forward sloping forehead on sag view)
- Upper lips (r/o cleft lip and cleft palate); do coronal image
- No Micrognathia if see nose tip, lips, and chin all in same coronal image
- Nuchal cord (noted it but usually not significant finding)

THORAX/HEART
- FCA@5-6wks (normal)100+/-10bp then increases to 140bp); FCA (generally) 100-180 (normal with NSR), some say 120-160bp from 16-40wks; <85 (brady)
- Bradycardia= CRL<5mm <80bp, 5-9mm <100bp, 10-15mm <110bp
- Cardiac axis 40-45deg (some say 20-50deg)—draw line from spine to sternum to determine axis (only LA to right of this line); cardiac size ~1/3 of thoracic (can fit 3 hearts within thoracic cavity); make sure no mediastinal shift; RV=LV and also equal wall thick (in reality RV slightly smaller than LV); RA=LA (due to FO, LA may appear slightly small than RA); tricuspid valve is slightly lower or closer to apex than mitral valve; normal pericardial effusion<2mm; make sure descending aorta in close proximity to LA on 4chamber view otherwise suspect mass or dia hernia; look for pulm vein inserting into LA; make sure dark blood within LV extends to LV apex otherwise consider HLHS; make sure to look for VSD (adjacent ecocgencv; septal step-off sign)
- Cardiac situs (compare w/ stomach need to know fetal lie and where is spine ) If both on wrong side=situs solitus or inversus totalis; if on opposite side=situs ambiguous->high assoc w/ CHD ~90%
- By convention, cardiac chamber closest to spine is LA (also look for inserting pulm veins)
- Foramen ovale bwt RA and LA; leaflets visibly moving within LA no more than half way into atrial cavity (septum primum is normal and extends to crux of heart while septum secundum not seen due to FO)
- LVOT (ant wall of aortic root must be continuous with IV septum to exclude overriding aorta; also posterior wall of aorta is continuous with anterior leaflet of MV; also look for right pulm artery seen posterior to aorta and touching aortan perpendicular plane)
- RVOT (pulm trunk divides into ductus arteriosus which continues straight back towards spine and RPA which curves anterior to aorta; LPA is not visualized as it is more inferior; PA should be same size as Ao and perpendicular to each other and not parallel; on 3-vessel view there is normal decreasing size Pulm trunkAo>SVc on transverse image with MPA more anterior than aorta and also RPA course behind and touches aorta)
- PA> Ao=SVC and if ant wall of Ao continuous with intervent septum ->not TOF or DORV; if PA same size as Ao ->not TOF or HLHS; if RPA travels behind Ao ->not TGA; Ao>PA=tetralogy; SVC> Ao=PAPVR or peripheral systemic shunt; PA> Ao=coaartation or HLHS
- Moderator band RV apex (along IV septum) and Ecocgenic papillary muscle LV
- Intracardiac Ecocgenic Focus (do triple screen; if mom>34yo, 40d risk of Down’s)
- Beware of pseudo-VSD near membranous septum (usually seen as artifactual VSD when IV septum is oriented parallel to ultrasound beam)—confirm with color flow (also look for ecocgenic artifact at site of VSD and step-off sign)
- Aortic arch (*curved* walking stick appearance on sag with great vessels originating from top; look for any narrowing or coarctation)
- Ductal arch (flatte curve with “hockey stick” appearance on sag with no vessels originating from top)

ABD/PELVIS
- AC (more difficult measurement; better correlation with EFW in 3rd trimester; measure at level of stomach and J-shaped LPV curving into RPV; measured from outside of skin line and should be circular not oval)
- Renal length 20-22mm
- Normal renal pelvis (no pyelectasis<4mm <33wks and ≥7mm ≥33wks) <4mm (<20wks), <7mm (20-30wks), <10mm (>30wks); hydronephrosis >10mm (if see in 2nd tri) recc 3rd tri flu recc neonatal renal u/s >3d-1wk after birth)—report fetal gender & inspect bladder for distension or keyhole (PUV)
- Adrenal> in size before 2nd trimester
- External genitalia formed by end of week 14
- 3v cord (2 umb arteries): not 2vessel (r/o cardiac anomalies, consider flu at 28wks for IUGR)/nuchal/vasa previa/velamentous insertions/prolapsed/cord entanglement (monochorionic twins) hypoechoic/hypercooled/straight/knot consider fetal hrt rate monitoring; for cord cyst (allantois>omphalomesenteric) r/o urinary anomalies (urachal) and omphalocoele
- Abd aorta sits in front of spine while SVC is anterior and right-sided
- Testis are normally undescended at 2nd trimester

SPINE/EXTREMITIES
- Spine: posterior elements (lamina) should be parallel or converge (no diverging lateral ossification centers) with intact overlying skin; railroad long view w/ tapering towards sacrum; should see symmetric iliac wings on transverse view of sacrum; r/o spinal dysraphism (or open spinal bifida)
- FL (should be oriented perpendicular to ultrasound beam; <2.5th percentile or >3SD below mean suggest skeletal dysplasia or enuploidy; best measurement in 3rd trimester since more reproducible than AC)
- Tibia= Fibula but Ulna=Radius (by 2-3mm at level of elbow)
- Clubfoot (see tib/fib and toes in same view) T13,18 and oligohydramnios
- Should see flexion or extension of a limb at least once during scan to avoid missing Arthrogryposis
- Clenched fist (additional imaging to ensure open hand)—Trisomy 18
PLACENTA/CERVIX
- Placenta normally 1-4 cm in thickness (<1 cm consider placenta insuff)—comment on position (previa) if >16wks; placenta >4 cm is enlarged
- Hypoechoic placent al venous lakes are normal findings (if >2x2 cm, increased risk of SGA in 3rd trimester)
- Succenturiate lobe (accessory); bi-lobed (2 equal lobes); circumvallate (raised peripheral placental shelfs); membranacea (thin 1-2 mm) placenta
- "Normal insertion" if cord inserts into placental mass; "Marginal insertion" if cord inserts along the margin of placenta; "Velamentous insertion" if cord inserts away from uterine mass and then vessels then course around the wall to insert into side of placental mass
- Inferior placental tip (placenta to internal cervical os distance) >2 cm from internal os → Low lying → Marginal/Partial "approaches" (most don't use this terminology) → Complete Previa "covers" (report placental position for gestation>16wks); placenta to cervix distance may be underestimated if distended bladder
- Vasa previa (fetal vessels not the cord crossing internal os; may be assoc w/ marginal placenta or succen lobe) vs cord presentation
- Cervix length ≥ 2.5 cm EV and ≥ 3 cm TA on empty bladder (<2.5 indicates incompetence and risk of preterm delivery) → if less than 3 cm, consider transperineal/transvaginal exam; remember distended bladder and lower UT se contraction elongates cervix
- Placenta abruption (occurs after 20-24 wks; low sensitivity of ultrasound for detection; 40% with retrolapetal hemorrhage which is hypoechoic without flow unlike normal retroplacental venous plexus with slow flow; thickened placenta with rounded edges; look for intra-amniotic hemorrhage which is ecogenic foci within amniotic cavity; higher risk if trauma, smoker, cocaine abuse, fibroid etc)
- Placenta accreta (loss of hypoechoic interface b/w placenta and myometrium; look for multiple irregular shaped lacunes aka vascular sinuses within placenta to increase specificity)
- Lesion around placenta cord insertion (subamniotic cyst can be simple or complex, usually larger than 4.5 cm and more than 3 can lead to increased risk of IUGR; Chorioangioma is rounded, can be heterogeneous, protrude into amniotic cavity, higher risk of fetal complication if hypervascular)

GROWTH SCAN
- HC not accurate; AC most corre llate w/ EFW but difficult to do it right; FL is hence most reproducible
- Should be concordant <2wks w/ dating ultrasound or LMP
- Fetal position: breech (complete vs incomplete vs frank), cephalic, transverse head left/right (comment if ≥25wks)
- 4 quadrant AFI (measured ≥22 wks) ~5-20 cm(normal); <5-7 cm(oligo); ≥20-25 cm (poly); single max vertical fluid pocket >8 cm(poly) or <2 cm(oligo)
- Oligo prior to 20-22 wks of any cause leads to pulm hypoplasia (oligo due to inadequate urinary function only occurs after 16-18 wks)
- EFW by Hadlock (also singletone by Douillet) or twin EFW by Yorkoni; normal growth is 200g in 2 wks or 14d
- Macrosomia EFW>90th percentile or >4000g
- LGA (large for GA) >2 wks compared to dating U/S
- Twin gestation discordant growth if EFW differ by 15% or more (EFW1-EFW2)/ (EFWlargest) x100= %discordant (≥25% is worse)
- IUGR (EFW<10th %tile for gest ≥24 wks; always compare w/ prior u/s; DO CORD DOPPLER if ≥30 wks): asymm(decreased AC; HC>AC) vs symm(worse); FL/AC>2.5
- Nuchal cord (usually not significant even in 3rd trimester)
- Cord Doppler (umbilical artery) for IUGR and indicator of placental insufficiency: measure free-floating cord, @placenta, @baby; normal S/D<4(26-30 wks), <3.5(30-34 wks), <3(>34 wks); and RI ≤0.7(normal); S/D≤3.5 (before 30 wks) and ≤3.0 (after 30 wks); 3 categories: reduced ED flow, absent ED flow, reversed ED flow (increased perinatal mortality → consider pre-term delivery); normal UA doppler implies placental insufficiency → also do MCA doppler which reflects compensatory response with increased diastolic flow to brain (aka "brain-sparing" effect)
- Fetal MCA: absolute (not relative) PSV (Doppler angle should be 0deg and definitely less than 30deg; cutoff "1.5 multiples of median") is predictor of severe fetal anemia (due to red cell isoimmunization) w/o need for cordocentesis fetal hemoglobin measurement; normally MCA should have minimal diastolic flow (normal RI>80%, S/D>6.0); MCA to umbilical artery ratio of ≤1 is abnl

MISC
- Trisomy 13 (Patau): holoprosencephaly, cleft lip+palate, polydactyly, clubfoot
- Trisomy 18 (Edwards): choroid plexus cyst, overlapping 2nd/3rd digits w/ adducted thumb, rocker bottom feet, encephalocele

<table>
<thead>
<tr>
<th>Soft markers</th>
<th>TRISOMY 21</th>
<th>TRISOMY 18</th>
<th>TRISOMY 13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nuchal fold thickening</td>
<td>Ventrilomegaly</td>
<td>Enlarged cisterna magna</td>
<td>Echogenic</td>
</tr>
<tr>
<td>Short femur or humerus</td>
<td>Ventrilomegaly</td>
<td>Short femur or humerus</td>
<td>intracardiac foci</td>
</tr>
<tr>
<td>Hypoplastic nose</td>
<td>Hypoplastic nose</td>
<td>Hypoplastic nose</td>
<td>Enlarged cisterna magna</td>
</tr>
<tr>
<td>Echogenic bowel</td>
<td>Echogenic bowel</td>
<td>Ventrilomegaly</td>
<td>Ventrilomegaly</td>
</tr>
<tr>
<td>Pyelectasis</td>
<td>Pyeectasis Single umbilical artery</td>
<td>Pyeectasis</td>
<td>Single umbilical artery</td>
</tr>
</tbody>
</table>

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<tr>
<td>Hypoplastic nose</td>
<td>Echogenic bowel</td>
<td>Pyeectasis</td>
</tr>
<tr>
<td>Pyeectasis</td>
<td>Single umbilical artery</td>
<td>Single umbilical artery</td>
</tr>
</tbody>
</table>
Landmarks (by 16wks all normal variants gone)
- 12wk physio bowel herniation
- 14wk nuchal translucency
- 16wk chorio-amnion fusion
- 16-18wks oligo after this may be sec to renal agenesis
- 16wks corpus luteal should resolve

Oligohydramnios (AFI<5) “DRIPPS”
- Demise
- Renal/Bladder (agenesis/obstruction)
- IUGR (do cord doppler for placental insuff; S/D >3)
- PROM
- Post-dates
- Syndromes (chromosomal)
- Note: at risk for pulm hypoplasia and clubfoot

- Twins, Hydrops, DM
- Chorioangioma
- Cant swallow (neuro vs GI)

IUGR (or SGA; EFW<10th percentile; detected after 32wks)
- Symmetric (decreased HC and AC)=chromosomal abnl or TORCH infx
- Asymmetric (HC>>AC)=placental insufficiency (do cord doppler; S/D>3)

Macrosonia (or LGA; EFW>90th percentile or >4000g at term)
- HC<<AC (with AC >3SD above mean for age)
- Increased risk for shoulder dystocia
- DM mother

Increased AFP (MS-AFP>2.5)
- Neural tube defect (incln abnl swallowing)
- GI abnl (Eso atresia, gastrochisis>omphalocele)
- Renal defects (ARPKD, Renal dysplasia, obstruction)
- Placental problems (Chorioangioma)

Decreased AFP (MS-AFP<0.5)
- Down’s
- Demise
<table>
<thead>
<tr>
<th>SYNDROME</th>
<th>COMMON ULTRASOUND FINDINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trisomy 21</td>
<td>Brachycephaly, mild ventriculomegaly, flattening of the face, nuchal edema, atrioventricular septal defects, duodenal atresia and echogenic bowel, mild hydronephrosis, shortening of the limbs, sandal gap and clinodactyly or mid-phalanx hypoplasia of the fifth finger.</td>
</tr>
<tr>
<td>Trisomy 18</td>
<td>strawberry-shaped head, choroid plexus cyst, absent corpus callosum, Dandy-Walker complex, facial cleft, micrognathia, nuchal edema, heart defects, diaphragmatic hernia, esophageal atresia, exomphalos, renal defects, myelomeningocele, growth retardation and shortening of the limbs, radial aplasia, overlapping fingers, and talipes or rocker bottom feet</td>
</tr>
<tr>
<td>Trisomy 13</td>
<td>Holoprosencephaly, microcephaly, cardiac abnormalities, enlarged and echogenic kidneys, exomphalos and postaxial polydactyly</td>
</tr>
<tr>
<td>Triploidy</td>
<td>IUGR, molar placenta, mild ventriculomegaly, micrognathia, cardiac abnormalities, myelomeningocele, syndactyly, and ‘hitchhiker’ toe deformity.</td>
</tr>
<tr>
<td>Turner syndrome</td>
<td>cystic hygroma, generalized edema, mild pleural effusion and ascites, and cardiac abnormalities</td>
</tr>
</tbody>
</table>

Table 2. Sonographic markers for aneuploidy in second trimester
<table>
<thead>
<tr>
<th>Condition</th>
<th>Image</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Normal</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Dandy–Walker malformation</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Dandy–Walker variant</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Megacisterna magna</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Spina bifida</strong> (Arnold–Chiari II)</td>
<td></td>
</tr>
</tbody>
</table>
Suspected IUGR

Weekly UA Doppler

Normal UA Doppler
- Consider delivery at 38-39 weeks

Abnormal UA Doppler
- Decreased diastolic flow
  - Increase frequency of testing
  - Consider delivery at >37 weeks
- Absent end diastolic flow
  - Corticosteroids
  - Consider delivery at ≥34 weeks
- Reversed end diastolic flow
  - Corticosteroids
  - Consider delivery at ≥32 weeks
Crown–Rump Length

Hansemann et al.
Geburtsh Frauenheilk
1979;39:656-666

Gestational Sac Diameter versus Gestational Age

**Middle Cerebral Artery Pulsatility Index (PI)**


**Umbilical Artery Resistive Index**

**4Quadrant AFI**

*www.ultrasoundpaedia.com*

### Table 1. Follow-up of Isolated Second-Trimester Ultrasoundographic Markers for Down Syndrome Beyond a Targeted Ultrasonogram

<table>
<thead>
<tr>
<th>Marker</th>
<th>Other Considerations and Follow-Up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Echogenic cardiac focus*</td>
<td>None</td>
</tr>
<tr>
<td>Pyelectasis*</td>
<td>32-week ultrasound to assess kidneys; Postnatal follow-up</td>
</tr>
<tr>
<td>≥4 mm up to 20 weeks of gestation</td>
<td></td>
</tr>
<tr>
<td>≥7 mm at 32 weeks of gestation</td>
<td></td>
</tr>
<tr>
<td>Short humerus length*</td>
<td>Consider third-trimester growth ultrasound</td>
</tr>
<tr>
<td>Short femur length*</td>
<td>Consider third-trimester growth ultrasound</td>
</tr>
<tr>
<td>Nuchal thickening</td>
<td>Genetic counseling</td>
</tr>
<tr>
<td>Echogenic bowel</td>
<td>Genetic counseling; 32-week ultrasound to assess growth, bowel</td>
</tr>
<tr>
<td>Absent/hypoplastic nasal bone</td>
<td>Genetic counseling</td>
</tr>
</tbody>
</table>

* If there is an isolated finding and no aneuploidy screening is performed, recommend cell-free fetal DNA testing or quad screen. If aneuploidy screening is performed and is low-risk, then no further risk assessment is needed. If more than one marker is identified, then genetic counseling is recommended.

**TRISOMY 18 markers**
- Cardiac defects (90% of cases)
- Choroid plexus cysts
- Flexed/clubbed wrist and clenched fists
- Rocker-bottom or clubfeet
- Small cerebellar dia
- Large cisterna magna >10mm
- Micrognathia
- IUGR
- SUA
- Polyhydramnios

**TRISOMY 21 markers**
- Nuchal fold thickening ≥7mm
- Short limbs (femurs and humeri)
- Iliac wing angle >90deg
- Cardiac defect (50% of cases)
- EICF
- Absent middle phalanx 5th digit
- Bilat pyelectasis
- Ecogenic bowel
- Nasal bone (normal<9, suspicious9-11, strongly positive>11)
- Enlarged RA
- TRRegurgitation

**Perinatology referral (KP guidelines):**
- Ecogenic bowel (as bright as bone without harmonics, probe ≤4mHz)
- Choroid plexus cysts ≥3mm
- EICF (same criteria as ecogenic bowel)
- Nuchal fold ≥6mm
- Pyelectasis ≥4mm
- mild ventriculomegaly ≥10mm
- single umbilical artery

**CAVEAT:** FOLLOWING RECOMMENDATIONS ARE PER CANADIAN SOCIETY (ACTUAL MEASUREMENTS MAY DIFFER FROM THOSE ESTABLISHED IN THE U.S. LITERATURE BUT OVERALL GUIDELINES ARE HELPFUL)...

**FETAL SOFT MARKERS IN PREGNANCY**

**8 markers**
5 are assoc w/ increased risk of fetal aneuploidy
- mild ventriculomegaly
- choroid plexus cyst
- thickened nuchal fold
- EICF
- ecogenic bowel

3 are only assoc w/ increased risk of non-chromosomal abnormalities when seen in isolation
- 2-vessel cord (single umbilical artery)
- enlarged cisterna magna
- pyelectasis

-Mention when it is an isolated findings and recommend correlation w/other risk factors by history, maternal age, maternal serum testing
- Use 5MHz or less transducer

**EICF**
- compare to bone (ecogenicity equal to or more than bone)
- located in region of papillary muscle
- LV (80%)>>RV (5%)>biventricular (7%)
- RV and biventricular have higher risk of aneuploidy
- not assoc w/ congenital heart dz
- higher risk if advanced maternal age (>31yo) ➔ do maternal serum testing and counsel regarding fetal karyotyping
- as an isolated findings, no F/U ultrasound or echo needed

**MILD PYELECTASIS**
- hypoechoic spherical or elliptical space within renal pelvis ≥5mm and ≤10mm
- largest AP measurement on transverse image
- <5mm is normal
- >10mm is equivalent to congenital hydronephrosis
- as an isolated finding, assoc w/ Down syndrome is ~2%
- ≥5mm ➔ recq neonatal renal U/S (do maternal serum testing and if an isolated finding, no fetal karyotyping needed)
- >10mm ➔ recq 3rd trimester U/S (report fetal gender)
- consider referral if maternal age>34yo or additional findings

**2-VESSLE CORD (SINGLE UMB ARTERY)**
- absence of one of the arteries surrounding fetal bladder and w/in fetal umbilical cord
- use color flow doppler
- isolated anomaly is assoc w/ both fetal renal and cardiac abnl as well as low birth wt
- do detailed assessment of fetal kidney and heart (including fetal echo)
- assess for appropriate fetal growth (recq f/u if concern)
- isolated finding does not warrant fetal karyotyping

**ECOGENIC BOWEL**
- fetal bowel w/ homogenous areas of ecogenicity equal to or greater than bone
- can be either focal or multifocal
- turn down the gain to make sure finding is real
- sig assoc w/ chromosomal and non-chromosomal abnl
- as an isolated finding, assoc w/ aneuploidy in 9% (trisomy 13,18, 21, and sex chromosome)
- assoc w/ increased risk for CF (2%), intra-amniotic bleeding (due to placental abruption or invasive procedure), cong malformation of bowel (esp upper GI), or other perinatal complications including IUGR
- assoc w/ congenital infx (CMV, herp, parvovirus, rubella, varicella, toxo)
- look for any assoc ascites, dilated bowel loops, or other signs of bowel obstruction or perforation
- do detailed assessment of fetal anatomy, growth, and placental characteristics (thickness, ecogenicity, position, placental cord insertion site)
- workup: fetal karyotyping and DNA testing for CF; maternal serum titers, fetal amniotic cultures or PCR for viral DNA for congenital infx
- elevated alpha fetoprotein and hCG on maternal serum testing has increased perinatal morbidity or mortality
- consider ultrasound F/U

**THICKENED NUCHAL FOLD**
- skin thickening in post aspect of fetal neck
- transverse section of fetal head at level of cavum septum pellucidum and thalami (angled posteriorly to include cerebellum)
- outer edge of occiput bone to outer skin limit directly in midline
- ≥5mm (btwn 16-18wks) is abnl


-≥6mm (btw 18-24wks) is abnl
-need to distinguish from cystic hygroma (fluid filled loculations and septae)
-Not same as “Nuchal translucency” which is specific measurement of fluid in post aspect of neck at 11-14wk gestation
-assoc w/ ~17-fold risk for downs
-may also be rare assoc w/ single gene abnl like Noonan syndrome, multiple pterygium syndrome and skeletal dysplasias
-also assoc w/ congenital cardiac defects
-offer fetal karyotyping
-Nuchal index (takes into account normal increase in nuchal fold measurement w/ advancing gest age) = mean nuchal fold/mean BPD x100 (≥11 has sensitivity of 50% and specificity of 96%)

MILD VENTRICULOMEGALY
-atria of lateral ventricles measuring ≥10mm (axial plane at level of thalami just below standard image for BPD measurement; measured on far image field to avoid near-field artifacts)
-cursors are perpendicular to long axis of vent at the edge of ventricular lumen (near posterior portion of choroid plexus)
-mean atrial measurements are 7.6mm (SD of 0.6mm)
-mild ventriculomegaly is ≥10mm to ≤15mm
-as an isolated finding, assoc w/ aneuploidy is ~3.8% (trisomy 21)
-may be assoc w/ agenesis of CC, cerebral malformation, vascular anomalies, ventricular obstruction
-if resolves, abnl outcome is infrequent (<10%)
-isolated unilateral mild ventriculomegaly has favorable outcome
-do careful assessment of fetal anatomy including heart
-may offer karyotyping and eval for congenital infx
-could consider fetal MRI

CHOROID PLEXUS CYST
-cysts (≥3mm) within choroid plexus of lateral ventricles (14-24wks)
-transverse plane at same level as lateral vent eval
-inspect bilateral choroid plexuses for cysts
-number, size, or distribution of cyst does not change the risk
-incidence of CPC in fetus w/ trisomy 18 is 50% (but only 10% will have isolated CPC on ultrasound eval)
-CPC in chromosomally normal fetus is not assoc w/ other fetal abnl
-correlate w/ maternal age>35yo and maternal serum testing (trisomy 18 or 21)
-no F/U US needed if isolated finding

ENLARGED CISTERNA MAGNA
-measured on transaxial head angled 15deg caudal to canthomeatal line
-AP diameter is taken btwn btm inf/post surface of vermis of cerebellum to the inner surface of the cranium
-enlarged cisterna magna is defined by AP dia ≥10mm
-mean dia of cisterna magna is 5mm (SD of 3mm)
-may be false exaggerated by steep angle thru posterior fossa or dolichocephaly
-increased risk for aneuploidy esp trisomy 18 (strongest in absence of ventricular dilatation and in presence of other anomalies)
-isolated finding however, does not appear to be strongly assoc w/ aneuploidy (no need for karyotyping)
-assoc w/ anatomic abnl (arachnoid cyst, DW malformation, DW variant) and syndromes (oro-facial-digital syndrome, Meckel-Gruber, DiGeorge)
-document any ventriculomegaly, IUGR, abnl amniotic fluid volume
-may consider fetal MRI

Other useful markers:
-soft femur length
-soft humerus length
-nasal bone (hypo/absent)
-5th finger clinodactyly

Less useful markers:
-brachycephaly
-increased iliac angle
-small fetal ear length
-sandal gap (toe)

RENAL TRANSPLANT

Fluid collections
-Hematoma/seroma
-Lymphocele (4-8wks; may be septated)
-Urinoma

Parenchyma
-generally pyramids are easily seen b/c superficial kidney therefore pron corticomedullary differentiation
-absence of cortical-medullary differentiation may be nl
-rounding of kidney with AP dimension = transverse dimension, sign of diffuse renal swelling
- volume of transplants may increase up to 20% in 1st 2-3 wks after transplantation (may increase by 40% in 1st 6mos)
- look for any focal/disseuse hyperperfusion on color mode
- check spectral waveforms of interlobar/arcuate arteries in upper/mid/lower poles
  - RI of renal arteries <0.5 (range 0.5-0.7)
    - Elevated RI: intrinsic dysfunction such as rejection, ATN, obstruction, postop edema, RVT, perinephric fluid collection
    - Decreased RI: seen downstream from arterial stenosis
  - Acc time (delta T) <0.08s
- ATN (occurs to some extent in all cadaveric kidneys; may be completely normal u/s; may have decreased color flow, elevated RI and/or increased ecogenicity)
- Rejection (acute>upto 40% in 1st week; u/s findings non-specific; chronic=>3mos with cortical thinning, prom sinus fat, dystrophic calc, decreased color, increased RI)
- Drug toxicity
- Hydronephrosis (mild pelviectasis is common, usually normal finding; caliectasis is reliable sign of obstruction; may be due to decreased ureteric tone or VUR)
- Pyelonephritis
- Stones
- AVM or pseudoaneurysm (esp after renal bx)
- RCC

Vessels
- Renal artery (stenosis vs thrombosis vs AVF)
- Renal vein
- EIA/EIV

Renal Artery Thrombosis
- no arterial or venous flow
- no color flow with parenchyma

Renal Artery Stenosis
- most common post-transplant vascular complication (1.5-4%)
- renal artery should have brisk upstroke and low resistance; range of renal artery PSV 60-203 cm/s (flow should be forward into kidney throughout cardiac cycle; low resistance)
- main renal artery PSV >200 cm/sec suggest sig stenosis (could be artifactual due to tortosity)
- main renal artery to external iliac artery ratio >2.5
- Vel > 2:1 between stenotic and ?pre/poststenotic segments indicates sig stenosis
- Normal RI 0.5-0.7
- marked turbulence and parvus-tardus waveform seen downstream from narrowing (within interlobar/arcuate arteries)
- parvus-tardus highly indicative of sig stenosis, but often not present
- stenosis may occur at anastamosis (esp end-to-end) vs donor portion (esp end-to-side) vs recipient portion (uncommon clamp injury)

Renal Vein Thrombosis
- renal vein flow is flat with low velocity and flow away from kidney
- normally monophasic continuous flow (could have cardiac cycle pulsatility)
- etiology: hypovolemia, femoral/iliac vein thrombosis, external compression by fluid collection
- RVT has absent venous flow with reversal of diastolic flow in renal artery + enlarged hypechoic edematous kidney
- 3-4 fold velocity increase at anastamosis suggest RV stenosis

Causes of Impaired Function of Renal Transplant
ATN
- Rejection-acute, chronic
- Drug nephrotoxicity (cyclosporine)
- Ureteral obstruction
- Infection
- Arterial stenosis
LIVER TRANSPLANT

Normal
Whole liver (cadaveric) vs split liver transplant (cadaveric vs living donor)—right lobe in adults and left lobe in child
Usually end-to-end anastomosis; usually “fish-mouth” at end-to-end anastomosis of HA to celiac axis vs aortic patch to recipient aorta
Normal hep artery—low resistance Doppler spectrum with RI 0.5-0.7 (increased: graft dysfunction, immediate post-op, rejection, drug toxicity; decreased: stenosis, tachycardia)
Normal acceleration time < 0.1 cm
Flow in portal vein flat, toward liver
Flow in hep vv multiphasic, reflecting cardiac contractions; flow into IVC
Biliary tree with nl non-dilated appearance
Periportal edema normally present (21%) in postoperative period
Adrenal hemorrhage 4%

Parenchyma
-look for any focal/diffuse hyperperfusion on color mode
-perihepatic fluid collection
-intra/extrahepatic biliary dilation
-HCC
-ascites (with all quadrants)
-splenomegaly
-collateralization

Vessels
-document patency, spectral waveform (velocity, and direction of flow) of MPV and left/right PV
-document patency, spectral waveform (should be triphasic) of HV
-document patency of IVC
-document patency, spectral waveform (PSV) of main hepatic artery (@ portahepatis)
-document patency, spectral waveform (RI andaccel time) left/right intrahepatic arteries (@ periphery not central)

H. Artery Stenosis (11%)
-@ anastomotic site usually
-focal velocities >2-3 cm/s w/assoc turbulence found at or just distal to arterial anastomosis
-tardus parvus waveform highly indic of hep arterial stenosis
-acceleration time > 0.1 sec and RI < 0.5 (suggest prox stenosis)

Portal Vein Stenosis
-focal narrowing of portal vein (< 2.5 mm)
-Doppler: aliasing flow jet formation at site of narrowing with 3-4X increase in venous flow velocity
-flow direction may be reversed in SMV and splenic vein
-enlarged porto-systemic collateral vv may be seen
-post op may see mild increased vel at anastamosis which may be due to
IVC Stenosis
- 5-fold increase in velocity at anastomosis
- Aliasing and increased flow velocity evident at or just beyond stenosis
- Hepatic vein and intrahepatic IVC show loss of normal phasic pattern when the stenosis is suprahepatic; hepatic vv may be dilated

OTHER
r/o HA pseudoaneurysm (esp after bx)
EXAM: 1st trimester dating

HISTORY: LMP of [] predicts [weeks [days with EDD of []

FINDINGS: Images show single, well formed intrauterine gestational sac containing a living [embryo<9wks / fetus]. Yolk sac is visualized measuring [mm and is normal. The crown rump length is [mm, which correlates to estimated gestational age of [weeks. [days +/- [days. [Embryonic/Fetal] cardiac activity is [bpm. The placenta is forming []. [No] perigestational hemorrhage is seen. Right ovary is [cm. Left ovary is [cm. No adnexal free fluid.

IMPRESSION: 1. Single living intrauterine fetus with estimated gestational age of [weeks, [days, based on crown rump length. This is [concordant/discordant] with clinical dates based on LMP, which predicts age of [weeks, [days. (EDD based on today’s exam is [].)
2. Bilateral ovaries and adnexa are normal.

EXAM: 2nd trimester anatomy

FINDINGS: A single living intrauterine fetus is present, in [] position. The cervix is [cm in length and closed. The placenta is [] and normal in appearance. Cervix to placenta distance is [cm and there is no previa. Fetal cardiac activity is documented at [bpm. Amniotic fluid level is subjectively normal.

BIOMETRY: Measurement (cm) Gestational age (weeks, days)

- Head circumference: []
- Bi-parietal diameter: []
- Abdominal circumference: []
- Femur length: []
- Average ultrasound age: [] weeks, [] days +/- [] days
- Expected age based on LMP of [] weeks, [] days
- Expected age based on dating ultrasound [] weeks, [] days
- Estimated fetal weight (Hadlock): [] grams
- Estimated fetal weight percentile: []%

ANATOMY: Supratentorial brain (ventricles, choroid, cavum septum pellucidum), infratentorial brain (cerebellum, posterior fossa), nuchal skin fold thickness, nose and lips, heart (four chamber view, LVOT, RVOT), stomach, kidneys, bladder, 3 vessel cord, cord insertion, spine in longitudinal and transverse planes, and extremities are all sonographically normal. [Hands and feet were not evaluated.] [Facial profile is also normal.]

IMPRESSION: 1. SLIUP in [] position at [wks, [days by EDD [] established by [] which is concordant with this ultrasound which predicts [wks, [days

EXAM: 3rd trimester growth

IMPRESSION: 1. SLIUP at [wks, [days by EDD [] established by [] which is concordant with this ultrasound which predicts [wks, [days
2. EFW of [] is []%ile for GA.
3. AFI of [] is []%ile for GA.
4. Cervix is [cm in length and is closed. Placenta-to-cervix distance is [cm and normal.

EXAM: LE Doppler (r/o DVT)

FINDINGS: Grayscale and color Doppler imaging of the [] lower extremity was performed from the common femoral vein through popliteal vein at the confluence of the deep veins of the calf, with and without compression. Images show [complete compressibility of the deep veins and no evidence of thrombus]. Spectral waveforms obtained in the common femoral and popliteal veins show [normal respiratory variation, phasicity, and response to augmentation]. The tibial and peroneal veins of the calf were not interrogated. Visualized portion of the profunda vein shows [no evidence of thrombus]. Limited evaluation of the contralateral common femoral vein reveals [normal phasicity, respiratory variation and response to augmentation].

IMPRESSION: [No evidence of deep vein thrombosis] in the [] common femoral vein through popliteal vein.

EXAM: Limited RUQ

[RUQ ultrasound was performed]. The liver is normal in size, contour, echogenicity and measures [cm in cranio-caudal dimension. No focal lesions are evident. No biliary dilatation. The common bile duct is [mm. The gallbladder is normal in size and has normal wall thickness of [mm. No cholelithiasis. No sonographic Murphy’s sign. The visualized portions of the pancreas are normal. [The pancreas was not visualized in its entirety due to shadowing bowel gas.] The right kidney measures [cm and left kidney measures [cm in length. Kidneys are normal in echogenicity and contour. No hydronephrosis or focal renal lesions. [Left kidney and spleen were not imaged or evaluated on this right upper quadrant exam.]

IMPRESSION: 1. Normal right upper quadrant ultrasound.

EXAM: Carotid U/S

IMPRESSON:
1. No hemodynamically significant ICA stenosis. [Mild] atherosclerotic plaque or intimal hyperplasia.
2. Antegrade flow within bilateral vertebral arteries.
Figure 12.33 The use of diagrams makes it easier for the clinician to interpret the findings of a venous duplex examination (see text).

Figure 10.2 The arterial anatomy of the arm and hand.
**OVARIES**

<table>
<thead>
<tr>
<th>SIZE</th>
<th>NORMAL</th>
<th>ABNORMAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>▪ Pre-menopausal 5x3x2cm (volume 9cc for nulliparous and 15cc for multiparous)</td>
<td>▪ Pre-menopausal &gt;18cc volume</td>
</tr>
<tr>
<td></td>
<td>▪ Post-menopausal 2.5x2x2cm</td>
<td>▪ Post-menopausal &gt;8cc volume</td>
</tr>
<tr>
<td></td>
<td>▪ Pediatrics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>▫ 6yo ~1cc</td>
<td></td>
</tr>
<tr>
<td></td>
<td>▫ Pre-pubertal (6-10yo) 1.2-2.3cc</td>
<td></td>
</tr>
<tr>
<td></td>
<td>▫ Pre-menarchal (11-12yo) 2-4cc</td>
<td></td>
</tr>
<tr>
<td></td>
<td>▫ Post-menarchal &gt;2.5-18cc</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Note: volume = (L x H x W x 0.5)</td>
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<td></td>
</tr>
</tbody>
</table>

**SIMPLE CYST**

<table>
<thead>
<tr>
<th>APPEARANCE</th>
<th>PRE-MENOPAUSAL FOLLOW-UP</th>
<th>POST-MENOPAUSAL FOLLOW-UP</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Circumscribed margins</td>
<td>▪ Cyst ≤3cm (physiologic developing/dominant follicle; no f/u needed and do not have to describe)</td>
<td>▪ Cyst ≤1cm (inconsequential)</td>
</tr>
<tr>
<td>▪ Posterior acoustic enhancement</td>
<td>▪ Cyst &gt;3 and ≤5cm (mention but no f/u needed)</td>
<td>▪ Cyst &gt;1cm and ≤7cm (almost certainly b9 but yearly f/u with u/s at least initially)</td>
</tr>
<tr>
<td>▪ No internal echoes</td>
<td>▪ Cyst &gt;5cm and ≤7cm (yearly f/u)</td>
<td>▪ Cyst &gt;7cm (further evaluation with MR or consider surgery)</td>
</tr>
<tr>
<td></td>
<td>▪ Cyst &gt;7cm (further evaluation with MR or consider surgery)</td>
<td></td>
</tr>
</tbody>
</table>

**HEMORR. CYST**

<table>
<thead>
<tr>
<th>APPEARANCE</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Reticular pattern (“fishnet”) of internal echoes</td>
<td></td>
</tr>
<tr>
<td>▪ May have ecogenic clot w/o flow</td>
<td></td>
</tr>
<tr>
<td>Condition</td>
<td>Appearance</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>------------------------------------------------</td>
</tr>
</tbody>
</table>
| **FOLLOW-UP**                 |                                               | ▪ Cyst ≤3cm (no f/u needed)  
 ▪ Cyst >3 and ≤5cm (describe but no f/u needed)  
 ▪ Cyst >5cm (f/u u/s in 6-12wks to ensure resolution; image on day 3-10 of menses) |
| **ENDOMETRIOMA**              | Homogenous low level internal echoes           | ▪ Short-term f/u initially in 6-12wks to exclude hemorrhagic cyst mimickers, then yearly if no surgical removal  
 ▪ Malignancy risk ~1% (endometroid or clear cell CA) if >9cm (not if <6cm) and age >45yo |
| **DERMOID**                   | Focal ecogenic plug with acoustic shadowing  
 ▪ Hyperechoic lines and dot internal echoes | ▪ F/u in 6-12mos interval regardless of age if no surgical removal  
 ▪ Malignancy risk ~2% (SCC) if >10cm and age >50yo |
| **COMPLEX CYST**              | Single cyst but w/ single thin septa <3mm or small wall calcification  
 ▪ FOLLOW UP: use same f/u as simple cyst by size & age | ▪ Size>10cm (13% chance of malignancy so surgery is recommended)  
 ▪ Pre-menopausal (6-12wks f/u; if persists, consider MR w/ gad and if not hemorrhagic cyst or endometrioma or dermoid, do surgery)  
 ▪ Post-menopausal (surgery) |
| **INDETERMINATE BUT PROB B9** | Multipled septations <3mm  
 ▪ Solid nodule w/o flow  
 ▪ Focal wall thickening | ▪ Thick septa ≥3mm  
 ▪ Solid nodule w/ flow  
 ▪ Focal wall thick ≥3mm  
 ▪ FOLLOW UP: no f/u; surgery recommended |
| **CORPUS LUTEUM**             | Thick crenulated wall  
 ▪ Small cystic center  
 ▪ May have surrounding “ring-of-fire” flow | ▪ Thick septa ≥3mm  
 ▪ Solid nodule w/ flow  
 ▪ Focal wall thick ≥3mm  
 ▪ FOLLOW UP: no f/u; surgery recommended |
<table>
<thead>
<tr>
<th><strong>PCO</strong></th>
<th>Polycystic Ovaries</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>APPEARANCE</strong></td>
<td></td>
</tr>
<tr>
<td>• &gt;10-12 peripheral follicles bilaterally</td>
<td></td>
</tr>
<tr>
<td>• Hyperechoic/hypervascular central stroma</td>
<td></td>
</tr>
<tr>
<td>• Ovarian volume &gt;15cc</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>OHSS</strong></th>
<th>Ovarian hyperstimulation syndrome</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>APPEARANCE</strong></td>
<td></td>
</tr>
<tr>
<td>• Bilateral enlarged ovaries &gt;5-10cm in diameter</td>
<td></td>
</tr>
<tr>
<td>• Numerous thin-walled cysts &gt;1cm</td>
<td></td>
</tr>
<tr>
<td>• May have ascites and pleural effusion</td>
<td></td>
</tr>
</tbody>
</table>

**UTERUS**

<table>
<thead>
<tr>
<th><strong>SIZE</strong></th>
<th>NORMAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Pre-menopausal 9x5x5cm</td>
<td></td>
</tr>
<tr>
<td>• Post-menopausal 7x2x2cm</td>
<td></td>
</tr>
<tr>
<td>• Pediatrics</td>
<td></td>
</tr>
<tr>
<td>▫ Neonate (&lt;1mo old) 4x2x2cm</td>
<td></td>
</tr>
<tr>
<td>▫ Pre-pubertal child 3x1x1cm</td>
<td></td>
</tr>
<tr>
<td>▫ Post-pubertal child 8x3x3cm</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>EMS</strong></th>
<th>Endometrial stripe</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NORMAL</strong></td>
<td></td>
</tr>
<tr>
<td>• Pre-menopausal ≤15mm</td>
<td></td>
</tr>
<tr>
<td>▫ Menses (day 1-5) &lt;4mm</td>
<td></td>
</tr>
<tr>
<td>▫ Proliferative phase (day6-10) 4-8mm</td>
<td></td>
</tr>
<tr>
<td>▫ Secretory phase (day14+) ≤15mm</td>
<td></td>
</tr>
<tr>
<td>• Post-menopausal</td>
<td></td>
</tr>
<tr>
<td>▫ Without bleeding (or on Hormone Replacement) ≤8mm</td>
<td></td>
</tr>
<tr>
<td>▫ With bleeding ≤5mm</td>
<td></td>
</tr>
</tbody>
</table>

| **ABNORMAL** | |
| Post-menopausal atrophy <3mm |
| Post-partum retained products of conception (RPOC) >5mm (<2mm RPOC unlikely) |
| DDX for thickened EMS= secretory phase; pregnancy; retained POC, hyperplasia; polyp; CA; Tamoxifen |

**PELVIS**

<table>
<thead>
<tr>
<th><strong>FREE FLUID</strong></th>
<th>Physiologic ~10cc in (may increase during ovulation)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PELVIC CONGESTION</strong></td>
<td></td>
</tr>
<tr>
<td>• Pelvic veins &gt;4-5mm in diameter</td>
<td></td>
</tr>
<tr>
<td>• Slow flow ~3cm/s</td>
<td></td>
</tr>
<tr>
<td>• Tortuous dilated pelvic venousplexuses and arcuate veins</td>
<td></td>
</tr>
<tr>
<td>• Associated with dyspareunia</td>
<td></td>
</tr>
<tr>
<td><strong>ABDOMEN</strong></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>
| **LIVER** | •Liver size ≤17cm in CC dimension  
  ▪Biliary  
   ◦Intrahepatic ducts ≤2mm  
   ◦Normal CBD ≤6mm (≤60yo): add 1mm per decade over 60yo  
   ◦Post-cholecystectomy CBD up to 1cm  
   ◦Pediatrics CBD <4mm |
| **GB** | •Gallbladder size  
  ◦Wall <3mm  
  ◦Diameter ≤4cm  
  ◦Length <10cm  
  •GB polyp ≥5mm consider follow up (≥1cm may consider surgery) |
| **SPLEEN** | •Spleen size ≤13cm length (usually <7cm in width)  
  •Splenic artery aneurysm ≥2.0-2.5cm consider endovascular therapy |
| **PANCREAS** | •Pancreas size  
  ◦Head width ≤3cm  
  ◦Body width ≤2.5cm  
  ◦Tail width ≤2.5cm  
  •Pancreatic duct (≤3mm adults and up to 5mm in elderly patients)  
   ◦Head ≤3mm  
   ◦Body ≤2mm  
   ◦Tail ≤1mm |
| **ADRENALS** | •Adrenal size  
  ◦limb length <5cm  
  ◦limb width <7mm |
| **KIDNEYS** | •Renal size  
  ◦Length 9-12cm  
  ◦Cortical thickness ≥1cm  
  •Asymmetric renal length difference ≥1.5cm is usually significant  
  •Renal artery aneurysm ≥2cm consider endovascular repair |
| **BLADDER** | •Wall thickness: <4mm when distended and <8mm post-void  
  •Post-void residual volume >100-150cc may need intervention |
| **MISC** | •Normal ecogenicity of pancreas > spleen > liver > kidneys  
  •Appendix <6mm and compressible is normal  
  •Hypertrophic pyloric stenosis if pyloric muscle thickness >3mm and channel length >14mm  
  •Visceral artery aneurysm ≥2cm  
  •Normal anal sphincter muscle thickness 4mm |

**THYROID**
<table>
<thead>
<tr>
<th>SIZE</th>
<th>NORMAL</th>
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</thead>
<tbody>
<tr>
<td>• Lobe length 4-6cm</td>
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<tr>
<td>• Lobe diameter 1.3-1.8cm</td>
<td></td>
</tr>
<tr>
<td>• Isthmus AP &lt;1cm</td>
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</tr>
<tr>
<td>• Volume 20cc (+/- 5cc) males and 18cc (+/- 4cc) females</td>
<td></td>
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</table>

**GOITER**
- Volume >25g

<table>
<thead>
<tr>
<th>NODULES</th>
<th>LIKELY B9 FEATURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Colloid cyst (cyst with bright echoes or avascular colloid clot)</td>
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<tr>
<td>• Predominantly cystic nodule (without internal flow)</td>
<td></td>
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<tr>
<td>• Spongiform nodule</td>
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<tr>
<td>• Giraffe pattern</td>
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<tr>
<td>• Diffusely hyperechoic nodule (especially if multiple)</td>
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</tbody>
</table>

**SUSPICIOUS FEATURES**
- Micro-calcifications (highest specificity)
- Diffusely hypoechoic solid nodule
- Irregular/infiltrative margins
- Taller than wide (larger AP dimension on transverse view)
- Chaotic internal flow
- Associated cervical adenopathy

**HIGH RISK HISTORY**
- Thyroid cancer in first degree relative(s)
- External beam radiation as a child
- Exposure to ionizing radiation as a child
- PET avid thyroid nodule
- MEN2 syndrome
- Familial Medullary thyroid carcinoma associated gene mutation

**SIMPLIFIED NODULE GUIDELINE**
- Nodule 5mm or less does not need follow up (Thy-RADS)
- Nodule 6mm to 1cm without suspicious features or high risk history = consider 6mos follow up
- Nodule 6mm or more with suspicious features or high risk history = consider FNA

**SIGNIFICANT GROWTH OF NODULE**
- Increase in volume by 50%
- Increase in diameter by 20% within at least 2mm increase in two or more dimensions
- Growth of mixed solid/cystic nodule is judged by growth of solid component

<table>
<thead>
<tr>
<th>TESTIS</th>
<th>NORMAL TESTIS</th>
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<tbody>
<tr>
<td>• Length up to 5cm</td>
<td></td>
</tr>
<tr>
<td>• Width up to 4cm</td>
<td></td>
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</tbody>
</table>
| NORMAL EPIDIDYMIS | • Head 1.0-1.2 cm
| | • Body/tail 2.0 cm

| PATHOLOGY | VARICOCELE | • Dilated pampiniform plexus >3 mm upon valsalva

| MICROLITHIASIS | • More than 5 micro-calcifications on a single image
| | • Yearly follow up may be considered

| OB | TRIMESTER | 1\textsuperscript{ST} TRIMESTER: 1-12 wks (up to 3 mos)
| | 2\textsuperscript{nd} TRIMESTER: 13-27 wks (up to 6 mos)
| | 3\textsuperscript{rd} TRIMESTER: 28 wks till birth

| VIABILITY | VIABILITY CRITERIA (2012 consensus)
| | • MSD >25 mm (endovaginal) = should see Y-sac and embryo
| | • CRL ≥7 mm (endovaginal) or ≥15 mm (transabdominal) = should have heartbeat

| FOLLOW-UP OF PREGNANCY OF UNKNOWN VIABILITY | • If see G-sac but no Y-sac → followup in 2 wks or more → absence of embryo with a heartbeat is diagnostic of pregnancy failure
| | • If see G-sac with Y-sac but no embryo → followup in 11 days or more → absence of embryo with a heartbeat is diagnostic of pregnancy failure

| DIFFERENTIAL DIAGNOSIS | • Viable IUP
| | • IUP of unknown viability (+/- suspicious for pregnancy failure)
| | • Pregnancy of unknown location (if normal appearing endometrium ddx= early IUP vs occult ectopic vs completed spontaneous abortion; if abnormal appearing endometrium ddx= spontaneous abortion in progress vs indeterminate intrauterine fluid collection)
| | • Non-viable IUP

| GUIDELINES | • G-sac appears at 4.5-5.0 wks (intradecidual sign or double sac sign)
| | • Y-sac appears at 5.0-5.5 wks (normal size 3-5 mm)
| | • Embryo appears ~6.0 wks
| | • Amnion usually seen at 7.0 wks

| QUANTITATIVE Beta HCG | • HCG >1000 = generally see gestational sac
| | • HCG >7000 = generally see Y-sac
| | • HCG >11,000 = generally see embryo

| POOR PROGNOSIS (SUSPICIOUS FOR PREGNANCY FAILURE) | • Empty amnion (no embryo)
| | • Sustained bradycardia <80 bpm
| | • Small MSD relative to CRL (<5 mm difference between MSD and CRL)
- Enlarged Y-sac >7mm
- Low-lying gestational sac
- Subchorionic hemorrhage ≥40% of gestational sac volume
- Thin poorly-ecogenic decidua

<table>
<thead>
<tr>
<th>ANATOMY</th>
<th>SOFT MARKERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Choroid plexus cyst(s) ≥3mm</td>
<td></td>
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<tr>
<td>▪ Ecogenic intracardiac focus (as bright as bone)</td>
<td></td>
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<tr>
<td>▪ Ecogenic bowel</td>
<td></td>
</tr>
<tr>
<td>▪ Nuchal fold thickness ≥6mm</td>
<td></td>
</tr>
<tr>
<td>▪ Pyelectasis ≥4mm (2nd trimester) and Persistent pyelectasis ≥7mm (3rd trimester)</td>
<td></td>
</tr>
<tr>
<td>▪ Single vessel cord (single umbilical artery)</td>
<td></td>
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<tr>
<td>▪ Ventriculomegaly ≥1cm</td>
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<table>
<thead>
<tr>
<th>BIOMETRY</th>
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</thead>
<tbody>
<tr>
<td>▪ Use biometry for CRL &gt;6cm</td>
</tr>
<tr>
<td>▪ In 2nd trimester, single best measure of GA is HC (others further improve prediction)</td>
</tr>
<tr>
<td>▪ In 3rd trimester, single best measure of GA is FL (more reproducible than AC)</td>
</tr>
<tr>
<td>▪ AC is least predictive of GA but most useful for EFW determination esp in 3rd trimester</td>
</tr>
<tr>
<td>▪ Flattened head (dolicocephaly) or rounded head (brachycephaly) are normal variants (HC more reliable than BPD for GA)</td>
</tr>
<tr>
<td>▪ Disproportionally small HC &lt;3 SDs below mean for GA = microcephaly</td>
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<table>
<thead>
<tr>
<th>NORMAL ANATOMIC MEASUREMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Nuchal translucency (1st trimester 11-13w6d) &lt;3.5mm</td>
</tr>
<tr>
<td>▪ Nuchal fold thickness (2nd trimester) &lt;6mm</td>
</tr>
<tr>
<td>▪ Choroid plexus cyst &lt;3mm (≥3mm is abnormal)</td>
</tr>
<tr>
<td>▪ Ventricles &lt;1cm (Ventriculomegaly ≥1cm)</td>
</tr>
<tr>
<td>▪ Trans-cerebellar diameter correlates in mm with gest age in mm upto 20wks (ie 20mm at 20wks; usually larger after 20wks; abnormal if 2mm less than gest age)</td>
</tr>
<tr>
<td>▪ Cisterna magna 2-10mm</td>
</tr>
<tr>
<td>▪ Nasal bone length ≥4mm (2.5th percentile is 4.4mm at 18wks and 5mm at 20wks)—look for hypoplastic or absent nasal bone</td>
</tr>
<tr>
<td>▪ Fetal cardiac activity 100-180bpm (bradycardia &lt;80-100 bpm)</td>
</tr>
<tr>
<td>▪ Ecogenic intracardiac focus is significant if as bright as bone (be aware of normal variant moderator band within RV)</td>
</tr>
<tr>
<td>▪ Renal length symmetric 20-22mm in length</td>
</tr>
<tr>
<td>▪ Renal pelvis &lt;4mm (Pyelectasis if ≥4mm in 2nd trimester; Persistent pyelectasis if ≥7mm in 3rd trimester)</td>
</tr>
<tr>
<td>▪ 3 vessel cord with 2 umbilical arteries (2 vessel cord = single umbilical artery)</td>
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<thead>
<tr>
<th>PLACENTA/CERVIX</th>
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</thead>
<tbody>
<tr>
<td>▪ Placental thickness 1-4cm (&lt;4cm in thickness)</td>
</tr>
<tr>
<td>▪ Inferior placental tip should be ≥2cm from internal os of cervix (otherwise, consider low-lying placenta vs placenta previa)</td>
</tr>
<tr>
<td>▪ Cervical length ≥2.5cm and closed (otherwise consider incompetent cervix and look for funneling)</td>
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</tbody>
</table>

| GROWTH | GROWTH ASSESSMENT |
• Fetal scan for growth assessment should be done at least 2 weeks apart.
• Estimated fetal weight (EFW) within 10th to 90th percentile for gestational age
  • Macrosomia >90th percentile or >4000-4500g (also look for polyhydramnios)
  • SGA (small for gestational age) <10th percentile or <2500g at term
  • IUGR = SGA + AC <2.5th percentile (size<dates) → do cord Doppler
    • Asymmetric IUGR (high HC:AC ratio; possible placental insufficiency)
    • Symmetric IUGR (normal HC:AC ratio; constitutionally small baby or genetic/chromosomal abnormality or TORCH infection or maternal ETOH)
  • Check AFI (oligohydramnios can be seen with IUGR)
• Large for gestational age (LGA) if 3rd trimester dates >2wks compared to clinical dates

AMNIOTIC FLUID
• Amniotic fluid index (AFI) 5-20cm
  • Polyhydramnios >20-25cm (single max vertical pocket depth >8cm)
  • Oligohydramnios <5cm or <5th percentile (single max vertical pocket depth <2cm)

CORD & MCA DOPPLER
• Fetal cord Doppler (assess umbilical arterial waveform for reduced/absent/reversed diastolic flow and corresponding abnormal resistive index)
• Fetal MCA Doppler (assess fetal middle cerebral artery S/D ratio which is normally greater than umbilical artery S/D ratio)

VASCULAR

<table>
<thead>
<tr>
<th>ANEURYSM</th>
<th>ABDOMINAL AORTA</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Ectasia 2.5-2.9cm</td>
</tr>
<tr>
<td></td>
<td>Aneurysm ≥3cm</td>
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<thead>
<tr>
<th>COMMON ILIAC ARTERY</th>
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</thead>
<tbody>
<tr>
<td>Ectasia 1.5-2.4cm</td>
<td>Aneurysm ≥2.5cm</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>POPLITEAL ARTERY</th>
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<tbody>
<tr>
<td>Ectasia 1.0-1.9cm</td>
<td>Aneurysm ≥2cm (1/3 associated with AAA)</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>SPLENIC ARTERY</th>
<th></th>
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<tbody>
<tr>
<td>Aneurysm ≥2.5cm, consider endovascular repair</td>
<td></td>
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<table>
<thead>
<tr>
<th>CAROTIDS</th>
<th>ICA STENOSIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>NORMAL or STENOSIS &lt;50%</td>
<td></td>
</tr>
<tr>
<td>PSV &lt;125cm/s</td>
<td></td>
</tr>
<tr>
<td>ICA/CCA ratio &lt;2</td>
<td></td>
</tr>
<tr>
<td>ICA EDV &lt;40cm/s</td>
<td></td>
</tr>
<tr>
<td>STENOSIS 50-69%</td>
<td></td>
</tr>
<tr>
<td>PSV 125-230cm/s</td>
<td></td>
</tr>
<tr>
<td>ICA/CCA ratio 2-4</td>
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</tbody>
</table>
### RAS

**RENAL ARTERIAL STENOSIS CRITERIA**
- Renal artery PSV >200 cm/s
  - EDV >150 m/s suggests >80% stenosis
  - RI >0.8 predicts response to renal vascularization
- Renal artery to aortic PSV ratio >3.5
- Intra-renal arterial systolic rise (acceleration time) ≥0.07s (parvus-tardus)

### TIPS

**TIP SHUNT DYSFUNCTION**
- Intra-shunt PSV <50-60 m/s or >200-250 m/s
- Change in PSV of +/- 50 m/s compared to baseline scan
- Decrease in PSV by <2/3rd (66% less than) compared to baseline scan
- Hepatofugal flow within main portal vein

### PAD

**PERIPHERAL ARTERIAL DISEASE CRITERIA**
- Mild stenosis (1-19%)
  - Distal-to-proximal PSV ratio <2:1
  - Triphasic waveform
- Moderate stenosis (20-49%)
  - Distal-to-proximal PSV ratio <2:1
  - Biphasic waveform
- Severe stenosis (50-99%)
  - Distal-to-proximal PSV ratio >2:1 (>4:1 suggest >70%; >7:1 suggest >90%)
  - Monophasic waveform

**PERIPHERAL ARTERIAL GRAFT ASSESSMENT**
- Minimal graft stenosis (<20%)
  - Distal-to-proximal PSV ratio <1.4
  - PSV <125 cm/s
- Moderate graft stenosis (20-50%)
  - Distal-to-proximal PSV ratio 1.5-2.4
  - PSV <180 cm/s
- Significant graft stenosis (50-75%)
  - Distal-to-proximal PSV ratio 2.5-4.0
  - PSV >180 cm/s
- High-grade graft stenosis (>75%)
  - Distal-to-proximal PSV ratio >4.0
  - PSV >300 cm/s

**PERIPHERAL ARTERIAL STENOSIS AFTER PERCUTANEOUS REVASCULARIZATION**
- Distal-to-proximal PSV >2
- PSV >180 cm/s