TRUE NORTH IMAGING

ULTRASOUND PROTOCOLS

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ACKNOWLEDGEMENT

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ULTRASOUND PROTOCOLS

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OPERATOR TRAINING/QUALIFICATIONS

A) Technologist

All technologist/sonographers shall either be certified by, or eligible for certification by the American Registry of Diagnostic Medical Sonographers (ARDMS).

B) Imaging Physician

The ultrasound imaging physician shall be as of April 23, 1990:

i) A licensed Ontario physician certified by the Royal College of Physicians & Surgeons of Canada as a specialist in Radiology who has a minimum of three months of training in ultrasound at an approved institution. **OR**

ii) A licensed Ontario physician with a Royal College Specialist Certificate in a field other than Radiology, who also has a minimum of six months of training in ultrasound at an accredited institution. **OR**

iii) A licensed Ontario physician certified by the College of Family Physicians of Canada with a minimum of 12 months of training in ultrasound at an accredited institution.

IMAGE DOCUMENTATION

All points of protocol must be documented on videotape.

Paediatric examinations are to be documented on designated, clearly marked paediatric videotapes.

Breast ultrasound examinations are to be documented on designated, clearly marked breast videotapes and kept for 10 years.

A permanent record of the images obtained at each facility shall be kept for a minimum of three years, following the patient's last visit or three years after the patient's 18th birthday. Representative images from each examination may be in the form of videotape, thermal printer, multiformat camera film (X-ray or print), or such similar medium which will not deteriorate with time.

Regardless of the method of archiving, each facility must be able, with the patient's consent, to retrieve easily the stored images, and forward them, or a copy to a consulting physician who has requested them.

Written reports and requisitions must be kept for six years following the patient's last visit or six years after the patient's 18th birthday.

INFECTION CONTROL AND GLOVING PROTOCOL

Reasonable care for infection control must be exercised with all patients. The technologist should wash their hands between each scan and will wear latex/non-latex gloves for, but not limited to, transvaginal, transrectal, and scrotal examinations. In addition, gloves must be worn for any examination that the technologist feels may be an infection risk. All gloves and condoms used for endocavity procedures must be disposed of in the designated biohazardous waste receptacle.

If a technologist has an open wound on a scanning hand he/she must wear gloves.

Endocavity probes must be prepared and cleaned according to the protocol. All other probes must be wiped clean at the end of each scan, and where there is a risk of infection, a disinfecting agent must be used.

> **Note: Prior to using latex gloves or condoms, the patient must be questioned regarding possible sensitivity. If a patient indicates they are sensitive, non-latex alternatives must be used.**

PAGING RADIOLOGISTS

If the referring physician needs an immediate report, or if, during the course of an examination, the technologist requires the input of a radiologist and none are available at head office, a radiologist is to be paged. Three (3) attempts, via head office, at 10-minute intervals must be made. If this fails the Medical Director (Dr. Alex Hartman) is to be paged. His pager number is listed in each ultrasound facility.

The radiologist must be contacted in all cases where an ectopic pregnancy is suspected, or where an abdominal aortic aneurysm is at risk of rupture. An abdominal aortic aneurysm "at risk of rupture" is one which is greater than 5 cm in cross-sectional diameter or which is associated with para-aortic fluid.

There are two situations in which an ectopic pregnancy or an abdominal aortic aneurysm will be noted. The first occurs when the doctor suspects this diagnosis and requests the examination to specifically rule out the entity. The second situation occurs when the technologist finds these entities or suspects them on his or her exam.

In the event that either the referring physician requests the exam to specifically rule out one of these entities or that the technologist suspects one of these entities on his or her exam the following should be done:

If no positive findings are found in regards to an abdominal aortic aneurysm no call is necessary and this protocol can be discontinued. **However, for ectopic pregnancies, even with no findings on the exam the protocol is to be**

completed.

1. After the exam, call head office and consult with one of the radiologists, preferably the one who will see the exam the next day. The patient is to wait in the clinic until this has been done.

2. The radiologist will then call the referring physician and give a verbal report on the specific problem. At that time, it is expected that the referring physician will make a decision as to how to deal with the patient.

4. After the referring physician has been contacted, the radiologist will then call back to the clinic and speak to the technologist, indicating that the verbal report has been given and the referring wishes the patient to either go home or go to his /her office as the case may be.

5. Should the referring physician indicate, to the clinic, the refusal of a radiologist’s consultation when the situation requires it, this must be documented on the technologist's preliminary observation worksheet.

EXAMINATION PROTOCOLS

NO PATIENT IS TO BE EXAMINED WITHOUT A REQUISITION.

Ask the patient if he/she was given a requisition for the examination. The requisition is a "source document" which must accompany the file of all patients examined at the clinic. It must be filled out and signed by the referring doctor, and must be filed with the patient's report and kept for a minimum of six years. **A complete requisition must include patient's name, and 1 other identifying factor (i.e. DOB or HC#), type of examination, and referring physician's signature.**

If the patient does not have a requisition, then you must call the referring doctor's office and obtain the necessary information and authorization, fill out and sign a new requisition on behalf of the referring doctor. If this is not possible, then the technologist should question the patient and determine the reason for the referral, consult with the Quality Advisor, and fill in a requisition on behalf of the referring physician and initial it pending authorization by Dr. . A separate video tape is to be used. The case is to be held until confirmation of the requisition is obtained. If authorization is not granted, the billing for that study must be cancelled.

If there is any doubt as to why the patient has been sent to the clinic, the referring physician must be contacted.

After an appropriate explanation of the procedure, a verbal consent must be received. Verbal consent may be expressed by a statement or implied by the patient's conduct. For children and incompetent adults, authourization from a parent or other responsible person (i.e. referring physician) should be obtained. **No procedure is to be undertaken without the patient's consent or the consent of his/her parent or representative.**

For all procedures involving injected contrast media a signed consent form must be attached to the patient's file.
For all breast ultrasounds and endocavity ultrasounds ultrasounds, **when performed by the opposite sex**, a signed consent form must be attached to the patient's file.

Each clinic must have a complete set of examination protocols for all ultrasound examinations.

ABDOMINAL ROUTINES

NOTE: All organs shall be scanned saggital or in their long axis from side to side and beyond, as well as transversely or in their short axis from top to bottom and beyond.

1. a) With the patient in a supine position scan in a saggital plane over the aorta, making sure that the gains are adequately adjusted to allow visualization of the walls of the abdominal aorta and an echo free aortic lumen. If you are unable to see the aortic bifurcation, the patient may be placed in an RLD or an LLD position.

   The abdominal aorta must be shown from the diaphragm to the bifurcation. The proximal common iliac arteries must be included. Note should be made of the following vessels: celiac axis, the superior mesenteric artery and the inferior mesenteric artery.

   b) Follow the same procedure in the transverse plane. The proximal iliac arteries must be included. Note should be made of the celiac axis (including splenic and hepatic branches), and the right and left renal arteries.

   Note should be made of the size of the vessel (AP diameter should be measured 3 cm above the bifurcation of the abdominal aorta in the transverse plane - *outer edge to outer edge*), its pulsatility, and the presence of plaque or Para-aortic lymph nodes. Document origin of renal arteries in the presence of an aortic aneurysm.

2. Scan the IVC in a Saggital plane noting a change in the calibre of the vessel with inspiration and expiration.

3. a) Scan the pancreas in a transverse plane (supine and upright position if necessary) - the gains should be adjusted to demonstrate the echogenicity of the pancreas as compared with the liver. Be sure to include the uncinate process, head, body and tail of pancreas in your scans. Look for the GDA, CBD and pancreatic duct.

   b) Scan the pancreas in the saggital plane – from the great vessels scan laterally to view the neck, head, uncinate process, and back through midline to visualize the body and tail.

   NOTE: If the pancreas is not visualized at this time, re-scan it with the patient in another position at the end of the exam (erect or decubitus) or following the patient drinking a glass of water.

4. Scan the spleen in saggital and transverse. Sweep through the entire organ, and beyond. Note any abnormalities. Measure the length of the spleen. The patient can be done supine or in a right lateral decubitus position.

   Look for the tail of the pancreas, the costophrenic angle (for pleural effusion) and the adrenal space.

5. a) Slowly scan the left kidney in saggital and transverse. Evaluate the renal sinus and cortex. Sweep through the entire organ, and beyond, looking for any abnormalities.

b) Take a longitudinal measurement on the saggital scan; transverse and AP measurements of the kidney, on the transverse scan.

6. a) Slowly scan the right kidney in saggital and transverse. Evaluate the renal sinus and cortex. Sweep through the entire organ, and beyond, looking for any abnormalities.

Look for the right adrenal space, the right costophrenic angle (for pleural effusion) and Morrison's pouch.

b) Take a longitudinal measurement on the saggital scan; transverse and AP measurements of the right kidney, on the transverse scan.

NOTE: If any degree of hydronephrosis is present, document and calculate the patient's urinary bladder volume. If colour Doppler is available demonstrate urine jets. Have the patient void (or attempt to) and do a post-void examination of both kidneys, and the urinary bladder.

7. Scan the liver in both the saggital and transverse planes, high enough to include the diaphragm on your scans. Make sure gains are properly adjusted (at least 2 focal spots are recommended) to give the liver an evenly echogenic appearance from anterior to posterior aspects, within the organ. Include a view demonstrating the three hepatic veins with the inferior vena cava, and the portal veins at the Porta Hepatis. At least 1 image should include liver and right kidney to compare the echogenicity. Note should also be made of the size, in a subjective evaluation (compare to right renal size). A length measurement should be taken in the Right mid clavicular plane.

8. Evaluate the CHD, the CBD and the main branches of the portal vein. If any of the ducts appear dilated measure the lumen of the duct. Routinely measure the CBD lumen as follows: In the saggital plane, where the right branch of the portal vein crosses the IVC, identify the duct as a tubular fluid filled structure running caudally over the portal vein. The hepatic artery may sometimes be seen in cross-section here between the duct and the P.V. (see diagram). Make sure you are not measuring the artery. If there is any doubt, trace the structure to its origin or apply colour Doppler. The artery can be traced to the aorta. The duct can be traced back to the liver.

9. Scan the gallbladder in both the saggital and transverse planes from neck to fundus. Decrease gains as required (use as high a frequency probe as possible). The gallbladder must be scanned with the patient in the three positions. Note the thickness of the gallbladder walls. Measure the AP thickness of the wall and, the gallbladder in the transverse plane. Make note in the technologist’s preliminary observation worksheet.

10. Scan the flanks and lower abdomen (into the pelvis) for any fluid or masses.

ABDOMINAL MEASUREMENTS: NORMAL VALUES

AORTA → diaphragm = 2.3cm, > 3.0 cm = aneurysm
→ bifurcation = 1.5cm
→ common iliacs = ≤ 1.0cm, > 1.0cm = aneurysm
→ SMA = three times smaller than aorta

IVC → varies - dependent on phases of respiration
→ deep inspiration may increase size of IVC

PANCREAS → head = 2.7 +/- 0.7cm
→ body = 2.2 +/- 0.7cm
→ tail = 2.0 +/- 0.4cm
→ pancreatic duct = < 0.3cm

SPLEEN → 4 x 8 x 13cm (adult)
→ < 12cm (10-19 yrs)
→ < 10cm (6-10 yrs)
→ < 9 cm (1-5 yrs)
→ < 7 cm (< 1 yr)

ADRENALS → up to 5cm craniocaudal
→ 3cm transverse
→ 0.5-1cm AP

KIDNEY → 9-12cm long
→ 2.5-4cm thick
→ 4-5cm wide
→ cortex = 1cm

LIVER → approximately → 16cm transverse
→ 15cm AP
→ 17cm craniocaudal
→ hepatic veins = < 1cm
→ portal vein = 1.1cm +/- 0.2cm

GALLBLADDER → 8-9cm long
→ 5cm wide
→ wall = < 0.3cm
→ CBD = ≤ 0.6cm
up to 0.9cm = post cholecystectomy

EARLY PREGNANCY ROUTINE (up to 12 weeks)

1. Begin in a sagittal plane in midline. View the entire uterus from the vagina to the fundus. Make special note of the cervix. If able, measure length and AP diameter of the uterus.

2. Angle the probe to the right and left to view the ovaries and other adnexal structures.

3. In a transverse plane, view the entire uterus from the vagina to the fundus and then angle the probe to both the right and left sides to view the ovaries and adnexae. If able, measure the transverse diameter of the uterus.

4. Annotate and measure ovaries and any adnexal masses, in three planes.

Evaluate the posterior cul-de-sac for fluid.

5. Now concentrate on the uterus.

   a. In the saggital plane evaluate the gestational sac. Make note of and measure any area suspect for implantation bleeding. You may want to magnify the image to evaluate within the sac.

   b. In a transverse plane evaluate the gestational sac - as in "a" (above).

   c. Measure the gestational sac in three planes and record the average (mean sac diameter).

5. Look for and evaluate the yolk sac. Measure the AP diameter if the yolk sac (inner to inner).

6. IF A FETAL POLE IS SEEN, look for a fetal heart beat. Document fetal heart activity using an m-mode trace. Calculate fetal heart rate. **If the heart rate is less than 100 bpm (under 6 weeks), suggest a repeat examination in 1-2 weeks for viability.** Measure the CRL (crown rump length) of the fetus (or embryo) in at least three different scans and use the average measurement.

   IF NO FETAL POLE/HEART BEAT can be detected on a transvesical scan, do a transvaginal scan to assess for a viable intrauterine pregnancy. **Pulse-wave doppler should not be used because of increased intensity used in PW doppler and the possibility of bio effects in the developing embryo. Colour doppler should be used in high risk pregnancies only.**

7. Take note of the area where the placenta is forming, (this can usually be determined after six weeks gestational age).

8. Demonstrate as many fetal structures as possible. At 12 weeks a BPD, HC, AC, and femur length can be included.

9. Between 11 and 14 weeks (minimum 4.3cm CRL) the nuchal translucency

is to be measured. With the embryo occupying 75% of the field of view, in a longitudinal profile image, the measurement is performed from inner border to inner border, at the widest area or level of the mandible. It should measure no greater than 3.0mm.

10. If patient’s first examination and an empty early gestational sac is found, do a limited abdominal examination of retro peritoneal spaces, to include both flanks and Morrison’s Pouch.

OBSTETRICAL ROUTINE (2nd Trimester and beyond)

1. a) Start in a sagittal plane in the midline, at the pubic bone. Measure length of endocervical canal (mucous plug). If cervical length is requested this is best done by either translabial or endovaginal ultrasound.

   b) Do sagital survey of the mid uterus from the cervix to the fundus, noting placental location and fetal position.

   c) Scan sagitally down the right and left sides. Note the position of the placenta and its complete attachment to the uterine wall, and also take a good look at the walls of the uterus. Note any fibroids or other pathology.

   d) Note the amniotic fluid volume and the fetal position.

2. Turn transverse and do the same. Note fetal number, the placental location, amniotic fluid volume, fetal position and uterine walls. Ovaries may be seen along the uterine wall.

3. a) Evaluate the fetal spine from the base of the skull to the coccyx in both the sagital and coronal planes, demonstrating the vertebral bodies and overlying skin.

   b) Evaluate the fetal spine in the transverse plane in both posterior and lateral views, checking for abnormal flaring of the ossification centres. Make sure also that the skin surface covering the spine is intact.

4. a) Evaluate the fetal abdomen and thorax in the sagittal plane. Note the fetal heart, aortic arch, hemidiaphragms, stomach, kidneys, umbilical insertion, echogenicity of the fetal bowel and lungs, and the urinary bladder. Try to demonstrate the fetal heart, stomach and bladder on 1 image.

   b) Evaluate the fetal internal anatomy in the transverse plane. Demonstrate the fetal four-chamber heart and ventricular outflow tracts. Do an m-mode tracing of the heart and calculate fetal heart rate. Demonstrate the fetal stomach, liver, kidneys, umbilical insertion, echogenicity of the fetal bowel, and the urinary bladder.

   c) Document the fetal gender when possible.

5. a) Scan the fetal cranium from side to side and from occiput to frontal bone. Note the shape of the head (lemon sign), ventricular size and cerebral anatomy. Evaluate the ventricular size subjectively in the area of the ventricular atrium where, in the normal fetus, the choroid plexus occupies most of this space. If there appears to be dilatation, take the transverse diameter of the

ventricular atrium.

b) Take a BPD and head circumference measurements. This is done on an axial scan of the fetal head at the level of the thalamus and the cavum septum pellucidum (level of third ventricle). The BPD is measured from the outer edge of the near surface to the inner edge of the far surface (leading edge to leading edge), where as the HC is measured outer edge to outer edge

c) In the same plane as the BPD, angle the probe inferiorly in the posterior aspect of the fetal skull and measure the cisterna magna and nuchal fold. (This is done on a plane which demonstrates the anterior horns, thalamus, and cerebellum) Note must also be made of the
cerebellar hemispheres with relation to their size and configuration.

d) Scan the fetal face coronally noting the orbits, nose, palate (to rule out cleft palate) mouth and mandible. Repeat in a transverse and sagittal plane.

6. Take a femur length (FL) measurement. The femur length should be measured in the sagittal plane, with the long axis of the bone perpendicular to the ultrasound beam. Measure from one end of the ossified portion of the femoral diaphysis to the other end. Do not foreshorten the bone.

Note the presence of four limbs, both hands and feet.

7. a) If the BPD and the FL are discrepant or if the fetus has a dolichocephalic or brachycephalic head, do a head circumference (HC) measurement. On an axial scan of the fetal head measure the BPD (from outer edge to outer edge) and the OFD (from outer edge to outer edge).

$$HC = (BPD + OFD) \times 1.57$$

$$\text{Corrected BPD} = \sqrt{\frac{BPD \times OFD}{1.265}}$$

b) Using BPD, FL, and HC a composite fetal age is estimated.

8. For all pregnancies 12 (twelve) weeks and over, an abdominal circumference measurement (AC) must be taken. Measurements for abdominal circumference are taken on the transverse or axial scan of the fetal abdomen. The bifurcation of the umbilical vein (as it enters the liver), left adrenal gland, the stomach and the fetal spine should be seen. If the umbilical vein extends to the anterior abdominal wall, the plane is too low. If the kidneys are visible, the plane is too low. Measure the external orthogonal diameters.

9. Calculate the estimated fetal weight using BPD, HC, FL, and AC measurements for all pregnancies. The estimated fetal weight of both

fetuses should be documented in all twin pregnancies over twenty-five (25) weeks.

10. In all pregnancies thirty-five (35) weeks and over, where the fetus is in breech position, the technologist must note the following:

    a) is the neck flexed or extended?

    b) are the hips flexed or extended?

    c) are the knees flexed or extended?

    Also note the presenting fetal part (i.e. frank breech, footling breech).

11. Evaluate the umbilical cord in cross-section to confirm three vessels. Note the abdominal and placental insertion.

12. Evaluate the placental location (and its proximity to the internal cervical os), texture and attachment. Look for retroplacental hemorrhage.

BREECH PRESENTATIONS

Re: 35+ week pregnancies in breech position

flexed = bent
extended or straight = standing position

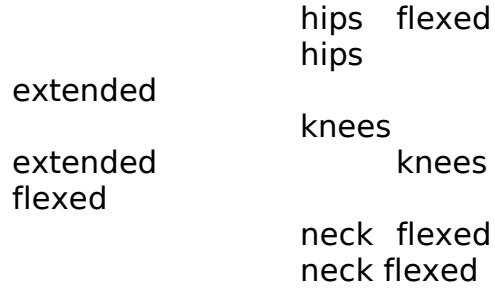
1. Hips flexed or extended
   hips flexed - hips are bent
   hips extended - hips straight (knees may or may not be flexed)

2. Knees flexed or extended
   flexed knees - knees bent (hips may or may not be flexed)
   extended knees - straight legs from hips to ankles

3. Neck flexed or extended
   flexed neck - chin bent into chest
   extended neck - head tilted towards back

Examples:

hips flexed
knees flexed
neck flexed



neck flexed

OBSTETRICAL MEASUREMENTS

1. GESTATIONAL SAC (MSD) - from detection to 12 weeks if necessary
2. CROWN RUMP LENGTH (CRL) - 5 to 12 weeks
3. YOLK SAC – 4 to10 weeks
3. BIPARIETAL DIAMETER (BPD) - 12 weeks and greater
4. FEMUR LENGTH (FL) - 12 weeks and greater
5. CISTERNA MAGNA (up to 24 wks) - 5 mm +/- 3 mm.
6. ABDOMINAL CIRCUMFERENCE (AC) - 12 weeks and greater
7. ESTIMATED FETAL WEIGHT –

8. VENTRICULAR ATRIUM - from 15 to 35 weeks
- approximately 7 mm, upper normal is 10 mm

9. CEPHALIC INDEX (CI) USED WHEN THERE IS A DIFFERENCE BETWEEN FL AND BPD

$$CI = \frac{BPD}{OFD} \times 100$$

-normal = 78
-dolichocephalic = under 70
-brachycephalic = over 86

10. HEAD CIRCUMFERENCE (HC) = (BPD + OFD) x 1.57

* Note for both #8 and #9 the BPD is measured from outer edge to outer edge.

11. FOR SUSPECTED IUGR $\frac{HC}{AC}$ (0.9-1.1 cm = normal) $\frac{FL}{AC}$ (normal is 22 - over 24 is IUGR)

FOR IUGR $\frac{FL}{AC}$ and $\frac{HC}{AC}$ have LARGE values

-in early pregnancy HC is greater than AC
-in mid pregnancy HC is approximately equal to AC (26-34 weeks)
-in late pregnancy AC is slightly greater than HC (at term)

12. MACROSOMIA

$\frac{FL}{AC}$ AND $\frac{HC}{AC}$ have SMALL values

13. FOR NO DATES

-do as many measurements as can be obtained and determine a composite fetal age in a range acceptable to the specific trimester (i.e. dating at 34 weeks is +/- 3-4 weeks)

EMBRYONIC HEART RATES

DAYS	MIN TO MAX	MEAN	STD
34	89-99	94	5
35	79-126	92.8	14.78
36	77-113	98.8	8.43
37	86-110	97.1	8.65
38	85-108	98	5.77
39	90-120	104	9.34
40	97-118	107.2	7.12
41	83-135	109	12.7
42	90-131	110.6	10.8
43	89-143	118.4	12.49
44	108-135	120.6	7.57
45	108-151	123.3	8.63
46	111-147	129.8	8.46
47	104-164	128.1	14.62
48	118-148	133.9	8.37
49	123-185	148.5	15.69
50	118-182	145.5	20.04
51	126-164	144.2	12.36
52	118-169	151.7	13.29
53	126-175	153.5	13.91
54	132-175	158.1	11.91
55	147-181	163	9.88
56	139-181	166.2	13.09

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GESTATIONAL SAC SIZE COMPARED WITH MENSTRUAL AGE

Mean Sac Diameter (cm)	Menstrual age (wks)	Mean Sac Diameter (cm)	Menstrual age (wks)	Mean Sac Diameter (cm)	Menstrual age (wks)
0.2	4.5	2.0	7.2	3.7	9.7
0.3	4.6	2.1	7.3	3.8	9.8
0.4	4.8	2.2	7.5	3.9	10.0
0.5	4.9	2.3	7.6	4.0	10.1
0.6	5.1	2.4	7.8	4.1	10.3
0.7	5.2	2.5	7.9	4.2	10.4
0.8	5.4	2.6	8.1	4.3	10.6
0.9	5.5	2.7	8.2	4.4	10.7
1.0	5.7	2.8	8.4	4.5	10.9
1.1	5.8	2.9	8.5	4.6	11.0
1.2	6.0	3.0	8.7	4.7	11.2
1.3	6.1	3.1	8.8	4.8	11.3
1.4	6.3	3.2	9.0	4.9	11.5
1.5	6.4	3.3	9.1	5.0	11.6
1.6	6.6	3.4	9.2	5.1	11.8
1.7	6.7	3.5	9.4	5.2	11.9
1.8	6.9	3.6	9.5	5.3	12.1
1.9	7.0				

Hellman

EARLY PREGNANCY - NORMAL VS ABNORMAL

Normal gestational sac growth is approximately:

1.1 mm/day between 5 & 11 weeks gestation.

Abnormal gestational sac growth is:

< 0.6 mm/day between 5 & 11 weeks gestation.

Abnormal: Absence of a yolk sac in a gestational sac measuring 20 mm

and/or

Absence of embryo in a gestational sac measuring 25 mm

Optimal time for a follow-up study is:

$$\text{time interval (in days)} = 25 - \text{initial mean sac diameter (mm)}$$

RELATION BETWEEN MEAN SAC DIAMETER, MENSTRUAL AGE AND HUMAN CHORIONIC GONADOTROPIN

Mean Gestational Sac Diameter (mm)	Predicted Age (wk) Range = 95% CI*	Predicted hCG (mIU/mL) Range = 95% CI+
2	5.0 (4.5-5.5)	1,164 (629-2,188)
3	5.1 (4.6-5.6)	1,377 (771-2,589)
4	5.2 (4.8 5.7)	1,629 (863-3,036)
5	5.4 (4.9-5.8)	1,932 (1,026-3,636)
6	5.5 (5.0-6.0)	2,165 (1,226-4,256)
7	5.6 (5.1-6.1)	2,704 (1,465-4,990)
8	5.7 (5.3-6.2)	3,199 (1,749-5,852)
9	5.9 (5.4-6.3)	3,785 (2,085-6,870)
10	6.0 (5.5-6.5)	4,478 (2,483-8,075)
11	6.1 (5.6-6.6)	5,297 (2,952-9,508)
12	6.2 (5.8-6.7)	6,267 (3,502-11,218)
13	6.4 (5.9-6.8)	7,415 (4,145-13,266)
14	6.5 (6.0-7.0)	8,773 (4,894-15,726)
15	6.6 (6.2-7.1)	10,379 (5,766-18,682)
16	6.7 (6.3-7.2)	12,270 (6,776-22,235)
17	6.9 (6.4-7.3)	14,528 (7,964-26,501)
18	7.0 (6.5-7.5)	17,188 (9,343-31,621)
19	7.1 (6.6-7.6)	20,337 (10,951-37,761)
20	7.3 (6.8-7.7)	24,060 (12,820-45,130)
21	7.4 (6.9-7.8)	28,464 (15,020-53,970)
22	7.5 (7.0-8.0)	33,675 (17,560-64,570)
23	7.6 (7.2-8.1)	39,843 (20,573-77,164)
24	7.8 (7.3-8.2)	47,138 (24,067-93,325)

* Predicted age from mean sac diameter is from Daya S, Woods S, Ward S, et al: Early pregnancy assessment with transvaginal ultrasound scanning. Can Med Assoc J 144:441, 1991.

+ Predicted hCG from mean sac diameter is from Nyberg DA, Filly RA, Filho DL, et al: Abnormal pregnancy: Early diagnosis by US and serum gonadotropin levels. Radiology 158:393, 1986 (hCG calibrated against the Second International Standard).

CROWN RUMP MEASUREMENTS RELATED TO MENSTRUAL AGE

CRL (cm)	Mean Predicted Menstrual Age (weeks)	CRL (cm)	Mean Predicted Menstrual Age (weeks)	CRL (cm)	Mean Predicted Menstrual Age (weeks)	CRL (cm)	Mean Predicted Menstrual Age (weeks)
0.2	5.7	1.6	8.0	3.0	9.9	4.3	11.2
0.3	5.9	1.7	8.1	3.1	10.0	4.4	11.2
0.4	6.1	1.8	8.3	3.2	10.1	4.5	11.3
0.5	6.2	1.9	8.4	3.3	10.2	4.6	11.4
0.6	6.4	2.0	8.6	3.4	10.3	4.7	11.5
0.7	6.6	2.1	8.7	3.5	10.4	4.8	11.6
0.8	6.7	2.2	8.9	3.6	10.5	4.9	11.7
0.9	6.9	2.3	9.0	3.7	10.6	5.0	11.7
1.0	7.1	2.4	9.1	3.8	10.7	5.1	11.8
1.1	7.2	2.5	9.2	3.9	10.8	5.2	11.9
1.2	7.4	2.6	9.4	4.0	10.9	5.3	12.0
1.3	7.5	2.7	9.5	4.1	11.0	5.4	12.0
1.4	7.7	2.8	9.6	4.2	11.1	5.5	12.1
1.5	7.9	2.9	9.7				

Hadlock 1992

PREDICTED MENSTRUAL AGE FOR BPD

BPD (cm)	Menstrual Age (weeks)	BPD (cm)	Menstrual Age (weeks)	BPD (cm)	Menstrual Age (weeks)
2.0	13.2	4.7	20.2	7.4	29.7
2.1	13.4	4.8	20.5	7.5	30.1
2.2	13.6	4.9	20.8	7.6	30.5
2.3	13.8	5.0	21.1	7.7	30.9
2.4	14.1	5.1	21.5	7.8	31.3
2.5	14.3	5.2	21.8	7.9	31.7
2.6	14.5	5.3	22.1	8.0	32.1
2.7	14.8	5.4	22.4	8.1	32.5
2.8	15.0	5.5	22.8	8.2	33.0
2.9	15.2	5.6	23.1	8.3	33.4
3.0	15.5	5.7	23.4	8.4	33.8
3.1	15.7	5.8	23.8	8.5	34.2
3.2	16.0	5.9	24.1	8.6	34.7
3.3	16.3	6.0	24.5	8.7	35.1
3.4	16.5	6.1	24.8	8.8	35.6
3.5	16.8	6.2	25.2	8.9	36.0
3.6	17.0	6.3	25.5	9.0	36.5
3.7	17.3	6.4	25.9	9.1	36.9
3.8	17.6	6.5	26.3	9.2	37.4
3.9	17.9	6.6	26.6	9.3	37.8
4.0	18.1	6.7	27.0	9.4	38.3
4.1	18.4	6.8	27.4	9.5	38.7
4.2	18.7	6.9	27.7	9.6	39.2
4.3	19.0	7.0	28.1	9.7	39.7
4.4	19.3	7.1	28.5	9.8	40.2
4.5	19.6	7.2	28.9	9.9	40.6
4.6	19.9	7.3	29.3	10.0	41.1

Hadlock 1984

PREDICTED MENSTRUAL AGE FOR FEMUR LENGTH

FEMUR LENGTH (cm)	MENSTRUAL AGE (weeks)	FEMUR LENGTH (cm)	MENSTRUAL AGE (weeks)
1.0	13.0	4.5	24.9
1.1	13.3	4.6	25.3
1.2	13.5	4.7	25.7
1.3	13.8	4.8	26.1
1.4	14.1	4.9	26.5
1.5	14.4	5.0	26.9
1.6	14.7	5.1	27.3
1.7	15.0	5.2	27.7
1.8	15.3	5.3	28.2
1.9	15.6	5.4	28.6
2.0	16.0	5.5	29.0
2.1	16.3	5.6	29.5
2.2	16.6	5.7	29.9
2.3	16.9	5.8	30.3
2.4	17.2	5.9	30.8
2.5	17.6	6.0	31.2
2.6	17.9	6.1	31.7
2.7	18.2	6.2	32.1
2.8	18.6	6.3	32.6
2.9	18.9	6.4	33.1
3.0	19.3	6.5	33.5
3.1	19.6	6.6	34.0
3.2	20.0	6.7	34.5
3.3	20.3	6.8	34.9
3.4	20.7	6.9	35.4
3.5	21.0	7.0	35.9
3.6	21.4	7.1	36.4
3.7	21.8	7.2	36.9
3.8	22.2	7.3	37.4
3.9	22.5	7.4	37.9
4.0	22.9	7.5	38.4
4.1	23.3	7.6	38.9
4.2	23.7	7.7	39.4
4.3	24.1	7.8	39.9
4.4	24.5	7.9	40.4

Hadlock 1984

ESTIMATED FETAL WEIGHT (in grams)

Abdominal Circumference (cm)

F.L. (cm)	20.0	20.5	21.0	21.5	22.0	22.5	23.0	23.5	24.0	24.5	25.0
4.0	663	691	720	751	783	816	851	887	925	964	1006
4.1	680	709	738	769	802	836	871	907	946	986	1027
4.2	697	726	756	788	821	855	891	928	967	100	1049
4.3	715	745	776	808	841	875	912	949	988	7	1071
4.4	734	764	795	827	861	896	933	971	101	102	1094
4.5	753	783	815	847	882	917	954	993	0	9	1118
4.6	772	803	835	868	903	939	976	1015	103	105	1142
4.7	792	823	856	889	924	961	999	1038	3	1	1166
4.8	812	844	877	911	947	984	1022	1062	105	107	1191
4.9	833	865	899	933	969	100	1046	1086	6	4	1216
5.0	855	887	921	956	993	7	1070	1111	107	109	1243
5.1	877	910	944	980	101	103	1095	1136	9	8	1269
5.2	899	933	967	100	6	1	1120	1162	110	112	1296
5.3	922	956	992	4	104	105	1146	1188	3	2	1324
5.4	946	981	101	102	1	5	1172	1215	112	114	1352
5.5	971	100	6	8	106	108	1199	1242	8	6	1381
5.6	995	5	104	105	6	0	1227	1271	115	117	1411
5.7	102	103	1	3	109	110	1255	1299	3	1	1441
5.8	1	1	106	107	1	5	1285	1329	117	119	1472
5.9	104	105	7	9	111	113	1314	1359	9	7	1503
6.0	7	7	109	110	8	1	1345	1390	120	122	1535
6.1	107	108	4	5	114	115	1376	1421	5	3	1568
6.2	4	4	112	113	4	8	1408	1454	123	125	1602
6.3	110	111	1	2	117	118	1440	1487	2	0	1636
6.4	2	1	114	116	2	5	1473	1520	125	127	1671
6.5	113	113	9	0	120	121	1507	1555	9	7	1707
6.6	0	9	117	118	0	3	1542	1590	128	130	1743
6.7	116	116	8	8	122	124	1578	1626	7	5	1780
6.8	0	8	120	121	9	2	1615	1663	131	133	1819
6.9	118	119	7	7	125	127	1652	1701	6	3	1857
7.0	9	8	123	124	8	1	1690	1740	134	136	1897
7.1	122	122	7	7	128	130	1729	1779	5	2	1938
7.2	0	8	126	127	9	1	1769	1819	137	139	1979
7.3	125	125	8	8	131	133	1810	1861	5	2	2021
7.4	1	9	129	130	9	1	1852	1903	140	142	2065
7.5	128	129	9	9	135	136	1895	1946	6	2	2109
7.6	4	1	133	134	1	3	1939	1990	143	145	2154
7.7	131	132	2	1	138	139	1983	2035	7	4	2200
7.8	7	4	136	137	4	5	2029	2082	146	148	2247
7.9	135	135	5	3	141	142	2076	2129	9	5	2295
8.0	1	7	139	140	7	8	2124	2177	150	151	2344
8.1	138	139	9	7	145	146	2173	2227	1	8	2394
8.2	5	1	143	144	1	1	2224	2277	153	155	2446
8.3	142	142	3	1	148	149	2275	2329	5	1	2498
	1	7	146	147	6	6			156	158	
	145	146	9	7	152	153			9	5	
	8	3	150	151	1	1			160	161	

	149 5 153 4 157 3 161 4 165 5 169 8 174 1 178 6 183 2 187 9 192 8 197 8	150 0 153 8 157 7 161 6 165 7 169 9 174 2 178 6 183 2 187 8 192 6 197 4 202 4	6 154 3 158 1 162 1 166 1 170 2 174 5 178 8 183 3 187 8 192 5 197 3 202 2 207 2	3 155 0 158 8 162 6 166 6 170 7 174 9 179 1 183 5 188 0 192 6 197 3 202 1 207 0 212 1	155 8 159 5 163 3 167 3 171 3 175 4 179 6 183 9 188 3 192 8 197 5 202 2 207 1 212 0 217 1	156 7 160 4 164 2 168 1 172 0 176 1 180 2 184 5 188 8 193 3 197 8 202 5 207 3 212 1 217 1 222 3			4 164 0 167 6 171 3 175 2 179 1 183 0 187 1 191 3 195 5 199 9 204 3 208 9 213 5 218 3 223 2 228 1 233 2 238 4	9 165 5 169 1 172 8 176 5 180 4 184 3 188 3 192 4 196 6 200 9 205 3 209 8 214 4 219 1 223 8 228 7 233 7 238 8 244 0	

ESTIMATED FETAL WEIGHT (in grams) (continued)

Abdominal Circumference (cm)

F.L. cm	25.5	26.0	26.5	27.0	27.5	28.0	28.5	29.0	29.5	30.0

4.0	1048	1093	1139	1188		1291	134	1403	1463	1525
4.1	107	1115	1162	1211	1239	1315	6	1429	1489	1551
4.2	0	1138	1186	1235	1262	1340	137	1454	1515	1578
4.3	1093	1162	1209	1259	1287	1365	1	1480	1541	1605
4.4	1116	1185	1234	1284	1311	1391	139	1507	1568	1632
4.5	1139	1210	1259	1309	1336	141	6	1534	1596	1660
4.6	1163	1235	1284	1335	1362	7	142	1561	1623	1688
4.7	118	1260	1310	1361	1388	1444	2	1589	1652	1717
4.8	7	1286	1336	1388	1415	147	144	1618	1681	1746
4.9	1212	1312	1363	1415	1442	1	8	1647	1710	1776
5.0	123	1339	1390	1443	1470	1498	147	1676	1740	1806
5.1	7	1367	1418	1471	1498	152	4	1706	1770	1837
5.2	1263	1395	1447	1500	1527	7	150	1737	1801	1868
5.3	1290	1423	1476	1530	1556	1555	1	1768	1833	1900
5.4	131	1452	1505	1560	1586	1584	152	1799	1865	1933
5.5	7	1482	1535	1591	1617	1614	9	1832	1897	1966
5.6	1344	1513	1566	1622	1648	1645	155	1864	1931	1999
5.7	137	1544	1598	1654	1679	167	7	1898	1964	2033
5.8	3	1575	1630	1686	1712	5	158	1932	1999	2068
5.9	1401	1608	1663	1719	1744	170	5	1966	2034	2103
6.0	1431	1641	1696	1753	1778	7	161	2002	2069	2139
6.1	1461	1674	1730	1788	1812	173	5	2038	2105	2175
6.2	1491	1709	1765	1823	1847	9	164	2074	2142	2212
6.3	1523	1744	1800	1858	1882	177	4	2111	2180	2250
6.4	1555	1779	1836	1895	1919	2	167	2149	2218	2289
6.5	158	1816	1873	1932	1956	1805	4	2188	2256	2328
6.6	7	1853	1911	1970	1993	1839	170	2227	2296	2367
6.7	1620	1891	1949	2009	2031	187	5	2267	2336	2408
6.8	1654	1930	1988	2048	2070	3	173	2307	2377	2449
6.9	1689	1970	2028	2089	2110	1908	6	2348	2418	2490
7.0	172	2010	2069	2130	2151	1944	176	2391	2461	2533
7.1	4	2051	2110	2171	2192	1981	8	2433	2504	2576
7.2	176	2093	2153	2214	2234	2018	180	2477	2547	2620
7.3	0	2136	2196	2258	2277	2056	1	2521	2592	2665
7.4	179	2180	2240	2302	2321	2094	183	2566	2637	2710
7.5	7	2225	2285	2347	2365	2134	4	2612	2683	2756
7.6	1835	2270	2331	2393	2411	217	186	2659	2730	2803
7.7	187	2317	2378	2440	2457	4	7	2707	2778	2851
7.8	3	2365	2426	2488	2504	2215	190	2755	2827	2899
7.9	1913	2413	2474	2537	2553	2256	2	2805	2876	2949
8.0	1953	2463	2524	2587	2602	2299	193	2855	2926	2999
8.1	1994	2513	2575	2638	2652	2342	6	2906	2977	3050
8.2	2035	2565	2626	2690	2702	2386	197	2958	3029	3102
8.3	207	2617	2679	2743	2754	2431	2	3011	3082	3155
	8				2807	247	200			
	2122					6	8			
	2166					2523	204			
	2211					257	5			
	2258					0	208			
	2305					2618	2			
	2353					2668	212			
	2403					271	1			
	2453					8	216			
	2504					276	0			

ESTIMATED FETAL WEIGHT (in grams) (continued)

Abdominal Circumference (cm)

F.L cm	30.5	31.0	31.5	32.0	32.5	33.0	33.5	34.0	34.5	35.0
4.0	159	1658	172	1802	1879	1959	204	2129	2220	2314
4.1	0	1685	9	1830	1907	1987	2	2158	2249	2344
4.2	161	1712	175	1858	1935	2016	207	2187	2279	2373
4.3	7	1740	6	1886	1964	2045	1	2217	2308	2404
4.4	164	1768	178	1915	1993	2075	210	2247	2339	2434
4.5	4	1797	3	1944	2023	2105	0	2278	2370	2465
4.6	167	1826	181	1974	2053	2135	212	2309	2401	2497
4.7	1	1855	2	2004	2084	2166	9	2340	2432	2528
4.8	169	1885	184	2035	2115	2197	215	2372	2464	2560
4.9	9	1916	0	2066	2146	2229	9	2404	2497	2593
5.0	172	1947	186	2098	2178	2261	218	2437	2530	2626
5.1	7	1978	9	2130	2210	2294	9	2470	2563	2659
5.2	175	2010	189	2163	2243	2327	222	2503	2597	2693
5.3	6	2043	8	2196	2277	2360	0	2537	2631	2728
5.4	178	2076	192	2229	2311	2395	225	2572	2665	2762
5.5	5	2109	8	2264	2345	2429	2	2607	2700	2797
5.6	181	2143	195	2298	2380	2464	228	2642	2736	2833
5.7	4	2178	9	2333	2415	2500	3	2678	2772	2869
5.8	184	2213	199	2369	2451	2536	231	2714	2808	2905
5.9	5	2249	0	2405	2488	2573	5	2751	2845	2942
6.0	187	2286	202	2442	2525	2610	234	2789	2883	2980
6.1	5	2323	1	2480	2562	2647	7	2827	2921	3018
6.2	190	2360	205	2518	2600	2686	238	2865	2959	3056
6.3	6	2398	3	2556	2639	2725	0	2904	2998	3095
6.4	193	2437	208	2595	2678	2764	241	2943	3037	3134
6.5	8	2477	5	2635	2718	2804	3	2983	3077	3174
6.6	197	2517	211	2675	2759	2844	244	3024	3118	3215
6.7	0	2557	8	2716	2800	2885	7	3065	3159	3256
6.8	200	2599	215	2758	2841	2927	248	3107	3200	3297
6.9	3	2641	1	2800	2884	2969	3	3149	3242	3339
7.0	203	2683	218	2843	2927	3012	251	3192	3285	3381
7.1	6	2727	5	2887	2970	3056	6	3235	3328	3424
7.2	207	2771	222	2931	3014	3100	255	3279	3372	3468
7.3	0	2816	0	2976	3059	3145	2	3323	3416	3512
7.4	210	2861	225	3021	3105	3190	258	3369	3461	3557
7.5	4	2908	4	3068	3151	3236	7	3414	3507	3602
7.6	213	2955	229	3115	3198	3283	262	3461	3553	3648
7.7	9	3003	0	3162	3245	3331	6	3508	3600	3694
7.8	217	3051	232	3211	3294	3379	266	3555	3647	3741
7.9	5	3100	6	3260	3343	3427	0	3604	3695	3789
8.0	221	3151	236	3310	3392	3477	269	3653	3744	3837
8.1	1	3202	3	3360	3443	3527	8	3702	3793	3886
8.2	224	3253	240	3412	3494	3578	273	3752	3843	3935
8.3	8	3306	0	3464	3546	3630	6	3803	3893	3985

	2285		2438				2776			
	2323		2476				2813			
	2362		2515				2852			
	2401		2555				2892			
	2441		2595				2933			
	2481		2636				2974			
	2523		2677				3016			
	2564		2719				3058			
	2607		2762				3101			
	2650		2806				3144			
	2694		2850				3188			
	2739		2895				3232			
	2785		2940				3278			
	2831		2987				3324			
	2878		3034				3371			
	2926		3081				3418			
	2974		3130				3466			
	3024		3179				3514			
	3074		3228				3564			
	3125		3280				3614			
	3177		3331				3665			
	3230		3384				3716			

ESTIMATED FETAL WEIGHT (in grams) (continued)

Abdominal Circumference (cm)

F.L. (cm)	35.5	36.0	36.5	37.0	37.5	38.0	38.5	39.0	39.5	40.0

4.0	241	251	262	273	285	2972	3098	3230	3367	3511
4.1	3	5	2	4	0	3002	3128	3260	3397	3540
4.2	244	254	265	276	288	3032	3159	3290	3427	3570
4.3	2	5	2	4	0	3063	3189	3321	3458	3600
4.4	247	257	268	279	291	3094	3220	3353	3488	3630
4.5	2	5	3	4	1	3125	3251	3383	3519	3661
4.6	250	260	271	282	294	3157	3283	3414	3550	3692
4.7	3	6	3	5	2	3189	3315	3446	3582	3723
4.8	253	263	274	285	297	3221	3347	3478	3613	3754
4.9	3	7	4	6	3	3254	3380	3510	3645	3786
5.0	256	266	277	288	300	3287	3412	3542	3677	3818
5.1	5	8	6	8	4	3320	3445	3575	3710	3850
5.2	259	270	280	291	303	3354	3479	3608	3743	3882
5.3	6	0	7	9	6	3388	3513	3642	3776	3915
5.4	262	273	284	295	306	3422	3547	3676	3809	3948
5.5	8	2	0	2	8	3457	3581	3710	3843	3981
5.6	266	276	287	298	310	3492	3616	3744	3877	4015
5.7	0	4	2	4	0	3527	3651	3779	3911	4048
5.8	269	279	290	301	313	3563	3686	3814	3946	4082
5.9	3	7	5	7	3	3599	3722	3849	3981	4117
6.0	272	283	293	305	316	3636	3758	3885	4016	4151
6.1	6	0	8	0	6	3673	3795	3921	4051	4186
6.2	276	286	297	308	320	3710	3832	3957	4087	4222
6.3	0	4	2	4	0	3747	3869	3994	4124	4257
6.4	279	289	300	311	323	3785	3906	4031	4160	4293
6.5	4	8	6	7	4	3824	3944	4069	4197	4329
6.6	282	293	304	315	326	3863	3983	4106	4234	4366
6.7	8	2	0	2	8	3902	4021	4144	4271	4402
6.8	286	296	307	318	330	3941	4060	4183	4309	4439
6.9	3	7	5	6	2	3981	4100	4222	4347	4477
7.0	289	300	311	322	333	4022	4140	4261	4386	4514
7.1	8	2	0	1	7	4062	4180	4300	4425	4552
7.2	293	303	314	325	337	4104	4220	4340	4464	4591
7.3	3	8	5	7	2	4145	4261	4381	4503	4629
7.4	297	307	318	329	340	4187	4303	4421	4543	4668
7.5	0	4	1	3	8	4230	4344	4462	4583	4708
7.6	300	311	321	332	344	4272	4387	4504	4624	4747
7.7	6	0	8	9	4	4316	4429	4545	4665	4787
7.8	304	314	325	336	348	4360	4472	4588	4706	4827
7.9	3	7	4	6	0	4404	4515	4630	4748	4868
8.0	308	318	329	340	351	4448	4559	4673	4790	4909
8.1	0	4	2	3	7	4493	4604	4716	4832	4950
8.2	311	322	332	344	355	4539	4648	4760	4875	4992
8.3	8	2	9	0	4	4585	4693	4804	4918	5034
	315	326	336	347	359					
	7	0	7	8	2					
	319	329	340	351	363					
	5	9	6	6	0					
	323	333	344	355	366					
	5	8	5	5	8					
	327	337	348	359	370					

	4	8	4	4	7					
	331	341	352	363	374					
	5	8	4	3	6					
	333	345	356	367	378					
	5	8	4	3	6					
	339	349	360	371	382					
	7	9	5	4	6					
	343	354	364	375	386					
	8	1	6	4	6					
	348	358	368	379	390					
	1	3	8	6	7					
	352	362	373	383	394					
	3	5	0	8	8					
	356	366	377	388	399					
	7	8	2	0	0					
	361	371	381	392	403					
	0	2	6	2	2					
	365	375	385	396	407					
	5	6	9	6	5					
	370	380	390	400	411					
	0	0	3	9	8					
	374	384	394	405	416					
	5	5	8	3	1					
	379	389	399	409	420					
	1	1	3	8	5					
	383	393	403	414	425					
	8	7	9	3	0					
	388	398	408	418	429					
	5	4	5	8	5					
	393	403	413	423	434					
	3	1	1	4	0					
	398	407	417	428	438					
	1	9	9	1	6					
	403	412	422	432	443					
	0	7	6	8	2					
	408	417	427	437	447					
	0	6	5	6	9					

IN UTERO FETAL SONOGRAPHIC WEIGHT STANDARDS

Menstrual Weeks	Estimated Fetal Weight (g) by Percentile				
	3rd	10th	50th	90th	97th
10	26	29	35	41	44

11	34	37	45	53	56
12	43	48	58	68	73
13	55	61	73	85	91
14	70	77	93	109	116
15	88	97	117	137	146
16	110	121	146	171	183
17	136	150	181	212	226
18	167	185	223	261	279
19	205	227	272	319	341
20	248	275	331	387	414
21	299	331	399	467	499
22	359	398	478	559	598
23	426	471	568	665	710
24	503	556	670	784	838
25	589	652	785	918	981
26	685	758	913	106	1141
27	791	876	105	8	1319
28	908	100	5	123	1513
29	1034	4	121	4	1724
30	1169	114	0	141	1949
31	1313	5	137	6	2189
32	1465	129	9	161	2441
33	1622	4	155	3	2703
34	1783	145	9	182	2971
35	1946	3	175	4	3244
36	2110	162	1	204	3516
37	2271	1	195	9	3785
38	2427	179	3	228	4045
39	2576	4	216	5	4294
40	2714	197	2	253	4524
		3	237	0	
		215	7	278	
		4	259	1	
		233	5	303	
		5	281	6	
		251	3	329	
		3	302	1	
		268	8	354	
		6	323	3	
		285	6	378	
		1	343	6	
		300	5	401	
		4	361	9	
			9	423	
				4	

NOMOGRAM OF ESTIMATED FETAL WEIGHT IN TWIN GESTATIONS

Gestational Age (weeks)	Estimated Fetal Weight (g) by Percentile				
	5th	25th	50th	75th	95th
16	132	141	154	189	207
17	173	194	215	239	249
18	214	248	276	289	291
19	223	253	300	333	412
20	232	259	324	378	534
21	275	355	432	482	705
22	319	452	540	586	876
23	347	497	598	684	880
24	376	543	656	783	885
25	549	677	793	916	1118
26	722	812	931	1049	1352
27	755	978	1087	1193	1563
28	789	1145	1244	1337	1774
29	900	1395	1509	1883	
30	1011	1266	1546	1682	1992
31	1198	1693	1875	2392	
32	1385	1387	1840	2068	2793
33	1491	2032	2334	3000	
34	1597	1532	2224	2601	3208
35	1703	2427	2716	3336	
36	1809	1677	2631	2832	3465
37	2239	2824	3035	3679	
38	2669	1771	3017	3239	3894
		1866			
		2093			
		2321			
		2540			
		2760			

PREDICTED MENSTRUAL AGE FOR ABDOMINAL CIRCUMFERENCE VALUES

Abdominal Circumference (cm)	Menstrual Age (weeks)	Abdominal Circumference (cm)	Menstrual Age (weeks)
10.0	16.0	23.5	27.8
10.5	16.4	24.0	28.3
11.0	16.9	24.5	28.7
11.5	17.3	25.0	29.2
12.0	17.7	25.5	29.7
12.5	18.1	26.0	30.2
13.0	18.5	26.5	30.6
13.5	19.0	27.0	31.1
14.0	19.4	27.5	31.6
14.5	19.8	28.0	32.0
15.0	20.2	28.5	32.5
15.5	20.7	29.0	33.0
16.0	21.1	29.5	33.5
16.5	21.5	30.0	34.0
17.0	22.0	30.5	34.5
17.5	22.4	31.0	34.9
18.0	22.9	31.5	35.4
18.5	23.3	32.0	35.9
19.0	23.7	32.5	36.4
19.5	24.2	33.0	36.9
20.0	24.6	33.5	37.4
20.5	25.1	34.0	37.9
21.0	25.5	34.5	38.4
21.5	26.0	35.0	38.9
22.0	26.4	35.5	39.4
22.5	26.9	36.0	39.9
23.0	27.4	36.5	40.4

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LENGTH OF FETAL LONG BONES (MM)

Week No.	Humerus Percentile			Ulna Percentile			Radius Percentile			Femur Percentile			Tibia Percentile			Fibula Percentile		
	5	50	95	5	50	95	5	50	95	5	50	95	5	50	95	5	50	95
11	-4	6	-1	-4	5	-1	-4	5	-1	-4	6	-1	-4	4	-1	-4	2	-1
12	3	9	1	-3	8	-1	-3	7	-1	-3	9	-1	-3	7	-1	-3	5	-1
13	5	1	0	3	1	1	-3	1	-1	-6	1	1	4	1	1	-3	8	-1
14	5	3	2	4	1	8	8	0	1	5	2	9	2	0	7	6	1	10
15	1	1	0	1	1	1	1	1	2	1	1	1	5	1	1	1	1	18
16	1	6	2	0	3	7	2	3	1	1	5	9	7	3	9	0	1	22
17	1	1	0	8	1	2	9	1	9	1	1	2	1	1	2	6	4	31
18	2	8	2	1	6	2	1	5	2	3	9	6	5	6	7	7	1	28
19	1	2	6	1	1	2	1	1	1	2	2	2	1	1	2	1	7	30
20	9	1	2	1	9	4	1	8	2	0	2	4	4	9	5	0	1	30
21	1	2	5	3	2	3	4	2	9	1	2	2	1	2	2	1	9	34
22	8	4	2	2	1	2	2	0	2	9	5	9	9	2	9	8	2	37
23	2	2	9	0	2	3	0	2	6	2	2	3	1	2	2	1	2	44
24	2	7	3	2	4	0	2	2	2	3	8	1	9	4	9	8	2	41
25	2	2	0	1	2	3	1	2	9	2	3	3	2	2	3	2	4	42
26	3	9	3	2	6	2	2	4	2	2	1	8	4	7	5	4	2	43
27	2	3	6	5	2	3	5	2	8	2	3	3	2	2	3	2	7	47
28	8	2	3	2	9	2	2	7	3	7	3	9	5	9	5	1	2	47
29	2	3	6	4	3	3	4	2	2	2	3	4	3	3	3	2	9	50
30	8	4	4	2	1	6	2	9	3	9	6	5	0	2	9	3	3	52
31	3	3	0	7	3	3	6	3	4	3	3	4	2	3	3	2	1	57
32	2	6	4	2	3	7	2	1	3	5	9	4	8	4	9	6	3	56
33	3	3	0	9	3	4	7	3	9	3	4	4	3	3	4	3	3	59
34	1	8	4	3	5	3	3	2	3	4	1	8	1	6	3	3	3	56
35	3	4	5	4	3	4	1	3	8	3	4	4	3	3	4	3	5	57
36	5	1	4	3	7	1	3	4	4	8	4	9	3	9	5	2	3	56
37	3	4	6	4	3	4	0	3	0	3	4	5	3	4	5	3	7	58
38	6	3	5	3	9	4	3	6	4	9	6	4	9	1	0	5	3	59
39	4	4	1	7	4	4	3	3	1	4	4	5	3	4	4	3	9	62
40	2	5	4	3	1	4	3	7	4	5	9	3	8	3	9	6	4	62
	4	4	9	7	4	4	3	3	5	4	5	5	4	4	5	4	1	
	1	6	5	4	3	8	3	9	4	5	1	7	0	5	1	0	4	
	4	4	1	0	4	4	6	4	5	4	5	5	4	4	5	3	3	
	4	4	8	3	4	8	3	0	4	9	3	7	1	7	2	3	4	
	4	4	5	8	4	5	4	4	7	4	5	6	4	4	5	4	5	
	4	4	0	3	6	1	3	2	4	9	6	2	6	9	7	0	4	
	4	4	5	9	4	5	4	4	9	5	5	6	4	5	5	4	7	
	7	2	5	4	7	4	3	3	5	3	5	2	6	1	6	0	4	
	4	5	6	0	4	5	7	4	3	5	6	6	4	5	5	4	8	

	75050523575556	3555657586061616263	5959626265636466666969	434474749484950	950525354555657558	9586059611616263665	4139384145454646	44546474848494950500	5151535754533545	3565761611646266466	0626465676971727475	7677171707374777983381	947484952545858	2545657596061626465	8596262646968716969699	34651511554554	5051525455556575859	

PREDICTED MENSTRUAL AGES FOR HEAD CIRCUMFERENCES (HC)

H.C. (cm)	Menstrual Age (weeks)	H.C. (cm)	Menstrual Age (weeks)	H.C. (cm)	Menstrual Age (weeks)
8.0	13.4	17.5	20.0	27.0	29.2
8.5	13.7	18.0	20.4	27.5	29.8
9.0	14.0	18.5	20.8	28.0	30.3
9.5	14.3	19.0	21.2	28.5	31.0
10.0	14.6	19.5	21.6	29.0	31.6
10.5	15.0	20.0	22.1	29.5	32.2
11.0	15.3	20.5	22.5	30.0	32.8
11.5	15.6	21.0	23.0	30.5	33.5
12.0	15.9	21.5	23.4	31.0	34.2
12.5	16.3	22.0	23.9	31.5	34.9
13.0	16.6	22.5	24.4	32.0	35.5
13.5	17.0	23.0	24.9	32.5	36.3
14.0	17.3	23.5	25.4	33.0	37.0
14.5	17.7	24.0	25.9	33.5	37.7
15.0	18.1	24.5	26.4	34.0	38.5
15.5	18.4	25.0	26.9	34.5	39.2
16.0	18.8	25.5	27.5	35.0	40.0
16.5	19.2	26.0	28.0	35.5	40.8
17.0	19.6	26.5	28.1	36.0	41.6

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BIOPHYSICAL PROFILE

PREGNANCIES OVER 30 WEEKS

BIOPHYSICAL VARIABLE	NORMAL (score 2)	ABNORMAL (score 0)
1. Fetal breathing movements	>1 episode of >30 sec. in 30 min.	Absent or no episode 30 sec. in 30 min.
2. Gross body movements	>3 discrete body-limb movements in 30 min. (episodes of active continuous movement considered as single movement)	<2 episodes of body-limb movements in 30 min.
3. Fetal tone	>1 episode of active extension with return of flexion of fetal limbs or trunk. Opening and closing of hand considered normal tone.	Either slow extension with return to partial flexion or movement of limb in full extension or absent fetal movement.
4. Qualitative amniotic fluid volume	>1 pocket of fluid measuring >2 cm in two perpendicular planes.	Either no pockets or a pocket <2 cm in two perpendicular planes.

FEMALE PELVIC ROUTINE

1. a) Begin in saggital at the symphysis and angle up to the bladder making sure it is adequately filled to view the pelvic organs.

   b) Adjust the gains to make the bladder as echo free as possible and at the same time still being able to adequately visualize deeper pelvic structures with an evenly echogenic appearance to the uterus.

2. a) Evaluate the bladder, vagina, cervix, uterine body and endometrial canal in a saggital plane. Take longitudinal of the uterus in a plane where the endometrial canal is demonstrated.

   b) Angle to the left and to the right to view the adnexae, locate the ovaries and measure them in a longitudinal and AP planes.

   c) Evaluate the posterior cul-de-sac for free fluid.

3. a) Turn the probe transverse.

   b) Beginning at the symphysis angle up to view the bladder. Check the bladder for `fullness' contour.

   c) Check for smooth, thin bladder walls. Note any abnormal internal echoes. Attempt to view the distal ureters.

4. a) Remain transverse and angle caudad.

   b) Check the vagina and cervix.

   c) Angle up into the uterus making sure that your gains are properly adjusted.

   d) Evaluate the uterus for size and echogenicity. Make note of the endometrial canal.

   e) Take a transverse measurement of the uterine fundus with the endometrium in clear view. <u>Measure the AP dimension of the uterus in the transverse plane</u>.

5. a) Remain transverse and angle to both the right and left sides to view the adnexae (you will have to angle the probe caudal and cephalic).

   b) Locate the ovaries and take transverse measurements of both ovaries.

6. Survey the lower abdomen for any masses or fluid collections.

If there is a large pelvic mass, evaluate both kidneys for hydronephrosis. If hydronephrosis is present, post void evaluation of the kidneys must be performed.

7. Colour flow/Doppler may be used, where available, to further evaluate the pelvis in patients who may be suspect for pathology. Indications include:

- Family history of ovarian/breast cancer
- post menopausal patients with enlarged ovaries
- post menopausal patients with pelvic lesions
- post menopausal patients on hormone therapy

BENIGN MASSES*	MALIGNANT MASSES*
RI > 0.4	RI < 0.4
PI > 1.0-1.5	PI < 1.0

***REMEMBER:** **In patients in child bearing years, these numbers are only accurate in the first seven days of the cycle.**

In the case of suspected ectopic pregnancy colour flow may be used to evaluate the suspicious area, however pulsed Doppler should be kept to a minimum.

NORMAL MEASUREMENTS:

Ovarian Volume:	Children	under 5 yrs – less than 1cc
		at menarche – 4.2 cc +/- 2.3 cc
	Adult	10 cc+/- 3.9 cc (upper normal)
	Post menopausal	2.7 cc +/- 2.2 cc (upper normal)
Uterus:	Infant	2 – 3.3 cm in length with cervix 2/3 total length.
		0.5 – 1 cm in AP with cervix larger
	Post puberty	8 cm in length, 5 cm in width, 4 cm in AP
	Multiparity	add 1 cm to each dimension
	Postmenopausal (no HRT)	3.5 – 6.5 cm in length, 1.2 – 1.8 cm in AP
Endometrium	Adult	up to 13 mm in AP thickness
	Postmenopausal (no HRT)	less than 5 mm in AP thickness

ENDOVAGINAL (TRANSVAGINAL) ULTRASOUND EXAMINATION CONSENT FORM

An endovaginal diagnostic ultrasound examination allows the ultrasound transducer (probe) to be placed internally in close proximity to the pelvic organs and is performed to obtain further diagnostic information concerning the uterus, ovaries and surrounding regions.

The following procedure will be followed by the technologist:

1. The endovaginal ultrasound probe will be covered in a sterile sheath as well as a lubricant (usually KY jelly). The technologist will be wearing gloves.

2. The technologist will ask the patient to insert the ultrasound probe into the vagina, unless otherwise requested by the patient.

3. The technologist will position and then reposition the ultrasound probe as necessary to obtain the necessary diagnostic information.

4. The patient should not experience any pain or discomfort with this examination. **The technologist will immediately stop the examination and remove the probe at any time, at the patient's request.**

5. The diagnostic information obtained will be reported by a Radiologist and the written report of the examination results will be sent to your physician.

Please advise the technologist of any latex sensitivity or allergy, before signing this consent.

If you have any questions, please ask before signing this consent.

I, _____ consent to allow _____
(technologist)

to perform an endovaginal ultrasound examination.

Date: _____

Signature:_____

Witness: _____

TRANSVAGINAL SCANNING

Indications:

1. Infertility Patients
   - Viewing and measurement of ovarian follicles in patients for infertility treatment undergoing IVF or AI (in vitro fertilization or artificial insemination).

   - Ultrasound guidance for follicular aspiration.
2. Gynaecology
   - Imaging the uterus, ovaries, fallopian tubes (only with pathology) and adnexae. TV scanning should be employed in the evaluation of ovarian cysts over 2.0cm, ? ovarian pathology, endometrial thickness, abnormal uterine bleeding, ? endometrial pathology, adnexal masses, poor or non-visualization, post-menopausal bleeding, postmenopausal evaluation of the endometrium.

   - Especially useful when scanning obese patients who are not easily visualized with transvesical scanning.
3. Patients with Empty Bladder
   - Useful for patients who cannot drink fluid to distend bladder or in emergency cases where the patient must remain NPO and cannot be filled by IV due to time restrictions.

   - A transvaginal examination alone does not constitute a complete examination, and should only be conducted alone on the advice of a physician, or where the patient cannot fill her bladder.

4. Early Pregnancy
   - Confirmation of viable IUP earlier than transvesical scanning.

   - Useful in cases of suspected ectopic pregnancy.

   - Also shows much greater detail in early growth of the fetus where early BPD is required.

5. Late Pregnancy
   - Can be used as a complementary examination in second and third trimester pregnancy to image cervix for competency and to show the internal os, fetal head and position of a low lying placenta when it is difficult to show in the transvesical study.

6. Doppler
   - Doppler studies of ascending uterine arteries and arcuate vessels for evaluation of blood supply to the uterus.

   - investigation and management of infertility patients. Identification of abnormal blood flow patterns may improve management of fetuses in jeopardy.

- Doppler studies of ovarian arteries for assessment of ovarian or endometrial neoplasm.

- May also help in evaluation of IUGR in cases of pregnancy induced hypertension.

Contraindications:

1. The patient refuses the examination.
2. A patient who has never been sexually active and has never had an internal pelvic examination.
3. A third trimester pregnancy with a dilated cervix.
4. A patient with an incompetent cervix **and bulging membranes**.
5. A patient who does not understand English and who does not have an interpreter available.
6. A patient who states they understand the explanation and give consent for the procedure, yet it becomes evident, by reluctance or apprehension that they do not understand.

Patient Explanation:

1. When you have imaged the pelvic structures to the best of your abilities with the transvesicle method stop scanning and address the patient directly.

2. Your explanation must include:
    i) a general reason for the necessity of the examination
        ie. I am having difficulty imaging certain structures

    ii) a brief explanation of transvaginal ultrasound
        ie. it is a different type of scan that allows closer visualization of the pelvic structures through the use of a probe which is inserted into the vagina. Allay the patient's fears by stating that the probe is only inserted a small distance and should not be uncomfortable or painful at all but may feel a little cold.

    iii) **Be very clear that it is the patient's decision to proceed with the transvaginal examination**

    iv) verify consent
        i.e. Do you wish to have the examination?

    At this point, the patient is instructed to empty her bladder completely and return to the examination room. **A consent form must be signed if opposite sex sonographer.**

    v) Again, stress that the examination is internal but should not be uncomfortable or painful. Assure the patient that if they are not tolerating the examination well, it will be immediately terminated at their request.

    vi) While preparing the probe explain to the patient that a latex condom, together with sterile lubricating gel is going to be used. **Ask the patient if they have a known latex allergy**. If so, document this and use a non-latex alternative.

vii) Before insertion, confirm consent.
i.e. Do you have any further questions before I begin?

viii) Maintain a dialogue with the patient during the examination regarding their tolerance of the procedure, and the time remaining for the examination.

ix) **It is the patient's right to terminate the examination at any time. Even during the procedure.**

Orientation of Anatomy on Monitor:

1. Longitudinal:
   - slightly different orientation due to the placement of the probe
   - anterior part of the patient is on the upper portion of the monitor; posterior on the lower portion of the monitor
   - cephalic (toward the head) is shown on the left side of the monitor; caudad (toward the feet) is shown on the right side of the monitor

2. Axial/Coronal:
   - as with other methods of scanning, the right side of the patient is shown on the left side of the monitor
   - anterior is shown on the upper portion of the monitor and posterior is toward the lower portion of the monitor

The probe is positioned with the tip at the cervix pointing toward the patient's head. The tip of the probe will have the smallest viewing angle.

Endocavity Probe Preparation and Cleaning Protocol:

This procedure is to be followed before and directly after the use of all endocavity probes.

Supplies:
-convenient garbage container
-biohazardous waste receptacle
-roll of bed paper
-ultrasound gel in squirt bottle
-lubricated condoms or non-lubricated condoms and sterile lubricant. The condoms should ideally have no reservoir, and neither the condoms nor the sterile gel should contain spermicide. **Non-latex alternatives must be available**
-microbacterial solution (to be changed as per product directions)
-soaking container for the ultrasound probe
-clean gauze squares or clean tissues

Preparation:
-place garbage container within the working area
-roll out fresh bed paper

-set out supplies within working area

-tear off top of condom package to expose condom (do not touch exposed condom); place on worktop

-put non-latex glove on right hand

-take probe in right palm (do not touch tip)*

-apply gel to probe with left hand

-grasp condom package in left fingers (do not touch exposed condom)

-remove condom from package with gloved right hand (do not touch package)

-using thumb and index fingers of your right hand place condom on tip of probe

-transfer probe to your left hand

-unroll condom over probe tip with right hand; draw condom down over handle area

-check that there isn't any air left between the tip of the probe and the condom (do not touch tip of probe)

-transfer probe to right hand (right hand now unclean)

-do not touch clean probe tip to anything but patient

-using left hand apply K-Y jelly to tip of probe

* **NOTE** - tip refers to all of the probe above the handle

After Exam: -remove probe from patient and take in left hand

-have the patient dismount from table, etc.

-unravel condom from probe with gloved right hand (for your protection) roll inside-out (do not touch outside of condom)

-with condom in palm of right gloved hand, remove glove by pulling it inside-out (do not touch outside of glove or condom)

-drop the glove and condom in the designated biohazardous waste receptacle

-remove gel residue from probe with clean gauze or tissue before soaking it

-immerse probe in container of microbacterial solution and let soak as per manufacturer's specifications

-grasp bed paper from its underside and fold inwards to wrap and dispose of same (do not touch topside of paper or its contents)

-if necessary clean table with antibacterial/antiseptic solution

-to remove probe from solution, wearing gloves on both hands, draw the probe tip through clean gauze or tissue wrapped firmly around its base.

Final Cleanup: -clean machine with gauze or tissue dampened with an antiseptic/antibacterial solution, starting from the cleanest area (i.e. screen) to the most contaminated area (i.e. probe receptacle). Do not touch back to clean areas.

-swab probe with gauze or tissue dampened with an antiseptic/antibacterial solution, starting at handle and working towards tip (do not touch back to clean areas and do not let alcohol drip back over clean areas)

-rinse probe with gauze or tissue dampened with clean water, in the same manner

-dry probe in the same manner
-return probe to its clean receptacle

Patient Preparation/Scan Preparation:

1. Explain the examination to the patient.

2. Confirm a verbal consent, and/or written consent.

3. The patient should empty her bladder before the exam.

4. The patient lies supine with the head on a pillow and a cushion or sponge under the pelvis to lift it and allow more range of movement of the probe.

5. When ready to insert probe and keeping the patient covered as much as possible, have the patient bring knees up, put feet together and knees apart.

6. The probe can be inserted by the patient or by the sonographer*. The probe should be active and sonographer should be watching on the monitor during insertion.

*If sonographer is of opposite sex, it is recommended that the patient insert the probe.

Scanning Protocol:

In a saggital plane:

- locate the cervix demonstrating the anterior and posterior cervical lips with the central linear echo
- locate the midline of the uterus showing the endometrial stripe from cervix to fundus

measure the AP thickness of endometrial lining

tilt the probe tip to show fundus

angle the probe laterally to show the left and right myometrium and slightly beyond

Rotate the probe 90° from your sagittal position.

- tilt the probe tip posteriorly (for anteverted uterus) or anteriorly (for retroverted uterus) to demonstrate the cervix; the cervix is seen as a round homogeneous area with a small central echo

tilt the probe tip to image the uterus to the fundus and beyond

- measure the transverse dimension of the uterus at the widest section of the superior endometrium

- measure the AP dimension of the uterus

- tilt the probe to right and left side and angle up and down to demonstrate the ovaries and pelvic vessels

measure both ovaries in 3 dimensions

measure any pathology in 3 dimensions

Probe Motions:

1. rotation - 360°

2. tilt - up and down
   - side to side

3. in and out

Some Problems with Transvaginal Scanning:

1. Be aware of vascular packet in parametrium near cervical os.
   - this can look like ovaries

2. Location of Ovaries - Usually lateral to the uterus, medial to the iliac vessels but may be found out of the pelvic area or posterior or inferior to normal position. Suspended inspiration may be of use in locating ovaries. The anterior abdominal wall over the ovary may be compressed manually.

3. Large masses (greater than 5 cm) may not be shown completely due to limitations in the field of view.

4. Structures located superior to the uterus/bladder dome may be too far away to see.

5. Post-op adhesions or uterine fibroids may be very dense and cause attenuation.

ENDOMETRIUM

ISOECHOIC HYPERECHOIC
HYPOECHOIC

Measure the thickness of the endometrium, at the body of the uterus, making sure that the area of interest is perpendicular to the midline sound beam.

NOTE: whether the endometrium is:

a) ISOECHOIC - this means that the echogenicity of the endometrium is the same as the echogenicity of the myometrium

b) HYPERECHOIC - this means that the echogenicity of the endometrium is brighter than that of the myometrium.

c) HYPOECHOIC - this means that the echogenicity of the endometrium is less than that of the myometrium.

If the uterus contains a fibroid or is retroverted you may have difficulty obtaining a good perpendicular measurement. Explain the reason why on the report.

DOPPLER EVALUATION OF THE ARTERIES OF THE PELVIS

Vessels of Interest:

-Uterine Artery

-Main Ovarian Artery

-Uterine Artery Branches- extrauterine
- intrauterine

-Peri-ovular Branches

-Adnexal Branches

DOPPLER RECORDINGS

General Principles:

1. Adjust the doppler angle to the vessel in the 55°-70° range by visual inspection to minimize noise and maximize the clearest signal.

2. The beam to flow angle should ideally be less that 60°. In cases where tortuous vessels are encountered, the beam angle may be increased to a maximum of 70°. Spectral analysis of Doppler velocity signals above 70° are unreliable.

3. Use "low power" settings to keep maximum intensity (SPTA) below 94 mW cm^2.

4. Survey with colour first to identify vessels, then interrogate with pulsed Doppler.

5. Where Doppler pulse reception is weak, increase system gain, not power to keep power output low.

Equipment Settings:

	Transvaginal	Transabdominal
Velocity Range	2 KHZ	2 KHZ
Filter	50 HZ	100 HZ
Sample Volume	2 MM	2 MM
Pre Comp	MID 2	MID 2
Reject	00/14	00/14
Baseline	Centre	Centre
Invert	Normal	Normal
Unit	CM/SEC	CM/SEC

All the above settings are pre-programmed on Aloka 680 machines under PRE SET 1 (TV) for transvaginal Doppler, and PRE SET 2 (GYN) for transabdominal Doppler.

Uterine Arteries/Branches:

On each side of the midline, identify the uterine artery as it ascends along the lateral wall of the cervix and distal uterus. Using the equipment settings shown above, record peak systolic and diastolic velocities, perform spectral analysis, and calculate the pulsatility and/or resistance index, as follows:

a) In the sagittal plane at midline, angle in the direction of the cervix.

b) Demonstrate the junction of the uterine body and the cervix, position it directly in line with the central beam.

c) At the cervico-corporeal junction, rotate the probe 90° counter-clockwise to locate the ascending branch of the uterine artery of the dominant side. If uncertain, interrogate both sides.

d) Place the colour flow gates over the region of the uterine artery. Typically velocities in this vessel are 30 cm/sec (range 10-60 cm/sec). Intense colour concentration is usually seen within the artery. If colour is not detected, angle the probe slowly up or down until colour is seen.

e) Place sample point within the "vessel" demonstrating colour, increase the pulse wave velocity range to 16 or greater in order to display the maximum velocity.

f) To obtain pulsatility index (PI) trace the waveform of one cycle, starting at the baseline to the peak systole and down to the end diastole (see VASCULAR INDICES below).

g) If the PULSATILITY INDEX (PI) obtained is not higher than the previous study, Doppler the uterine artery on the other side, and indicate which side the flow was obtained from.

Ovarian/Uterine Artery Ovular Branches:

Identify branches of the ovarian or uterine artery in the vicinity of the ovary/follicles, and using the equipment settings shown above, record the peak systolic and diastolic velocities, perform spectral analysis, and document resistance index (RI) for each vessel. In each case, be sure to document the highest peak velocity (PV) value on each side, and also document a resistance index (RI). Follow the following protocol:

a) In the transverse plane locate the largest follicle within the ovary. Whenever possible, align the follicle within the central beam (area of maximum colour flow).

b) With the colour flow velocity set at 8, place the colour flow gates over the follicle. If no flow is obtained, lower the colour flow velocity down to four.

* IMPORTANT: YOU MAYMOVE THE COLOUR GATES AROUND THE OVARY/FOLLICLE OR YOU MAY CHANGE THE AREA OF INTEREST BY MOVING YOUR PROBE BUT NOT AT THE SAME TIME.

c) Place the sample point in the area where colour is detected, usually found around or adjacent to the lead follicle.

d) Increase or decrease the Pulse Wave velocity range where necessary to get the optimal spectral display.

e) Measure maximum peak systolic velocity and end diastolic velocity.

f) Compare RI and PV with the previous day's measurements. Try to obtain higher follicular velocity values, but make sure they are not artifactual (remember Doppler angle must be <70°).

Repeat procedure on the left ovary.

Uterus:

Using the equipment settings shown above, record the peak systolic, and where possible diastolic velocities, as well as Doppler spectra in the endometrium, and in the inner; mid, and outer thirds of the myometrium. Where calculable, record pulsatility and/or resistance index.

Pelvis Mass/Ovarian Screening:

Using the equipment settings shown above, interrogate all vascular structures within and around the ovary or mass itself, and record in each case the maximum peak systolic and diastolic velocities, and perform spectral analysis including calculation of pulsatility and/or resistance indices.

VASCULAR INDICES

The amount of parenchymal flow is reflected in the size and shape of the diastolic portion of the waveform. The frequencies contained in a wave should be quantitated as: RI - Resistance Index and/or PI - Pulsatility Index

$$RI = \frac{\text{Systolic peak - End diastolic velocity}}{\text{Systolic peak}}$$

$$PI = \frac{\text{Systolic peak - Diastolic peak}}{\text{Mean}}$$

FERTILITY APPLICATIONS:

Uterine artery - PI <3.0 is compatible with successful implantation.

In normal folliculogenesis, Peak Velocities in perifollicular arteries increase as the follicles enlarge.

80% of all colour Doppler activity is detected within 72 hours of ovulation.

ONCOLOGY APPLICATION

RI's -vary from 0 to 1.0
-Malignant less than 0.4

PI's -range from 0 to 10.0
-Most malignant masses range from 0.3 to 1.0
-Normal ovaries - 3.1 to 9.4

BENIGN MASSES*	MALIGNANT MASSES*
RI > 0.4	RI < 0.4
PI > 1.0-1.5	PI < 1.0

* **In patients in their child bearing years, these numbers are only accurate in the first seven days of the cycle.**

CYCLE MONITORING PATIENTS

1. On the first day of cycle monitoring, patients must drink 5 (8 oz) glasses of water, one hour prior to arrival. The ultrasound technologist is required to:
    a) Perform a transvesicle pelvic ultrasound examination demonstrating the uterus, cervix, vagina, right ovary, right adnexa, left ovary and left adnexa in both longitudinal and transverse planes (no K.Y. gel is used at any time; use water over the condom if necessary).
    b) After the patient has emptied her bladder, a transvaginal examination is performed evaluating the same parameters.

2. On days five to nine of cycle monitoring, the ultrasound technologist is required to:
    a) Measure endometrial thickness.
    b) Carefully scan the uterus and right and left adnexa, recording the existence and size of any abnormalities (eg. fibroids, cysts, ...). If a cyst is encountered, record the texture, shape and size in three dimensions.
    c) Thoroughly scan the right and left ovaries for follicles; count the follicles that are $\geq$ 0.5 cm in size and measure the width, depth and length of each follicle that is $\geq$ 1.0 cm. Record the average of these three measurements for each follicle.
    d) Perform colour flow/Doppler over the uterine arteries and document the highest pulsatility index (PI) (Minto only).

3. On days ten, eleven, twelve... until cycle is complete, the ultrasound technologist is required to:

   a) Measure endometrial thickness.

   b) Measure the size of each follicle ≥ 1.0 cm in three dimensions

   c) Record the number of follicles and the average follicle size

   d) Measure the blood flow in the uterine arteries and document the highest PI value. (Minto only)

PLEASE NOTE: If one side has a dominant follicle, then usually that is the side that has the highest uterine artery flow.

DOCUMENTATION AND RECORDING

Whereas it is important to document and record the entire examination, time spent locating vessels need not be recorded. The following measurements and readings MUST ALWAYS BE INCLUDED in your study.

1. Endometrial thickness
2. Endometrial echo pattern
3. Uterine artery P.I. (Minto only)
4. Total number of follicles ≥ 0.5 cm in right and left ovary

5. Average size and number of follicles $\geq$ 1.0 cm in right and left ovary in three dimensions
6. Free fluid collection
7. Any Abnormalities - measurements, location and echo pattern.

Record measurements on Follicle Monitoring Form (page USPRO 45)

TRUE NORTH IMAGING

PATIENT: _____ DOB: _____

PHYSICIAN: _____ CHART #: _____

TECHNICIAN: _____ DATE: _____

PELVIC KULTRASOUND (DAY ____) Previous days LH/Estradiol _____

CLINICAL HISTORY:

The uterus looks normal: _____ Yes _____ No E2= _____

The right ovary contains _____ follicles.

_____ over 1.0 cm in size, _____ under 1.0 cm in size, _____ multiple follicles under 5 mm in size

The lead follicle measure _____x _____x_____ cm (average)

Measuring: _____x_____x_____cm, _____x_____x_____cm, _____x_____x_____ cm

Measuring: _____x_____x_____cm, _____x_____x_____cm, _____x_____x_____cm

There is free fluid in the posterior cul de sac: _____ Yes _____ No

COMMENTS:

_____

_____

The left ovary contains _____ follicles

_____ over 1.0 cm in size, _____ under 1.0 cm in size, _____ multiple follicles under 5 mm in size

The lead follicle measure _____x _____x_____ cm (average)

Measuring: _____x_____x_____cm, _____x_____x_____cm, _____x_____x_____ cm

Measuring: _____x_____x_____cm, _____x_____x_____cm, _____x_____x_____cm

There is free fluid in the posterior cul de sac: _____ Yes _____ No

COMMENTS:

_____

_____

_____ **PRELIMINARY REPORT**

Technologist

IN VITRO FERTILIZATION (IVF) PATIENTS

1. On Day 0, the ultrasound technologist is required to:

   - perform a pelvic ultrasound examination
   - after the patient has emptied her bladder, perform a transvaginal examination
   - measure endometrial thickness
   - record the number of follicles seen that are ≥0.5cm in size, document the largest follicle (no colour flow Doppler)
   - perform colour flow/Doppler of the uterus

2. On Days One to Six the ultrasound technologist is required to:

   - perform a transvaginal examination; record the echogenicity and measurement of the endometrial lining

   - thoroughly scan the right and left ovaries; count the number of follicles ≥0.5 cm and measure each follicle ≥1.0cm in 3 dimensions recording the average of these dimensions from the largest to the smallest (no colour flow Doppler in the ovaries).
     1. perform colour flow/Doppler on the right and left uterine arteries
     2. document only the highest P.I. value

3. On Days five, six, etc. (or for follicles 1 cm or over)... until the day before egg retrieval the ultrasound technologist is required to:

   - perform a transvaginal examination; record the echogenicity and measurement of the endometrium

   - thoroughly scan the right and left ovaries; count the number of follicles ≥0.5cm and measure the size of each follicle ≥1cm in 3 dimensions

   - perform colour flow/Doppler as previously described for uterine artery PI and follicular PV's and RI

4. On the day of egg retrieval, the ultrasound technologist is required to:

- as each follicle is aspirated, document, on tape, those follicles which have colour flow or no colour flow and give the results to the embryologist

5. On the day of the embryo transfer the ultrasound technologist is required to:

   - Doppler the right and left uterine arteries and document both P.I. values.

   - measure the endometrial thickness and note echogenicity

6. On day seven of the embryo transfer the ultrasound technologist is required to:

   - perform a transvaginal examination

   - perform an LTD abdomen examination

7. On day fourteen of the embryo transfer the ultrasound technologist is required to

    - perform a transvaginal examination
    - perform an LTD abdomen examination

DOCUMENTATION AND RECORDING

Whereas it is important to document and record the entire examination, time spent locating vessels need not be recorded. The following measurements and readings MUST ALWAYS BE INCLUDED in your study.

1. Endometrial thickness
2. Endometrial echo pattern
3. Colour flow/Doppler of the uterus (first day only unless positive)
4. Both uterine artery P.I.'s
5. Total number of follicles _ 0.5 cm in right and left ovary
6. Average size and number of follicles _ 1.0 cm in right and left ovary
7. R.I. and P.V. of the vessel with the highest follicular flow (velocity) for cycle day 5 to ovulation (for follicles 1 cm or over)
8. Free fluid collection
9. Any Abnormalities - measurements, location, echo pattern, and Doppler values if applicable.

SONOHYSTEROGRAPHY

Indications:

1. Infertility
2. Habitual Abortion
3. Sterility
4. Bleeding
   - Menorrhagia
   - Metrorrhagia
   - Menometrorrhagia
   - Intermenstrual Bleeding
   - Premenstrual Bleeding
   - Postmenstrual Bleeding
   - Break-through Bleeding
   - Premenopausal Bleeding
   - Perimenopausal Bleeding
   - Postmenopausal Bleeding
5. Primary and Secondary Amenorrhea
6. Pelvic Pain
7. Myomas
8. Uterine Malformations
9. Recurrent Mole
10. Retained Products
11. Polyps
12. Carcinoma
13. Evaluation of Hormone Therapy
14. Hyperplasia
15. Adenomyosis
16. Combined Screening

Contra-indications:

1. Acute vaginitis or cervicitis

2. Pregnancy

Timing of Procedure:

1. In patients of childbearing age: Day 7 - Day 10 of menstrual cycle

2. In patients with menorrhagia: Time of light bleeding

Room Preparation:

The examination room should be equipped with a gynaecological bed, a movable light source, the ultrasound unit, a thermal printer (colour printer if a thermal printer is not available), a cart to hold the sterile tray and supplies.

Supplies:

1. Ackrad 5 French AS disposable balloon tip catheter

2. A sterile tray containing:
   a) two basins, one for warm Saline and the other for the cleaning solution. Each should be able to hold a minimum of 40 cc's.
   b) clamp
   c) bivalve speculum

3. Iodine preparation.

4. Warm sterile Saline. Sterile Saline is warmed to body temperature in order to decrease cramping. A heat source to warm the saline.

5. Syringes: Two syringes are required. The HS catheter comes with a 3 cc syringe for the inflation of the balloon, and a second 50 cc syringe is required for the instillation of the saline.

Procedure:

1. Prior to the procedure the patient is given an information sheet and a questionnaire to complete (pages USPRO 52 and USPRO 53).

2. Immediately prior to the procedure the patient is requested to empty her bladder.

The physician reviews pertinent findings on the questionnaire and explains, in further detail, about the procedure and why it is indicated as far as the patient's clinical presentation.

4. The patient is placed in a lithotomy position and following prep of the cervix, the catheter is inserted, and the balloon inflated.

5. 10-40 cc's of Saline is instilled into the uterine cavity at which time the uterus, tubes and adnexae are evaluated.

6. At the end of the procedure the balloon on the catheter is deflated and the lower uterine segment and cervix are visualized.

7. The patient is advised, again, that there may be some discharge, lightly brownish in colour due to the iodine cleaning agent. If the patient did not bring a panty liner with her, offer one.

8. The patient is advised to relax in the waiting room for 10-15 minutes following the procedure and if at that time there are no complaints, the patient is discharged.

Protocol:

1. Assure that the room is set up with all necessary supplies, with a second set available in case they are needed.

2. Check that all paper work is completed including the white copy, the preliminary scan report forms, and the patient questionnaire.

3. Make sure that the patient empties her bladder before the procedure is to begin.

4. Assist the doctor as required. Imaging and recording structures of interest in the appropriate planes, using Doppler when requested.

5. Aid the patient from the table after the procedure, and check on her while she is resting to monitor her condition.

USPRO 52

TRUE NORTH IMAGING

SONOHYSTEROGRAPHY REPORT

Patient:_____ Date:_____ Case#: _____

Ref. Dr:_____

Procedure: The patient was catherized by Dr. _____. _____cc of saline was installed in the uterine
cavity without complications. The endometrial thickness was _____ cm anteriorly and _____ cm posteriorly.

ANTEVERTED **RETROVERTED**

TRANSVERSE

Cavity: 1. _____ Normal
2. _____ Abnormal

_____ Polyp(s) Size ____x____x____cm, ____x____x____cm, ____x____x____cm

_____ Fibroid(s) Size ____x____x____cm, ____x____x____cm, ____x____x____cm.

_____ Adhesion(s) Size ____x____x____cm, ____x____x____cm, ____x____x____cm.

_____ Malformation(s) Size____x____x____cm, ____x____x____cm, ____x____x____cm.

_____ Other Size ____x____x____cm, ____x____x____cm, ____x____x____cm.

3. Location of abnormality

____ Fundal _____ Lower uterine segment ____ Right

____ Midbody _____ Doppler ____ Left

4. Comments: _____

_____

Tubes: During the procedure spill was/was not seen into the right/left adnexa and cul-de-sac.

Radiologist's Report:_____

_____

_____

Consultants Notes: _____

SONOHYSTEROGRAPHY
PATIENT INFORMATION SHEET

Your doctor has referred you to our clinic for a sonohysterogram. This ultrasound examination provides considerable information about your uterus, and fallopian tubes without the use of X-rays, X-ray dye and without the need of anaesthetic. We have been performing this procedure since 1994 and have performed more than 10,000 procedures. True North Imaging is regarded as being among the world's leading centres in this field.

Indications for this are numerous and may include: irregular vaginal bleeding, infertility, miscarriages, any suspected abnormalities of the uterus, or as a preliminary evaluation for in-vitro fertilization. You will have preliminary scans of your pelvis before the test.

The procedure itself takes from 5-10 minutes. A thin catheter is placed through the cervix into the uterus. A salt water solution is instilled through the catheter in order to allow us to see the inside of the uterus and check the fallopian tubes. Premedication is not given as it affects the uterus' ability to contract.

This test should not cause any pain. However, during the procedure you may feel some cramping during catheter placement, or as the saline is being instilled, although, most patients tolerate it easily. After the test you may get a brownish discharge from the cleanser we use. Some patients may get spotting.

After the test, we request that you get dressed and sit in the waiting room for 5-10 minutes. Your doctor's office will have the results within a week.

Should you have any questions or comments, please feel free to ask our staff.

SONOHYSTEROGRAPHY QUESTIONNAIRE

Dear Patients: Please answer the following questions in order to assist us in evaluating your studies.

1. What day of your menstrual cycle is today. (The first day of bleeding is day one) _____

2. Are your cycles regular? __Yes __No
   If not please describe:_____

3. Do you have abnormal episodes of vaginal bleeding? (eg. periods which are unusual in
   amount of bleeding or in their timing, eg. post-coital, premenstrual, midcycle.
   Yes __No
   If so please describe:_____

4. Have you had an X-ray hysterosalpingogram (dye test)?
   __Yes __No

5. Have you been told by your doctor that you have fibroids?
   __Yes __No

6. Have you been told by your doctor that you have endometriosis?
   __Yes __No

7. Do you have allergies? __Yes __No
   If so please describe:_____

8. Have you even been pregnant?
   __Yes __No
   If so, how many times: _____

9. How many children have you had? _____

10. Have you ever had a D&C, endometrial biopsy, or gynaecological surgery? __Yes No
    If so, please describe:_____

11. Have you ever had PID (pelvic inflammatory disease)?
    __Yes __No

12. Do you have any other gynaecological complaints, such as pelvic pain?_____Yes No
    If so, please describe:_____

13. Do you have any medical conditions?
    __Yes __No
    If so, please describe:_____

14. Do you take any medication? __Yes __No
    If so, please describe:_____
    _____

15. Have you ever had an IUD? __Yes __No

16. Do you know if your mother took medication when she was pregnant with you?

Yes ___No

If so, please describe:_____

17. Do you want a copy of your results to go to your family doctor? ___Yes ___No

If so, please give name and address:_____

Name of Patient (please print) Date

MALE PELVIC SCANNING ROUTINE

A survey of the entire pelvis must be completed in both sagital and transverse planes to include the external iliac vessels.

1. Scan in the sagittal plane beginning in the midline at the level of the symphysis.

2. Angle the probe cephalad to view the urinary bladder. Adjust gains to make bladder appear as echo free as possible.

3. Check for smooth, thin bladder walls. Look for any abnormal echoes within the bladder. Attempt to view distal ureters.

4. In midline measure AP and longitudinal dimensions of the bladder.

5. Angle the probe from side to side to evaluate the right and left sides of the pelvis.

6. Turn the probe to a transverse position. Begin scanning in the midline at the level of the symphysis.

8. Angle the probe cephalad through the urinary bladder to evaluate it.

9. Take transverse measurement at widest point. Calculate volume.

10. Angle the probe caudad to evaluate the prostate gland. Take transverse measurement.

11. Sweep to both the right and left sides in a transverse plane.

12. Turn the probe to a sagital position and evaluate the prostate gland to the right and left and slightly beyond. Take AP and longitudinal measurements at midline (urethra). Calculate volume.

12. Evaluate seminal vesicles in both sagital and transverse.

13. ALWAYS DO A POST-VOID SCAN to demonstrate the amount of residual urine. Measure the bladder in the same way as pre-void.

14. Calculate the % residual urine in the following way:

volume (in cc) = L X W X H X .5233

$$\text{RATIO} \quad \frac{\text{Post-void volume}}{\text{Pre-void volume}} \times 100 = \_\_\_\_\_\% \text{ retention}$$

15. If a moderate amount of residual urine examine both kidneys and flanks.

NORMAL MEASUREMENTS:

PROSTATE $\rightarrow$4 x 3 x 2cm

TRANSRECTAL PROSTATE ULTRASOUND

1. a) With the patient in the supine position, scan the distended urinary bladder and prostate gland in the transverse and longitudinal sections.

   b) Calculate the volume of urine within the bladder.

2. a) Have the patient void as completely as possible.

   b) Measure the residual volume, if any, and calculate the percent retention.

3. a) Scan both kidneys as per standard abdominal routine.

   b) Measure the longitudinal length of each kidney.

5. Prepare the probe as in the endocavity probe preparation protocol. **BE SURE TO ASK THE PATIENT IF ANY LATEX SENSITIVITY.** With the patient in a left lateral decubitus position, insert the sheathed probe into the rectum with orientation dial facing sonographer.

   NOTE: insertion and removal of the transducer may be facilitated by asking the patient to perform the Valsalva manoeuvre.

5. a) Begin in a transverse plane. Scan the seminal vesicles and vas deferens from insertion to lateral end by rotating the probe.

   b) Scan the gland itself from the base to the apex in a transverse plane, paying particular attention to the internal echo pattern.

   c) Freeze images of the base, mid-gland, and apex. Measure transverse dimension at the largest portion of the gland.

6. a) Adjust the probe 90° to obtain a longitudinal view. Scan the right seminal vesicle from the insertion to the lateral end, measuring the diameter at the insertion site.

   b) Scan the left seminal vesicle in the same manner as the right.

   c) Scan the prostate from right to left, freezing and labelling successive images as to their relation to the midline. The midline image should include the urethra and verumontanum as landmarks. Longitudinal dimension should be measured at midline.

7. Calculate prostate volume as per the formula:

   (AP)(W) (L) (.5233)

TRUE NORTH IMAGING

PATIENT INFORMATION ON PROSTATE ULTRASOUND

You are scheduled to have a transrectal ultrasound examination of the prostate on

_____ at _____

This examination is a relatively new procedure designed to obtain detailed images of your prostate gland. The entire test usually takes between 30 and 45 minutes. To begin with, the technologist will use ultrasound to examine your bladder. Your bladder must be full for this part of the exam. Once this is complete, you will be shown to the washroom, where you can empty your bladder. The test continues with another ultrasound of your bladder, and your kidneys. Finally, a very small ultrasound camera will be gently inserted into your rectum to obtain images of your prostate. This is obviously somewhat uncomfortable, but rarely causes any pain. If you do feel any pain, be sure to inform the technologist doing the exam.

Preparation for this procedure is very important. You must drink 40 ounces (1.2L) of fluid. This can include water, juice, coffee, tea, etc. You must have completed drinking one hour prior to your appointment time. If you feel this may be a problem, you are welcome to come to the clinic early (one hour), and drink your fluids here. We will try to examine you as soon as possible, so that you won't be uncomfortable for too long. Eat the meal nearest your examination – There is no reason not to eat.

If you have any questions, feel free to call our office. A technologist will be happy to speak to you, or return your call if temporarily unavailable.

TRUE NORTH IMAGING

ENDORECTAL (TRANSRECTAL) ULTRASOUND EXAMINATION CONSENT FORM

An endorectal diagnostic ultrasound examination allows the ultrasound transducer (probe) to be placed internally in close proximity to the pelvic organs and is performed to obtain further diagnostic information concerning the prostate gland and surrounding regions.

The following procedure will be followed by the technologist:

1. The endorectal ultrasound probe will be covered in a sterile sheath as well as a lubricant (usually KY jelly). The technologist will be wearing gloves.

2. The technologist will carefully insert the ultrasound probe into the rectum.

3. The technologist will position and then reposition the ultrasound probe as necessary to obtain the necessary diagnostic information.

4. The patient may experience some discomfort, but should not experience any pain with this examination. **The technologist will immediately stop the examination and remove the probe at any time, at the patient's request.**

5. The diagnostic information obtained will be reported by a Radiologist and the written report of the examination results will be sent to your physician.

Please advise the technologist of any latex sensitivity or allergy before signing this consent.

If you have any questions, please ask before signing this consent.

I, _____ consent to allow _____
(technologist) to perform an endorectal ultrasound examination.

Date: _____ Signature: _____

Technologist:_____

TESTICULAR ROUTINE

Patient Position: Supine with the ankles crossed and knees squeezed together.

Ask the patient to ensure the penis is located over the pelvis.

Roll a gown lengthways and place it under the scrotum with the ends tucked tightly under the patient's buttocks.

Place a drape over the patient's legs and bring the gown down over the penis, have the patient hold the sides of the gown tightly (the only area exposed is the scrotum).

With scanning hand gloved, demonstrate on 1 image using multiple focal zones, both testes in the transverse plane to compare echogenicity and scrotal skin thickness.

The left and right hemiscrotum are now imaged separately. Start with the unaffected side. Indicate on the screen which testicle, and plane, is being scanned. In the transverse plane scan through testis superior to inferior pole. Measure at the widest part. It may be necessary to use a split screen for proper measurements. In the longitudinal plane scan through from one side to the other side. Longitudinal and AP measurements should be taken at the longest axis of the testis.

Identify the epididymis and scan the length of the epididymis from head to tail. Measure the head in at least two dimensions and check for cysts or solid masses (measure, when found, in 3 planes). Document the comparative echo pattern of the epididymis in relation to the testis. Use a split screen to compare the right epididymal head and tail to the left side.

Scan the remainder of the scrotum to search for fluid collections or masses.

Now do the affected side.

When the indication is scrotal pain, blood flow in both testes and epididymal heads should be documented.

If dilated veins (varicoceles) are noted or if the physician is questioning a varicocele , measure the diameter of the veins with and without the Valsalva manoeuvre and apply Colour Doppler. If necessary, the scanning procedure outlined above can be duplicated in the upright position after the patient has been standing for at least three minutes.

NORMAL MEASUREMENTS:

Testis → 2 - 4 cm wide
→ 3 cm AP

→ 4-5 cm long
→ epididymal head = 0.7-1.0 cm maximum

NOTE: size and weight decreases with age.

FOR SUSPECTED TORSION:

1. a) With the patient in the supine position, scan the aorta in transverse and longitudinal views, as per general abdominal routine.

   b) Obtain a Doppler spectrum of the lower aorta, and measure peak velocity.

2. a) Scan the common and external iliac arteries in a longitudinal view on both the right and left side.

   b) Obtain a Doppler spectrum of the external iliac artery, and measure the peak velocity.

3. Scan both the right and left common and superficial femoral arteries. Measure peak velocity from the Doppler spectrum at a point in the superficial femoral artery 2 cm distal to the bifurcation.

4. Drape the patient as per a normal testicular routine.

5. a) Scan both testes as per **Testicular Routine.**

   b) Measure each testicle in three dimensions (AP, transverse and longitudinal).

6. a) In the longitudinal view, locate the spermatic cord running superior from the unaffected testicle. Look for a pulsatile area, and place the cursor in that area. Adjust the transducer/cursor slightly as needed to obtain a clear Doppler spectrum. Measure the peak systolic flow. Use Colour Doppler if under to obtain systolic flow.

   b) Attempt to locate an intratesticular vessel, and obtain a Doppler spectra. Use Colour Doppler if unable to obtain systolic flow.

   c) Repeat this procedure for the affected testicle.

THYROID ROUTINE

1. Place the patient in a supine position with their neck hyperextended.

2. Have the patient swallow. You should be able to palpate the thyroid gland by using both thumbs and running them along the patient's neck using the trachea as a guide.

3. Demonstrate both lobes on 1 image to compare size and echogenicity.

4. With the patient’s head turned away slightly from the side being scanned, scan the unaffected lobe of the gland using multiple focal zones. Scan sagitally from the Carotid Artery to trachea. Measure length and AP dimensions at the longest portion. A split screen may be necessary to accommodate the entire length.

5. Scan in a transverse plane from superior to inferior poles. Measure at the widest point.

4. Demonstrate the isthmus in both sagittal and transverse planes. Measure the AP thickness.

5. If a "nodule" is found, determine its echo characteristics (cystic, solid or complex) and measure it in three dimensions. Apply Colour Doppler. By palpation, determine if the nodule seen on ultrasound corresponds to a nodule that can be felt on the examination.

6. Scan along the carotid vessel in both sagittal and transverse planes for the presence of any extra-thyroid nodules or lymph nodes. If parathyroid glands (usually 2 superior and 2 inferior) are noted measure in 3 dimensions and note location.

NORMAL MEASUREMENTS

Thyroid → 1-2 cm cross-section
→ 4-6 cm length

Isthmus → 1 cm

Parathyroid → 5 x 3 x 1 mm

PAROTID GLAND

1. The patient should be in a supine position with their neck slightly hyperextended, and their head obliqued away from the side being scanned.

2. Start with the unaffected parotid gland and scan it in a transverse plane beginning at the superior border. Remember to include the portion of the gland that lies on the face. Measure at the widest point.

3. In a longitudinal plane scan, once again, through the glandular tissue. Measure AP and longitudinal measurements at the longest point.

4. Scan down the carotid chain to the base of the neck looking for any lymph node involvement.

5. If necessary, move to the submandibular gland under the angle of the mandible and scan it in both transverse and longitudinal planes.

6. Repeat the procedure for the affected side.

Careful attention must be paid to the proper labelling of the images since glandular tissue appears the same in all locations. Therefore the parotid gland must be labelled PAROTID, and the submandibular gland must be labelled SUBMANDIBULAR.

BREAST ULTRASOUND

Use the highest transducer frequency as possible to allow penetration to the chest wall. Multiple focal zones must be used. Adjust gain curve (TGC) so fatty tissue appears as medium gray-level echoes. All other echo textures in the breast should be compared to the fat.

The patient is in a supine position rotated slightly away from the breast of interest (to flatten breast on chest wall) with the ipsilateral arm positioned under the head. Divide each breast into quadrants, eg:

RUOQ	-- right upper outer quadrant
RLOQ	-- right lower outer quadrant
RLIQ	-- right lower inner quadrant
RUIQ	-- right upper inner quadrant

Make sure the appropriate label is on the screen and then complete sagittal and transverse scans of each quadrant.

Label the nipple and scan through.

AXILLA: Do transverse and sagittal scans.

NOTE: If a mass is identified, it must be scanned meticulously, altering TGC curve, power settings, etc. to determine whether it is cystic, solid or complex. Measure the mass in three planes, note its location and distance from nipple, and determine if it corresponds to a palpable mass. Measure the distance from skin surface to anterior wall of the mass. Apply Colour Doppler.

Radial Scanning

Radial scanning is to be employed:

1. when investigating a suspicious area found on a mammogram
2. when ultrasound examination displays an abnormality (ie. cystic or solid lesion)
3. when a patient presents with a history of a palpable lump.

In these circumstances, along with the standard scan planes, the quadrant of interest should be scanned radially and anti-radially. When a definite lesion is identified, the lesion should be scanned separately in a radial/antiradial fashion. If imaging a superficial area of the breast use a standoff pad.

Scanning is to be orientated using the clock face annotations and identifying the distance from the nipple to the lesion. Measure the distance from skin surface to anterior wall of the mass. Apply Colour Doppler. Area of tissue plane disruption should be documented. Ductal dilatation and/or calcifications should be documented.

Radial Plane

When scanning a quadrant begin radially and scan the entire quadrant in a rotational fashion using the nipple as the central pivoting point. When scanning a specific area line the area up with the nipple and scan parallel to the scan plane.

Anti-radial Plane
When scanning a quadrant, bisect the radial plane and scan the entire quadrant with all sweeps converging at the nipple. When scanning a specific area, line the area up with the nipple and scan perpendicularly to the scan plane.

(for additional information and scanning diagrams please refer to page USPRO 64)

TRUE NORTH IMAGING

RADIAL/ANTIRADIAL SCANNING TECHNIQUE FOR BREAST ULTRASOUND

Radial scanning has been suggested as an adjunct to traditional transverse and longitudinal scanning of the breast because it evaluates growth along the tissue plane.

ANATOMY:

The breast is composed of 15 to 20 lobes. Ducts extend from the lobes through the parenchyma to converge at the nipple. Cooper's ligaments extend radially as well. Due to the pathophysiology of cancerous growths, malignant nodules may have projections which extend radially within the duct toward or away from the nipple, following the direction of the tissue plane. For this reason, traditional transverse and longitudinal scanning may provide a false negative (ie. The appearance of a cluster of simple cysts).

Location of Mass **Longitudinal Plane**

-diagrammatic representation of the appearance of a benign lesion

If the same area were scanned radially/antiradially, the results may show a projection toward or away from the nipple. This may indicate ductal extension or a lobular shape. Terms for this appearance include “tennis racquet” or “frying pan”.

Location of Mass

Radial Plane
-diagrammatic representation of a lobulated mass with ductal extension

METHOD:

Radial scanning is to be employed:

1. When investigating a suspicious area defined on a mammogram.
2. When ultrasound examination displays an abnormality (ie. Cystic or solid lesion)
3. When a patient presents with a history of a palpable lump

In these circumstances, along with the standard scan planes, the quadrant of interest should be scanned radially and antiradially. When a definite lesion is identified, the lesion should be scanned separately in a radial/antiradial fashion.

Scanning is to be orientated using the clock face annotations and identifying the distance from the nipple to the lesion.

RADIAL SCANNING

When scanning a quadrant, begin radially and scan the entire quadrant in a rotational fashion (see diagram below) using the nipple as the central pivoting point. When scanning a specific area line the area up with the nipple and scan parallel to the scan plane.

Radial Quadrant Scan
ie. From 12 o'clock through 3 o'clock

Radial Scan of a Specific Lesion
-plane joining the mass to the nipple

ANTIRADIAL SCANNING

When scanning a quadrant, bisect the radial plane and scan the entire quadrant with all sweeps converging at the nipple. When scanning a specific area, line the area up with the nipple and scan perpendicularly to the scan plane.

Antiradial Quadrant Scanning

Antiradial Scan of a Specific Area

TRUE NORTH IMAGING

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TECHNOLOGIST PRELIMINARY OBSERVATION WORKSHEET

****THIS EXAMINATION HAS NOT YET BEEN REVIEWED BY A RADIOLOGIST****

PATIENT NAME:_____ CASE #: _____

AGE: _____ DATE: _____ REFERRING PHYSICIAN: _____

Type of exam: BREAST ULTRASOUND (RIGHT _____ LEFT _____ BILATERAL _____)

DLMP: _____

Pertinent history: (please attach the completed mammo questionnaire form to this worksheet)
_____
_____
_____

N ABN N ABN

Right Left

_____
_____
_____
_____
_____
_____

Tech Initials _____

BAKER'S CYST

1. The patient should be placed in a prone position with a small angle sponge or pad under the ankle of the leg being examined.

2. The tissues of the posterior leg should be imaged from the femoral condyles to the mid portion of the calf or full extension of the fluid collection, in a transverse plane.

3. Repeat in longitudinal plane demonstrating the entire popliteal fossa.

4. Careful documentation of the popliteal artery and vein must be included, watching the pulsations of the artery, and demonstrating augmentation of the vein following compression. Apply Colour Doppler if necessary.

5. If a Baker's cyst is detected separation of the mass from the popliteal vessels must be documented.

6. A Baker’s Cyst will be a horse-shoe shaped fluid collection within the medial aspect of the popliteal fossa.

DUPLEX EVALUATION OF THE CAROTID ARTERIES

IMAGES TO BE OBTAINED

1. Longitudinal scans of the entire common carotid artery (CCA) from its origin to and beyond the bifurcation. Velocities must be obtained from at least two levels.

2. Longitudinal scans of the internal carotid artery (ICA) from the bifurcation, to its disappearance beyond the angle of the jaw. Velocities must be obtained from at least two levels.

3. Longitudinal scans of the external carotid artery (ECA) from the bifurcation, to its disappearance beyond the angle of the jaw. Velocities must be obtained from at least one level.

4. Transverse scans of the entire common carotid artery.

5. Transverse scans at the bifurcation, bulb and both the internal and external carotid arteries as far as possible distally.

6. Longitudinal scans of the vertebral arteries (VA). Velocities must be obtained from at least one level.

PLAQUE IDENTIFICATION AND CHARACTERIZATION

1. In addition to routine images, additional images must be taken at any level where plaque is identified.

2. Magnification views of areas of plaque may be helpful.

3. Observations should be made as to the echogenicity, surface characteristics, homogenicity, the extent of narrowing of the lumen, the extent of the plaque along the course of the vessel, and location.

DOCUMENTATION: GENERAL CONSIDERATIONS

Doppler assessment of the vessels being examined should be made to determine the presence/absence, direction and velocity of flow, as well as the velocity waveform profile. Additionally, qualitative or quantitative assessments of blood flow turbulence must be made. Spectral analysis is always performed.

SAMPLE SIZE

1. The axial length of the sample size should be adjusted so that it is approximately _-½ the diameter of the vessel.

2. Sizes that are too small may limit the ability to determine the presence/absence of flow.

3. Sample sizes which are too large may produce slightly increased bandwidth measurements, and signal interference from adjacent vessels.

DOPPLER FLOW ANGLE

1. In general, the more parallel to flow the beam is the better the Doppler signals will be. It is commonly necessary, however, to use angles which are more perpendicular to flow. This may be due to the course of the vessel, or it may be necessary to reduce problems associated with signal aliasing.

2. The beam to flow angle should ideally be less than 60°. In cases where tortuous vessels are encountered, the beam angle may be increased to a maximum of 70°. Spectral analysis of Doppler velocity signals above 70° are unreliable.

DOPPLER RECORDINGS

1. The routine Doppler examination should include, at minimum, samples obtained in each of the carotid vessels.

2. Additional samples must be recorded at any level in the vessel where plaque is identified proximal, within and distal to the plaque.

3. Doppler readings of the vertebral and orbital directional Doppler are done routinely to document the direction of flow.

4. Calculate velocity ratio: $\frac{\text{ICA Peak Systolic Velocity}}{\text{CCA Peak Systolic Velocity}}$

STENOSIS MEASUREMENTS

1. At any area where a stenosis is demonstrated, velocity recordings should be obtained just proximal to the stenosis, at the point of maximum stenosis, and immediately distal to the stenosis.

2. If calcified plaque interferes with the ability to obtain Doppler signals at the point of suspected stenosis, the transducer position on the neck should be readjusted to attempt to position the beam so that the shadowing does not obscure the Doppler signal. Positioning the transducer Caudad or Cephalad to the plaque and directing the beam more parallel to the vessel may also aid in obtaining useable Doppler signals for stenosis measurement by spectral analysis.

SUSPECTED OCCLUSION

-techniques to avoid false positive diagnosis of occlusion

1. Increase the sample size to at least the diameter of the vessel.
2. Increase the Doppler gain until background noise is barely heard.
3. Sample at multiple areas within the vessel. Lack of signal may be due to interference from calcified plaque. **Demonstration of flow immediately distal in the vessel precludes the diagnosis of complete occlusion.**

4. Obtain samples in the internal and external carotid arteries. These vessels may still be patent as a result of collateral flow even in the presence of common carotid artery occlusion. Apply Colour Doppler.

DOPPLER EVALUATION OF THE ARTERIES OF THE LOWER LIMBS

Vessels of Interest:

-Aorta

-Iliac Arteries (common and external when visualized)

-Femoral Arteries

-Popliteal Arteries

-Ankle Arteries

DOPPLER RECORDINGS

General Principles:

1. Adjust the doppler angle to the vessel in the 55°-70° range by visual inspection to minimize noise and maximize the clearest signal.

2. The beam to flow angle should ideally be less that 60°. In cases where tortuous vessels are encountered, the beam angle may be increased to a maximum of 70°. Spectral analysis of Doppler velocity signals over 70° are unreliable.

Equipment Settings (DRF 400):

Transmit Power	8 dB
FFT	20 ms
High Pass Filter	200 Hz
Sample Volume	2.7 mm
Time Base	2 sec (or as required)
Frequency Window	as required

Aortoiliac Branches:

In the lower abdomen on either side of the midline, identify the aortic bifurcation and main pelvic branches (common and external iliac arteries). In the case of each vessel, using the equipment settings shown above, record peak velocities and perform spectral analysis.

Femoral/Popliteal Branches:

In each leg, identify the common femoral artery just above the level of the inguinal ligament (usually where it is most easily palpable). Using the equipment settings shown above, record peak velocities, and perform

spectral analysis in the common femoral, profunda, superficial femoral and popliteal arteries.

ANKLE/ARM PRESSURES

STRESS: At the beginning of the examination, have the patient walk on a treadmill at 1.5 MPH and a 7.5% grade for five minutes or until symptoms force the patient to stop. If a treadmill is not available stairs will do. Immediately after exercise, return the patient to the table and record both ankle pressures (posterior tibial) and the left arm (brachial) pressure.

RELAXED: After the Doppler ultrasound examination then do your ankle and arm pressures again.

B SCAN EVALUATION OF THE LOWER LIMBS

Obtain images of the above named vessels in the longitudinal and transverse planes. Note pulsatility.

Additional views should be taken at any level where plaque is identified.

Magnification views of areas of plaque may be helpful.

Observation should be made as to the echogenicity, surface characteristics, homogeneity, extent of narrowing of the lumen, and extent of plaque along the course of the vessel, and its location.

STENOSIS:

In areas of accumulation of plaque where more than 30% of the lumen is compromised, measurements should be obtained in the longitudinal and transverse views, in order to identify the percent diameter stenosis, and residual lumen calculation.