Pelvic Anatomy

Robert E. Gutman, MD
Objectives

- Understand pelvic anatomy
  - Organs and structures of the female pelvis
    - Vascular Supply
    - Neurologic supply
  - Pelvic and retroperitoneal contents and spaces
  - Bony structures
  - Connective tissue (fascia, ligaments)
  - Pelvic floor and abdominal musculature

- Describe functional anatomy and relevant pathophysiology
  - Pelvic support
  - Urinary continence
  - Fecal continence
Abdominal Wall
Rectus Fascia Layers

- What are the layers of the rectus fascia above the arcuate line?
- What are the layers of the rectus fascia below the arcuate line?
Medial umbilical ligaments & folds
Median umbilical fold
Lateral umbilical folds
Bony Anatomy and Ligaments
The bony pelvis is comprised of 2 innominate bones, the sacrum, and the coccyx. What 3 pieces fuse to make the coccyx?

- Pubis
- Ischium
- Ilium
Median (sagittal) section

- Body of L5 vertebra
- False pelvis
- Lumbosacral (L5–S1) intervertebral disc
- Sacral promontory
- Greater sciatic foramen
- True pelvis
- Ischial spine
- Sacrospinous ligament
- Lesser sciatic foramen
- Sacrotuberous ligament
- Coccyx
- Ischial tuberosity
- Body of L4 vertebra

Anatomical landmarks:
- Iliac crest
- Intermediate zone
- Inner lip
- Iliac fossa (wing of ilium)
- Anterior superior iliac spine
- Arcuate line
- Anterior inferior iliac spine
- Iliopubic eminence
- Obturator canal
- Superior pubic ramus
- Pecten pubis (pectineal line)
- Pubic tubercle
- Symphyseal surface
- Obturator membrane
Clinical Pelvimetry

Which measurements can be made on exam?

- Inlet
- Midplane
- Outlet
- Diagonal conjugate
- Interspinous diameter
- Transverse diameter
- Anteroposterior diameter of pelvic outlet (varies 9.5–11.5 cm because of mobility of coccyx)

Female pelvis: anterior view

- Sacroiliac joint
- Sacral promontory
- Conjugate (~11 cm)
- Transverse (~13 cm)
- Oblique (~12.5 cm)
- Ischial spine
- Iliopubic eminence
- Pubic symphysis
- Ischial tuberosity

Female pelvis: inferior view

- Transverse diameter of pelvic outlet (~11 cm)
- Tip of coccyx
- Ischial tuberosity
- Ischial spine

Female: sagittal section

- Plane of inlet
- Conjugate diameter of inlet (~11 cm)
- Plane of outlet
- Anteroposterior diameter of outlet (9.5–11.5 cm)
Retrospective Case Control Study
MRI Pelvimetry

- Pelvic MRI 1998 – 2002
- Medical record review
  - Pelvic examination
  - Pelvic floor dysfunction symptoms
- 98 total women
  - 59 with pelvic floor disorders
  - 39 without pelvic floor disorders

Retrospective Case Control Study
MRI Pelvimetry

- Women with pelvic floor disorders:
  - Wider transverse inlet
  - Wider intertuberous diameter
  - Wider interspinous diameter
  - Greater sacroccocygeal length
  - Deeper sacral curvature
  - Narrower AP outlet

- After controlling for age, race and parity
  - Wider transverse inlet (OR 3.4, p = .006)
  - Shorter obstetrical conjugate (OR 0.2, p = .026)
  - Wider interspinous diameter (OR 2.8, p = .069)
Pelvic Vasculature

- Ovarian arteries originate from: Aorta
- Ovarian veins return to: IVC and Left renal vein
  - Below kidney, lateral/medial to ovarian A?
    - Lateral
    - Near pelvic brim, lateral/medial to ovarian A?
      - Medial
      - Over or under the uterine vessels?
        - Under
Branches of the Internal Iliac Artery

- Anterior Division
  - Obturator
  - Obliterated umbilical
  - Sup & Inf vesical
  - Uterine
  - Vaginal
  - Middle rectal
  - Pudendal

- Posterior Division
  - Iliolumbar
  - Lateral sacral
  - Superior gluteal
What is the collateral circulation after hypogastric artery ligation?
Pudendal Artery
Blood Supply to Colon/Rectum
Innervation to Levator Ani

- 12 fresh-frozen female cadavers
- Each innervated S3-5
  - S4 alone 30%
  - S3-4 40%
  - S4-5 30%
- No pudendal nerve supply identified
- Similar findings in rat studies


<table>
<thead>
<tr>
<th>Nerve</th>
<th>Root</th>
<th>Sensory</th>
<th>Motor</th>
<th>Presentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ilioinguinal</td>
<td>L1-L2</td>
<td>Suprapubic and inguinal region</td>
<td></td>
<td>Sharp, burning pain relieved with local anesthetic</td>
</tr>
<tr>
<td>Iliohypogastric</td>
<td>L2-L4</td>
<td>Medial Thigh</td>
<td>Adductors of leg</td>
<td>Difficulty ambulating and driving, sensory loss medial thigh</td>
</tr>
<tr>
<td>Obturator</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Femoral</td>
<td>Anterior Division L2-L4</td>
<td>Anterior thigh</td>
<td>Quadriceps (knee extension)</td>
<td>Unable to get out of bed</td>
</tr>
<tr>
<td></td>
<td>Posterior Division</td>
<td></td>
<td></td>
<td>Difficulty walking</td>
</tr>
<tr>
<td>Sciatic</td>
<td>L4-L5</td>
<td>Posterior Thigh</td>
<td>Hamstrings (knee flexion)</td>
<td>Patellar reflex absent</td>
</tr>
<tr>
<td></td>
<td>S1-S3</td>
<td>Anterior leg</td>
<td>Anterior lower leg (dorsiflexion of foot)</td>
<td>Pain radiating down posterior thigh</td>
</tr>
<tr>
<td>Common Peroneal</td>
<td></td>
<td></td>
<td></td>
<td>Achilles’ reflex absent</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Foot drop</td>
</tr>
<tr>
<td>Pudendal</td>
<td>S2-S4</td>
<td>Perineum Perianal Clitoris</td>
<td>Urethral Sphinicter Anal sphincter</td>
<td>Sensory loss anterior leg and dorsal foot</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Stress Incontinence Fecal Incontinence Pelvic pain</td>
</tr>
</tbody>
</table>
Ilioinguinal and Iliohypogastric Nerve Injuries

- Mapping in 11 fresh frozen cadavers
- Ilioinguinal nerve
  - Entered 3.1 ± 1.5 cm medial, 3.7 ± 1.5 cm inferior to ASIS
  - Terminated 2.7 ± 0.9 cm lateral to midline, 1.7 ± 0.9 cm superior to pubic symphysis
- Iliohypogastric nerve
  - Entered 2.1 ± 1.8 cm medial and 0.9 ± 2.8 cm lateral to ASIS
  - Terminated 3.7 ± 2.7 cm lateral to midline and 5.2 ± 2.6 cm superior to pubic symphysis

Siddique SA, et al. Relationship of the uterosacral ligament to the sacral plexus and to the pudendal nerve. Int Urogynecol J Pelvic Floor Dysfunct 2006;17:642-5.
Name the 7 Surgical and Anatomic Spaces

- Prevesical (space of Retzius)
- Vesicovaginal and vesicocervical
- Paravesical
- Rectovaginal
- Pararectal
- Retrorectal
- Presacral
Components of Pelvic Support

- Bony pelvis
- Endopelvic Fascia (fibromuscular layer)
- Pelvic diaphragm
Crus of clitoris
Ischiopubic ramus
Bulb of vestibule
Greater vestibular (Bartholin’s) gland
Perineal membrane
Urethra
Sphincter urethrae muscle
Perineal membrane (cut and reflected)
Compressor urethrae muscle
Sphincter urethrovaginalis muscle
Vagina
Deep transverse perineal muscle
Urethral Closure Pressure

3 components

- Rhabdosphincter
- Circular smooth muscle
- Non-neuromuscular
  - Vascular cushions
  - Mucosa
  - Connective tissue
Pelvic Diaphragm Components

- Levator ani Muscles
  - Puborectalis
  - Pubococcygeus
  - Iliococcygeus

- Coccygeus muscles
Anal Continence Mechanism
- Anorectal Angle
- Puborectalis Shelf
- Levator Ani Muscle
- Pubis
- Internal Sphincter Muscle
- External Sphincter Muscle
- Coccyx
“Endopelvic Fascia”

- Fibromuscular layer
- Functionally single sheet of connective tissue
- Ligamentous condensations
  - Vasculature
  - Nerves
Levels of Support

- **Level I**
  - Uterosacral and cardinal ligaments
  - Support uterus and vaginal apex

- **Level II**
  - Lateral attachments of endopelvic fascia and vagina to arcus tendineus fascia pelvis
  - Support bladder, vagina, and rectum

- **Level III**
  - Perineal membrane and perineal body
  - Support UVJ and perineum

Uterosacral Ligament

- 15 female cadavers
- USL attaches to S1-3 and variably to S4
- Less vital structures below intermediate portion
- Mean distances from USL to ureter
  - Cervical: 0.9 ± 0.4 cm
  - Intermediate: 2.3 ± 0.9 cm
  - Sacral: 4.1 ± 0.6 cm
- Ischial spine to ureter: 4.9 ± 2.0 cm
- Ischial spine consistently beneath intermediate portion
- USL tension transmitted to ureter most near cervix
- Cervix and intermediate portions strongest

<table>
<thead>
<tr>
<th>Distances</th>
<th>Sup/Inf</th>
<th>Ant/Post</th>
<th>Right/Left</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cervical Vaginal Junction to Ischial Spine</td>
<td>1.6 ± 0.5</td>
<td>1.1 ± 0.5</td>
<td>4.7 ± 0.4</td>
</tr>
<tr>
<td></td>
<td>superior</td>
<td>anterior</td>
<td>medial</td>
</tr>
<tr>
<td>Posterior Fornix to S2</td>
<td>5.3 ± 0.8</td>
<td>1.0 ± 1.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>inferior</td>
<td>anterior</td>
<td></td>
</tr>
</tbody>
</table>
Tendinous arch of levator ani

Attachment of rectovaginal fascia

Tendinous arch of pelvic fascia

Ischial spine

Vagina

Levator ani (cut edge)
Pelvic Diaphragm

Functions

- Close genital hiatus
- Creates levator plate
Interrelationship of Ligamentous and Muscular Support

Muscular Support

- Long-term support
  - Closure of genital hiatus
  - Levator plate

Ligamentous support

- Short-term support
  - Tether viscera during relaxation of pelvic diaphragm.
Analogy to Ship in Dry Dock
Pelvic Floor Dysfunction

**URINARY DYSFUNCTION**
- Lower urinary tract symptoms
- Incontinence
- Voiding difficulties

**VAGINAL DYSFUNCTION**
- Protrusion symptoms
- Sexual dysfunction

**DEFECATORY DYSFUNCTION**
- Incontinence
- Defecatory disorders
## Risk Factors for Pelvic Organ Prolapse

<table>
<thead>
<tr>
<th>Predispose</th>
<th>Incite</th>
<th>Promote</th>
<th>Decompensate</th>
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<tbody>
<tr>
<td>Congenital</td>
<td>Vaginal delivery</td>
<td>Obesity</td>
<td>Aging</td>
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<td>Racial</td>
<td>Surgery</td>
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<tr>
<td>Gender</td>
<td>Neuropathy</td>
<td>Lung disease</td>
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<td></td>
<td>Myopathy</td>
<td>Constipation</td>
<td>Myopathy</td>
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<td></td>
<td></td>
<td>Recreation</td>
<td>Debilitation</td>
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<tr>
<td></td>
<td></td>
<td>Occupation</td>
<td>Medication</td>
</tr>
</tbody>
</table>
Sensory fibers from uterine body and fundus accompany sympathetic fibers via hypogastric plexuses to T11, 12 (L1?)

Motor fibers to uterine body and fundus (sympathetic)

Sensory fibers from cervix and upper vagina accompany pelvic splanchnic nerves (parasympathetic) to S2, 3, 4

Motor fibers to lower uterine segment, cervix and upper vagina (parasympathetic)

Sensory fibers from lower vagina and perineum accompany somatic fibers via pudendal nerve to S2, 3, 4

Motor fibers to lower vagina and perineum via pudendal nerve (somatic)
Mechanisms of Prolapse

Neuromuscular Failure

- Myopathic injury
  - Direct muscular compromise
  - Denervation
- Neuropathic injury
  - Stretching – Chronic injury
  - Compression – Acute injury
  - Combinations
Consequences of Neuromuscular Compromise

Normal tone

Loss of tone
Fecal Continence Mechanism
Mechanisms of Prolapse

- Ligamentous Failure

- Connective tissue compromise
  - Stretching – Chronic injury
  - Tears – Acute injury
  - Combinations
Lower Urinary Tract and Continence Mechanism
Perineal Descent
Pathophysiology of Prolapse

Inciting Promoting Factors

Detachment
Neuropathy
Myopathy
Attenuation
Summary

- Pelvic floor dysfunction is common and can be debilitating.
- Important to understand normal anatomy and pathophysiology to properly care for women with these conditions and to avoid surgical complications.