

**Female Pelvis
(Uterus, Cervix, and Vagina)**

1) Other Names:

- None

2) Definition/Location

- The wolffian and mullerian ducts form the male and female genital tracts (Curry-Tempkin, p. 249, 2/5/3).

Pelvic Musculature Anatomy

False Pelvis

- The psoas major muscles are prominent paired muscles extending across the posterior wall of the abdominopelvic cavity. These muscles originate at the lateral aspects of the lower thoracic vertebra and descend inferiorly through the false pelvis in the pelvic sidewalls. In the false pelvis they join the iliacus muscles to form the iliopsoas muscle (Curry-Tempkin, p. 253, 1/3/1), (Hagen-Ansert, p. 857, 1/2/2), (Curry-Tempkin, p. 253, Fig. 16-8).

True Pelvis

- The piriformis muscles are flat, triangular muscles that arise from the anterior sacrum and pass through the greater sciatic notch on the posterior aspect of the innominate bone to insert into the superior aspect of the greater trochanter of the femur (Hagen-Ansert, p. 857, 1/3/2).
- Obturator internus muscles are triangular sheets of muscle that arise from the anterolateral pelvic wall and surround the obturator foramen. They pass out of the pelvic cavity through the lesser sciatic foramen where they insert into the superior aspect of the greater trochanter of the femur (Hagen-Ansert, p. 857, 2/1/1), (Hagen-Ansert, p. 857, Fig. 35-7).
- The pelvic diaphragm is formed by the levator ani and coccygeus muscles and makes up the floor of the true pelvis (Hagen-Ansert, p. 857, 2/1/2).
- The levator ani muscles are a group of three muscles that extend across the pelvic floor like a hammock. This group of muscles consists of the pubococcygeus muscles, the iliococcygeus muscles and the puborectalis muscles. These muscles provide primary support to the pelvic viscera and aid in the contraction of the vagina and rectum (Hagen-Ansert, p. 857, 2/1/4), (Curry-Tempkin, p. 254, 2/2/2) (Hagen-Ansert, p. 859, Fig. 35-8).
- Coccygeus muscles are the most posterior muscle pair of the pelvic diaphragm. These muscles extend from the ischial spine to the sacrum and coccyx (Curry-Tempkin, p. 254, 2/2/3).

Broad Ligaments Anatomy

- The broad ligaments are a double-fold of peritoneum that drape over the fallopian tubes, uterus, and ovaries. They extend from the lateral sides of the uterus to the sidewalls of the pelvis. This ligament provides little support to the uterus, and it contains the uterine blood vessels and nerves. The upper fold of this ligament is called the mesosalpinx, which encloses the fallopian tube as it extends from the cornua of the uterus. The posterior portion of the broad ligament that encloses the ovary is the mesovarium (Hagen-Ansert, p. 862, 2/1/1), (Hagen-Ansert, p. 863, Fig. 35-12).
- The spaces within the peritoneal cavity located posterior to the broad ligaments are referred to as the adnexa (Curry-Tempkin, p. 254, 2/3/1).

Uterus

- The uterus and vagina are derived from the embryonic müllerian (paramesonephric) ducts as they elongate, fuse, and form a lumen between the 7th and 12th weeks of embryonic development (Hagen-Ansert, p. 860, 1/1/1).
- The uterus lies in the true pelvis between the bladder and the rectum (Curry-Tempkin p. 258, 2/1/1).
- The uterus is pear-shaped; its rounded superior portion is the fundus and its inferior tapering portion is the cervix, or the neck. The middle portion of the uterus is referred to as its body (Tempkin p.184 “Anatomy”), (Curry-Tempkin p. 258, Fig. 16-14).
- The fundus of the uterus is the widest and most superior portion of the uterus. At its lateral borders are the cornua, where the fallopian tubes enter the uterine cavity (Hagen-Ansert p. 860, 2/1/2), (Curry-Tempkin p. 278, Fig.16-38).
- The body or corpus of the uterus lies between the fundus and the cervix and is the largest portion of the uterus. It is also continuous with the uterine cervix at a point marked by a constriction of the uterus called the isthmus. (Hagen-Ansert p. 860, 2/2/4), (Curry-Tempkin p. 259, 1/3/4), (Curry-Tempkin, p. 259, Fig. 16-15).
- The uterine cavity is continuous with the centrally located vaginal canal (Tempkin p.184 “Anatomy”).
- The uterine wall consists of three layers: the serosa or perimetrium, the myometrium, and the endometrium (Hagen-Ansert, p. 861, 2/2/1).
- The serosa is the thin membrane that covers the myometrium and forms the outer layer of the uterus (Curry-Tempkin, p. 259, 1/2/1).
- The next layer is the myometrium or the muscular layer which forms the bulk of the uterus. It is composed of three distinct layers of different muscle fibers. This combination of fibers is responsible for the myometrium dramatically enlarging during pregnancy and producing the radial muscle contractions necessary to expel the fetus at parturition (Curry-Tempkin, p. 259, 1/1/1).
- The innermost layer of the uterine wall is the mucosal layer, or endometrium, which is continuous with the vaginal epithelium inferiorly and uterine tube mucosa superolaterally. It consists of two layers: superficial (functional) and deep (basal) layer. The functional layer increases in size during the menstrual cycle and partially sheds off at the time of menses. The deep basal layer is

- composed of dense cellular stroma and mucosal glands; it is not significantly influenced by the menstrual cycle (Curry Tempkin, p. 258, 2/1/3).
- The uterus can be found in five different positions. These positions being anteverted (entire uterus tipped forward), anteflexed (body and fundus folded anteriorly towards the cervix), retroverted (entire uterus tilted backwards), retroflexed (body and fundus folded posteriorly upon the cervix and a combination of retroversion with retroflexion. The average positions are anteverted and anteflexed (Hagen-Ansert, p. 862, 2/2/1), (Hagen-Ansert, p. 864, Fig. 35-14), (Curry-Tempkin, p. 261, Fig. 16-17).

Uterine Vasculature

- The uterine artery is a branch of the internal iliac artery and supplies blood to the reproductive organs of the pelvis. The left and right uterine arteries divide into vaginal and uterine branches at the level of the cervix. The uterine branches course along the lateral aspect of the uterus toward the fundus. The arterial and venous uterine branches are located within the peritoneal folds of the broad ligament. The uterine branches of each uterine artery give rise to the arcuate arteries. These arteries loop around the uterus and branch into the radial arteries. The radial arteries penetrate the myometrium and give rise to the straight arteries. The straight arteries supply the endometrial tissue, with smaller branches, called the spiral arteries. Flow in the spiral arteries is responsive to hormonal changes of the menstrual cycle. The venous drainage of the uterus is analogous to its arterial supply (Curry-Tempkin, p. 263, 2/1/1).

Cervix

- The cervix is the lower cylindrical portion of the uterus that projects into the vaginal canal (Hagen-Ansert, p. 861, 1/1/1), (Curry-Tempkin, p. 259, 1/3/6).
- The endocervical canal extends 2 to 4 cm from its internal os or opening, at approximately the same level as the isthmus and joins the endometrial canal (uterine canal) to its external os, which projects into the vaginal vault. The cervix protrudes into the upper portion of the vaginal canal forming four archlike recesses called fornices (Curry-Tempkin, p. 259, 1/3/7), (Hagen-Ansert, p. 858, 2/2/1).

Vagina

- The vagina is a collapsed muscular tube that extends from the external genitalia to the cervix of the uterus (Hagen-Ansert, p. 858, 2/2/1), (Curry-Tempkin, p. 258, 1/1/1).
- It lies posterior to the urinary bladder and urethra, and anterior to the rectum and anus. It is normally directed upward and backward, forming a 90-degree angle with the uterine cervix (Hagen-Ansert, p. 858, 2/1/2).
- The uterine cervix protrudes through the anterior vaginal wall into the upper portion of the vaginal canal. The space within the vaginal canal encircling the cervix forms the anterior, posterior, and lateral fornices of the vagina (Curry-Tempkin, p. 258, 1/1/4).

- The vaginal canal's anterior and posterior walls normally touch. It is a passageway for menstruation and is easily distended during sexual intercourse and childbirth (Hagen-Ansert, p. 858, 2/1/4).

3) Sonographic Appearance

Pelvic Musculature

- The filled urinary bladder displaces the bowel and acts as an acoustic window for evaluating major pelvic muscles. Many times these muscles can be mistaken for ovaries, fluid collections, or masses. To distinguish the pelvic muscles, two planes should be observed, and a symmetric bilateral arrangement indicates that they are muscles (appears tubular in the longitudinal axis) (Hagen-Ansert, p. 887, Fig. 36-19).
- The obturator internus muscles are located in the lesser or true pelvis, and can be seen at the posterior lateral corners of the bladder at the level of the vagina and cervix. They are hypoechoic, ovoid, thin, and linear with low-level echoes (Curry-Tempkin, p. 275, 1/2/2).
- The levator ani muscle is best visualized in transverse with superior angulation at the most inferior portion of the bladder. This muscle is hypoechoic, hammock-shaped, medial, caudal, and posterior to the obturator internus (Hagen-Ansert, p. 888, Fig. 36-21).
- The piriformis muscles are located on either side of the midline and can be visualized posterior to the uterine fundus and anterior to the sacrum. This is the most common muscle to be mistaken for the ovary (Hagen-Ansert, p. 886, 2/1/5).
- The muscles of the pelvic diaphragm (pubococcygeus, iliococcygeus [levator ani muscles], coccygeus) are the easiest to visualize in transverse views of the most inferior portions of the true pelvis. These bilateral muscles are seen medial to the obturator internus muscles adjacent and posterior to the cervix and vagina (Curry-Tempkin, p. 275, 2/2/1), (Curry-Tempkin, p. 275 and 276, Figs. 16-32 and 16-33).

Pelvic Vasculature

- Pelvic vascularity can easily be evaluated using real-time and Doppler imaging. The internal iliac vessels can almost always be visualized and used as a landmark for the lateral pelvic wall and ovary (lateral and deep to ovary). To differentiate the vessels from an ovarian cyst, apply color Doppler or rotate on the structure to elongate a vessel into a tube (Hagen-Ansert, p. 887, 1/2/1).
- The uterine vessels lie lateral to the cervix and lower uterine segment at the level of the internal os (Hagen-Ansert, p. 887, 2/1/2).

Uterus Sonographically

- The outer serosa is not visualized sonographically (Hagen-Ansert, p. 888, 2/2/1). The myometrium is homogenous with smooth-walled borders. Any areas of increased or decreased echotexture should be noted and measured. The endometrial basal layer appears highly echogenic due to the reflective mucosal glands that compose the layer. The superficial layer (zona functionalis) appears hypoechoic compared with the zona basal (Curry-Tempkin, p. 278, 1/3/2).

- The central, linear, opposing surfaces of the endometrium that form the endometrial canal present sonographically as a bright, reflective, thin, midline strip, called the endometrial stripe that varies in intensity and thickness depending on the menstrual phase and patient age. The endometrium is greatest near the uterine fundus and narrows toward the cervix (Curry-Tempkin, p. 278, 2/1/2).
- During the menstrual cycle (days 1-4), the endometrium appears thin and bright as the superficial layer is shed. In the early proliferative phase (days 5-9), the endometrium measures about 4-8 mm thick and appears linear and hyperechoic to surrounding structures. In the late proliferative phase (days 10-14), the functional zone of the endometrium thickens under the influence of estrogen and is hypoechoic compared with the bright, echogenic basal layer (Curry-Tempkin, p. 279, 1/2/2).
- Just prior to ovulation (day 14), the endometrium measures about 6-10 mm and takes on the three-layered appearance. The bright endometrial stripe is surrounded by the thickened, hypoechoic, functional zone. The functional zone is separated from the inner layer of the myometrium by the fairly thin hyperechoic basal layer. This layered appearance continues during the early secretory phase when the endometrium achieves its maximum echogenicity and thickness from 7 to 14 mm (Curry-Tempkin, p. 279, 1/2/5), (Curry-Tempkin, p. 280, Fig. 16-40).
- During the secretory phase (days 15 to 28), the functional zone is even thicker and edematous from the influence of progesterone and becomes isoechoic to the basal layer (Curry-Tempkin, p. 279, 1/2/6), (Curry-Tempkin, p. 281, Fig. 16-41).
- In postmenopausal women, the endometrium usually measures less than 8 mm (Curry-Tempkin, p. 279, 1/2/7).

Cervix Sonographically

- The body of the uterus is separated from the cervix by the isthmus at the level of the internal os and is identified by the narrowing of the canal. Muscular wall tissue should be homogenous to the uterus with mid- to low-gray echoes surrounding the thin, hyperechoic endocervical mucosal lining (Hagen-Ansert, p. 889, 2/2/1), (Curry-Tempkin, p. 281, Fig. 16-43).
- The endocervical canal is a continuation of the endometrial canal and appears as a fairly thin, bright echogenic stripe (Curry-Tempkin, p. 279, 2/4/3).
- It is normal to occasionally see anechoic fluid in the endocervical canal, particularly during the preovulatory phase. To help distinguish the uterus from the cervix, locate the shadows that are cast by the vaginal fornices surrounding the external os of the cervix (Curry-Tempkin, p. 279, 2/4/4), (Curry-Tempkin, p. 282 and 283, Figs. 16-44 and 16-45).

Vagina Sonographically

- The vagina can be identified in the inferior portion of the pelvis between the urinary bladder (anteriorly) and the rectum (posteriorly) (Curry-Tempkin, p. 277, 2/2/1).
- Longitudinally, the vagina appears as a tubular extension of the uterus. In transverse, the vagina has a flattened, oval shape (Curry-Tempkin, p. 277, 2/2/2), (Curry-Tempkin, p. 277 and 278, Figs. 16-36 and 16-37).

- The muscular vaginal walls appear low gray and homogenous with smooth contours. The central mucosal lining of the normally collapsed vaginal canal walls appears thin, linear, and bright. The muscles of the pelvic diaphragm and any fluid in the posterior cul de sac (Pouch of Douglas) can be visualized posterior to the vagina (Curry-Tempkin, p. 277, 2/2/1).

4) Normal Size Range(s):

Uterus

- The size of the uterus varies with age and parity (Hagen-Ansert, p. 860, 2/1/2).
- The average menarchal and nulliparous adult uterus measures approximately 6 to 8 cm in length, and 3 to 5 cm in width and anteroposterior dimensions (Hagen-Ansert, p. 860, 1/1/3).
- The ranges of a premenarchal uterus are 1.0 to 3.0 cm long by 0.5 to 1.0 cm wide (Hagen-Ansert, p. 861, Box 35-7).
- The ranges of an adult parous uterus are 8-10 cm in length and 5 to 6 cm in width and anteroposterior dimensions (Hagen-Ansert, p. 861, Table 35-1).
- The ranges of a postmenopausal uterus are 3 to 5 cm in length and 2 to 3 cm in width and anteroposterior dimensions (Hagen-Ansert, p. 861, Table 35-1).

Cervix

- The cervical canal is 2.4 cm in length (Curry-Tempkin, p. 294, "Normal Measurements").

Vagina

- The vaginal canal is 10 cm in length (Hagen-Ansert, p. 858, 2/2/4).

5) Pertinent Lab (Curry-Tempkin, p. 293, "Laboratory Values):

- **Human Chorionic Gonadotropin (hCG):** A highly accurate blood pregnancy test. This hormone is produced by the placental trophoblastic cells and plays an important role during the first trimester of pregnancy. Once the fertilized egg is implanted, the placenta releases hCG. HCG can be detected in the blood before the first missed menstrual period, as early as six days after implantation. HCG helps to maintain pregnancy and affects the development of the fetus. Levels of hCG increase steadily in the first 14 to 16 weeks following the last menstrual period (LMP), peak around the 14th week following the LMP, and then decrease gradually. The amount that hCG increases early in pregnancy can provide information about the pregnancy and the health of the baby (i.e. detecting down syndrome). HCG may also be produced abnormally by certain tumors, especially those that develop from an egg or sperm (germ cell tumors). Therefore, hCG levels are usually tested in a woman who may have cancer of the ovaries or abnormal tissue growing in her uterus instead of a normal fetus (http://www.webmd.com/hw/being_pregnant/hw42062.asp).
- **Leukocytosis:** An abnormally high serum white blood cell count (exceeding 10,000 per cubic mm). This condition is indicative of an infectious process (such as pelvic inflammatory disease).

- **Hysterosonography:** A sonograph used to examine the endometrium and uterine cavity. It is often used to investigate uterine abnormalities in women who experience infertility or multiple miscarriages. Hysterosonography is also used to evaluate unexplained vaginal bleeding. Such conditions can result from uterine abnormalities such as congenital defects, masses, adhesions (or scarring), polyps, fibroids, or atrophy (<http://www.radiologyinfo.org/en/pdf/hysterosono.pdf>).
- **Estrogen/Progesterone:** These hormones are produced by the ovary during the normal menstrual cycle. Serum concentrations of these hormones can be useful in evaluating ovulatory function. An increase in progesterone can indicate pregnancy, cancer of ovaries or adrenal glands, molar pregnancy (mass of abnormal placental growth in uterus that triggers symptoms of pregnancy), or overproduction of hormones by adrenal glands. A decrease in progesterone levels can be indicative of an ovulation problem or possible miscarriage (http://www.webmd.com/hw/healthy_women/hw42146.asp)

6) Patient Prep (Tempkin, p. 186, “Patient Prep”), (Hagen-Ansert, p. 874, 2/2/1):

- Before the exam begins, it is critical to obtain a complete medical history of the patient. Usually a routine patient questionnaire is used to request the following information: date of last menstrual period, gravidity, parity, physiological menstrual status, hormone regimen, symptoms, history of cancer, family history of cancer, past pelvic surgeries, laboratory tests, previous Pap or biopsy results, and pelvic examination findings.
- Review all previous images and studies to help in determining whether a mass was previously present and to assess if there has been any change in size or internal characteristics.
- Full urinary bladder required of the patient.
- 32 to 40 ounces of clear fluid should be ingested one hour before the exam and finished within a 15- to 20-minute time period.
- If for any reason the patient cannot have fluids, sterile water can be used to fill the bladder through a Foley catheter.

7) Transducer Frequency (Tempkin, p. 186, “Transducer”):

- 3.0 MHz or 3.5 MHz.
- 5.0 MHz for thin patients.

8) Protocol (Tempkin, p. 192, “Required Images”):

- About 10 images required to scan the female pelvis (more if pathology/abnormality is present).
- Longitudinal image of the midline of the pelvic cavity just superior to the symphysis pubis.
- Longitudinal image of the right adnexa that may include part of the uterus depending on its lie.
- Longitudinal image to include the right lateral wall of the bladder and pelvic side wall.
- Longitudinal image of the left adnexa that may include part of the uterus depending on its lie.

- Longitudinal image to include the left lateral wall of the bladder and pelvic side wall.
- Long axis image of the uterus to include as much endometrial cavity as possible with and without uterine length (superior to inferior) and height (anterior to posterior) measurements.
- Transverse image of the vagina.
- Transverse image of the cervix.
- Transverse image of the uterus body.
- Transverse image of the uterus fundus with and without measurements.
- NOTE: It may be necessary to take a separate image of the endometrial cavity (with and without measurement).

9) Image Reference:

- Curry-Tempkin, p. 253, Fig. 16-8
- Curry-Tempkin, p. 258, Fig. 16-14
- Curry-Tempkin, p. 259, Fig. 16-15
- Curry-Tempkin, p. 261, Fig. 16-17
- Curry-Tempkin, p. 275, Fig. 16-33
- Curry-Tempkin, p. 276, Fig. 16-33
- Curry-Tempkin, p. 277, Fig. 16-36
- Curry-Tempkin, p. 278, Fig. 16-37
- Curry-Tempkin, p. 278, Fig. 16-38
- Curry-Tempkin, p. 280, Fig. 16-40
- Curry-Tempkin, p. 281, Fig. 16-41
- Curry-Tempkin, p. 281, Fig. 16-43
- Curry-Tempkin, p. 282, Fig. 16-44
- Curry-Tempkin, p. 283, Fig. 16-45
- Hagen-Ansert, p. 857, Fig. 35-7
- Hagen-Ansert, p. 859, Fig. 35-8
- Hagen-Ansert, p. 861, Box 35-7
- Hagen-Ansert, p. 861, Table 35-1
- Hagen-Ansert, p. 863, Fig. 35-12
- Hagen-Ansert, p. 887, Fig. 36-19
- Hagen-Ansert, p. 888, Fig. 36-21

10) References

- Curry, R.A. and Tempkin, B.B. (2006). *Sonography: Introduction to Normal Structures and Function* (2nd ed.). St. Louis, MO: Saunders.
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