Pelvic Anatomy: Skill Set for the Savvy Minimally Invasive Surgeon – Generalist, Urogynecologist, Oncologist (Didactic)

PROGRAM CHAIR
Jubilee Brown, MD

Peter M. Lotze, MD        R. Wendel Naumann, MD
Professional Education Information

Target Audience
Educational activities are developed to meet the needs of surgical gynecologists in practice and in training, as well as, other allied healthcare professionals in the field of gynecology.

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Pelvic Anatomy: Skill Set for the Savvy Minimally Invasive Surgeon – Generalist, Urogynecologist, Oncologist (Didactic)

Jubilee Brown, Chair
Faculty: Peter M. Lotze, R. Wendel Naumann

Course Description

This course is designed for advanced minimally invasive gynecologic surgeons who want to enhance their knowledge base and apply it to minimally invasive surgical procedures. The didactic portion of this course will provide detailed instruction on intra- and retroperitoneal pelvic anatomy as it applies to successful general, urogynecologic, and oncologic surgery. Experts in each subspecialty will focus on anatomy and dissection techniques to improve the surgical skills of generalists and subspecialists alike. Practical anatomy will be highlighted with MIS videos throughout, and tips and tricks of optimal dissection will be emphasized.

Learning Objectives

At the conclusion of this course, the participant will be able to: 1) Identify and interpret pelvic and retroperitoneal structures; 2) discuss and analyze pelvic support defects, minimally invasive repair techniques, and avoidance of injury during such procedures; 3) detect successful approaches for surgical dissection of pelvic sidewall and retroperitoneal anatomical structures (e.g., ureter, nerves, blood vessels) in patients with complex anatomy; and 4) distinguish retroperitoneal spaces and apply these landmarks to minimally invasive surgical dissection.

Course Outline

8:00 Welcome, Introduction, and Course Overview J. Brown
8:10 Pelvic Sidewall Anatomy and Retroperitoneal Spaces J. Brown
8:35 Anatomy of the Pelvic Floor P.M. Lotze
9:00 Dissecting the Ureter R.W. Naumann
9:25 Identifying Blood Vessels and Controlling Hemorrhage J. Brown
9:50 Questions & Answers
10:00 Break
10:40 Vaginal Support and Uterosacral Ligaments P.M. Lotze
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<th>Time</th>
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<td>Ligaments and Anatomy Important in Pelvic Reconstructive Surgery</td>
<td>P.M. Lotze</td>
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<td>11:30</td>
<td>Identifying Retroperitoneal Structures to Stay Safe and Get Out of Trouble</td>
<td>J. Brown</td>
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<tr>
<td>11:55</td>
<td>Questions &amp; Answers</td>
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<tr>
<td>12:00</td>
<td>Course Evaluation and Lunch</td>
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The following members of AAGL have been involved in the educational planning of this workshop and have no conflict of interest to disclose (in alphabetical order by last name).
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Frank D. Loffer, Executive Vice President/Medical Director, AAGL*
Linda Michels, Executive Director, AAGL*
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Jubilee Brown*
R. Wendel Naumann*
Peter M. Lotze*
Dobie L. Giles*

Asterisk (*) denotes no financial relationships to disclose.
Pelvic Sidewall Anatomy and Retroperitoneal Spaces

Jubilee Brown, M.D.
Associate Professor
Department of Gynecologic Oncology

I have no financial relationships to disclose

Objectives

- To review pelvic sidewall anatomy including retroperitoneal spaces
- To describe the approach for safe laparoscopic dissection
- To view examples of dissection using minimally invasive surgery

> Geared for all gynecologic surgeons

Avascular tissue planes

- Paravesical space
- Pararectal space
- Prevesical (retropubic) Space of Retzius
- Vesicovaginal space
- Rectovaginal space
- Presacral (retrorectal) space
Left paravesical space

- Anterior wall: superior pubic ramus
- Medial wall: bladder & vagina
- Lateral wall: ext. iliacs, obturator fossa, levator ani
- Posterior wall: cardinal ligament

Right paravesical space dissection

- Left paravesical space
- Right paravesical space dissection
- Avascular tissue planes
  - Paravesical space
  - Pararectal space
  - Prevesical (retropubic) Space of Retzius
  - Vesicovaginal space
  - Rectovaginal space
  - Presacral (retrorectal) space

Left pararectal space

- Anterior wall: cardinal and uterines
- Medial wall: rectum & ureter
- Lateral wall: internal iliacs
- Posterior wall: sacrum
Avascular tissue planes

- Paravesical space
- Pararectal space
- Prevesical (retropubic) Space of Retzius
- Vesicovaginal space
- Rectovaginal space
- Presacral (retrorectal) space

Anders Retzius, 1796-1860
Anatomic borders of the space of Retzius

- Avascular potential space behind the pubic symphysis and in front of the urinary bladder

Lateral borders
- Pubic symphysis
- Obturator internus muscle
Borders of space of Retzius

- Urethra and bladder rest on anterior vaginal wall (floor)
- Vagina attaches to arcus tendineus fascia pelvis laterally (becomes lateral border)

Vascular contents of space of Retzius

- Veins of Santorini (in the floor)
- Obturator neurovascular bundle
- Aberrant obturator artery and vein
- External iliac artery and vein

Access to space of Retzius

- Open: divide the rectus muscle in the midline
- Dissect between the rectus muscle superficially and the peritoneum deep toward pubic symphysis
Access to space of Retzius

- Laparoscopic access: open from intraperitoneal approach
- Insufflation helps with dissection

Laparoscopic video: Space of Retzius

Avascular tissue planes

- Paravesical space
- Pararectal space
- Prevesical (retropubic) Space of Retzius
- Vesicovaginal space
- Rectovaginal space
- Presacral (retrorectal) space

Retrorectal (Presacral) Space

Avascular tissue planes

- Paravesical space
- Pararectal space
- Prevesical (retropubic) Space of Retzius
- Vesicovaginal space
- Rectovaginal space
- Presacral (retrorectal) space
Retrorectal spaces

Boundaries of presacral space
- Rectum
- Sacrum/coccyx
- Uterosacral ligs.
- Levator ani (floor)
- Right CI artery
- Left CI vein
- Right ureter

Vascular structures in presacral space
- Middle sacral artery
- Middle sacral veins
- Sacral venous plexus
Strategies for Successful Dissection

- Instrument choice
  - Optiview or Visiport entry
  - All atraumatic instruments and forceps
  - If using heated element or harmonic scalpel, always be aware of the active blade – no injury!
  - Remember to retract with available instruments
  - Keep bloodless space (suction irrigator – suction only/mostly)
  - Rotate camerahead to promote orientation

- Room setup
  - Orientation is key
  - Monitors at patient’s feet
  - Operator stands opposite side of dissection

Nerves in presacral space

- Hypogastric plexus of nerves
- Runs anterior to bifurcation of aorta
- Carries autonomic nerves (bowel, bladder)

Accessing the Presacral Space

- Sigmoid colon is retracted to the left
- Peritoneum is incised in the midline over the sacral promontory
- This avoids injury to the common iliac vessels
- Visualize ureters

Strategies for Successful Dissection

- Room setup
  - Orientation is key
  - Monitors at patient’s feet
  - Operator stands opposite side of dissection

- Port placement
- Instrument choice
- Anatomic landmarks
- Detection of avascular spaces

Peritoneum is incised in the midline over the presacral space

This avoids injury to the common iliac vessels

Identify sidewall structures before entering presacral space

Visualize ureters
Strategies for Successful Dissection

- Port placement
  - Do not struggle
  - 5 or 10 mm port in umbilicus; bilateral port placement 2-3 fingerbreadths in and cephalad to ASIS, angled to pelvis
  - In obese patient, avoid tunnelling

- Instrument choice
  - Optiview or Visiport entry
  - All atraumatic instruments and forceps
  - If using heated element or harmonic scalpel, always be aware of the active blade – no injury!
  - Remember to retract with available instruments
  - Keep bloodless space (suction irrigator – suction only/month)
  - Rotate camerahead to promote orientation

Strategies for Successful Dissection

- Anatomic landmarks
  - Round ligament
  - Psoas muscle
  - External iliac Artery

- Detection of avascular spaces
  - Paravesical space entered between external iliac vein laterally and superior vesical artery medially
  - Pararectal space follows curve of sacrum

Lateral pelvic wall dissection

- Rotate camerahead to promote orientation
- Keep bloodless space (suction irrigator – suction only/month)
- Remember to retract with available instruments
- In obese patient, avoid tunnelling

- Optiview or Visiport entry
- All atraumatic instruments and forceps
- If using heated element or harmonic scalpel, always be aware of the active blade – no injury!

Instrument choice

- Optiview or Visiport entry
- All atraumatic instruments and forceps
- If using heated element or harmonic scalpel, always be aware of the active blade – no injury!
- Remember to retract with available instruments
- Keep bloodless space (suction irrigator – suction only/month)
- Rotate camerahead to promote orientation
Lateral pelvic wall dissection

Thank You!
Lecture Objectives

- Describe the Bony Anatomy of the Pelvic Floor
- Describe the Skeletal Muscle of the Pelvic Floor
- Discuss the Role of the Pelvic Floor Musculature

Pelvic Bones

**Ilium**
- Uppermost / largest bone
- Divisible into body, ala
- Separation indicated on top surface by curved line (arcuate line), and on external surface by margin of acetabulum
- Body - part of acetabulum (~2/5)
- Wing (ala) - large expanded portion; bounds greater pelvis laterally

**Ischium**
- Lower / back part of hip bone (os coxae)
- Situated below ilium / behind pubis
- Superior portion forms ~1/3 of acetabulum

**Pubis**
- Covered by mons pubis
- Body, superior and inferior ramus
- Body forms 1/5 of acetabulum

Sacrum

- Typically 5 vertebrae - initially unfused and fuses at ~16–18 y/o (done by 34)
- Sacral promontory - projects forward and articulates with last lumbar-vertebra (sacrovertebral angle)
- Centrally - curved posteriorly (allows greater room in pelvis)
- Ala ("wings") - project laterally and articulate with ilium at sacroiliac joints

Upper vs. Lower Half
- Lower forms greater angle
- Upper half nearly straight
- Lower half with greatest amount of curvature
- In the female, sacrum is shorter and wider than a male

Bony Anatomy
Important ligaments

**Sacrotuberosus ligament (SSL)**
- Ischial spine to margins of sacrum / coccyx
- Fibers intermingles with STL
- Covered by Coccygeus muscle
- Greater / Lesser Sciatic Notch defined by SSL and STL
- Pudendal vessels / nerve behind SSL
- Inferior gluteal artery behind SSL
- Prevents posterior rotation of ilium with respect to sacrum

**Sacrotuberous ligament (STL)**
- Ischial tuberosity to lower transverse sacral tubercles, inferior margins sacrum / upper coccyx
- Narrow in middle portion of ligament
- Pudendal nerve potentially entrapped between STL and SSL (perineal pain)
- Prevents posterior rotation of ilium with respect to sacrum

Skeletal Musculature

**Piriformis**
- Origin: S2-4 vertebrae
- Insertion: greater trochanter of femur
- Innervation: S1, S2
- Action: Rotates thigh laterally

**Coccygeus**
- Origin: ischial spine
- Insertion: lateral sacral border
- Innervation: S3, S4
- Action: Supports / raises coccyx

**Obturator internus**
- Origin: surface of pelvic bone, margin of obturator foramen, ischial ramus, inferior pubic ramus
- Innervation: greater trochanter of femur
- Innervation: L5, S1, S2
- Action: Rotates thigh laterally
Skeletal Musculature

Levator ani (LA)
- Describes: pelvic diaphragm muscles
- Includes: pubococcygeus, puborectalis, iliococcygeus
- Action: Supports pelvic viscera; resist increases in intra-abdominal pressure

Iliococcygeus (posterior LA)
- Origin: anterior to obturator canal
- Insertion: coccyx, anococcygeal ligament
- Innervation: S3, S4

Pubococcygeus (anterior LA)
- Origin: anterior to obturator canal
- Insertion: anococcygeal body, coccyx
- Innervation: Pudendal nerve

Puborectalis
- Origin: more lateral origin from the pubic bone; continues posteriorly with corresponding muscle of opposite side
- Innervation: S3, S4

Perineal Body
- Pyramid-shaped / fulcrum of support
- Bulbocavernosus, ischiocavernosus and superficial transverse perinei, external anal sphincter
- Laterally, muscle fibers of puborectalis and pubococcygeus
- Superficially, associated with Colles’ fascia
- Compromise may be a precursor to compromise pelvic support

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DeLancey’s level of support

**Level I** - Uterosacral / Cardinal ligaments - maintain apical positioning of pelvic organs
  - Compromise risks apical prolapse

**Level II** - Visceral connective tissue located Anteriorly / Posteriorly / Laterally
  - Posterior visceral connective tissue referred to as Rectovaginal fascia (Denonvillier’s fascia)
    - Attaches laterally to pelvic sidewall beginning at perineal body.
    - Converges with arcus tendineus fasciae pelvina (ATFP) midway between symphysis and ischial spine
    - Creates a Y configuration on sidewall
  - Compromise risks anterior, lateral, posterior compartment defects

**Level III** - Perineal body
  - Compromise may be a precursor to compromise pelvic support

Visceral Connective Tissue (“Fascia”)
- Components include elastin & collagen fibers in polysaccharide ground substance
- Dynamic tissue which undergoes constant turnover and remodeling
- Regarded to be sensitive to hormonal changes

**The Role of the Levator Ani Muscles**
- Components of “support”: Levator ani / ligaments and “fascia”
- The role of the Levator Ani
  - Along with visceral connective tissue, it provides support to vagina and bladder
- The pelvic organs rest on the Levator plate
  - These muscles contract during increases in abdominal pressure, maintaining support
  - Pelvic floor injuries compromises support risking onset of pelvic organ prolapse
Objectives

• Review ureteral anatomy
• Review how to open the retroperitoneal space to identify the ureter and adjacent structures during gynecologic surgery
• Demonstrate techniques to identify and dissect the ureter during difficult gynecologic surgery

Laparoscopic Surgery

• Should NOT be considered “minor” surgery
• Liability is high
  – Anatomy looks different from open anatomy
  – Complications can be subtle and often overlooked or diagnosis delayed

GU Injury during TLH


Pelvic Ureter

Chart: vessels are tortuous and ALWAYS close to the ureter - GOT to FIND it!

Can always find at the pelvic brim - make the incision higher if you are struggling!
Types of Ureteral Injury
Review of 70 reports in 2,491 cases of laparoscopy

You MUST Define the Anatomy!

Andreas Vesalius1514-1564
De Humani Corpus Fabrica by Andreas Vesalius, Padua, Italy (1543)

Path of the Ureter

Finding the Ureter

Prevent Injury at Uterine Artery and Pelvic Sidewall

Prevent Injury at Uterine Artery
- Make colpotomy prior to uterine artery ligation
- Do NOT go below Koh ring
- Have strategies to deal with bleeding from uterine artery
  - Seal vessel WITHOUT tension
  - Hemostatic agents
  - Ligation of uterine artery at origin
- Isolation of ureter in difficult cases
Blood Supply to Uterus/Vagina

Taking the Uterine Arteries

Prevent Injury at the Vaginal Cuff

Cross Sectional Anatomy

Ways to Injure the Ureter at the Cuff

Ureters and Bladder
Stents

- Stents can be placed prior to difficult procedures
  - Make identification of ureter easier
  - They have not shown a reduction in injury
    - Lighted stents cannot often be seen when field is illuminated during surgery
  - May decrease unrecognized injury

Urologic Complications

A Case for Universal Cystoscopy?

- 471 hysterectomies in 3 centers - Prospective study
  - 24 urinary tract injuries (5.3%)
    - 8 ureteral (1.7%)
    - 17 bladder (3.6%)
  - Ureteral injury associated with prolapse surgery (7.3% vs 1.2%; P = 0.03)
  - Bladder injury associated with incontinence surgery (12.5% vs 3.1%; P = 0.05)
  - Only 12.5% of ureteral injuries and 35.3% of bladder injuries were detected before cystoscopy

Bladder Injury

- Two layer closure
  - Monofilament on mucosa
    - 3-0 suture
  - Can use braided on muscularis
    - 2-0
  - Catheter for 7-10 days

Intra-operative Recognition

- What if a clamp is placed across the ureter?
  - Remove clamp
  - Inspect for integrity
  - Stent (2-6 wk)
  - Drain (7-10 d)
  - Close Peritoneum
**Ureteral Injury**

- Detection
  - Intra-operative dye injection
  - Intra-operative ureteral catheterization
  - IVP
  - Dissection of the ureter
  - Retrograde ureteral dye study
- Cannot always detect crush injuries or partial obstruction

**Injury Documented with Methylene Blue**

**Drain for Urinary Injury**

- Output should be less than 50 ml per day
- Check Creatinine prior to removal - should be same as serum value
- Might leave longer if worried about necrosis or devascularization injury

**Early Diagnosis**

- Flank pain/CVA tenderness
- Unexplained fever
- Persistent ileus
- Lower abdominal mass
- Urinary discharge from vagina
- Decreased urinary output
- Unexplained hematuria

**Urinoma, Urinary Ascites**

- Normally urine/plasma creatinine is 30:1 to 100:1
- However, may equilibrate fast
- May be as low as 2:1
- Non-urine ascitic fluid would be 1:1

**Thanks!**
References

• Ostrazenski A, Obstet Gynecol Surv 58:793, 2003
• De Humani Corpus Fabrica by Andreas Vesalius, Padua, Italy (1543)
• Vakili B, Am J Obstet Gynecol 192, 1599, 2005
• Hurt WG, Gynecologic and Obstetrical Surgery (Nichols DH ed), Baltimore, Mosby, 1993
Identifying Blood Vessels and Controlling Hemorrhage

Jubilee Brown, M.D.
Associate Professor
Department of Gynecologic Oncology

I have no financial relationships to disclose.

Objectives

- To review the vascular supply in the pelvis
- To describe the approach for safe dissection avoiding hemorrhage
- To identify strategies for controlling hemorrhage in the pelvis
- To view examples of dissection using minimally invasive surgery

Arterial Supply to Pelvis

- Common iliac artery begins at L4, terminates over SI joint; over psoas major
  - Divides into external and internal iliac arteries
  - Both are crossed at bifurcation by the ureter
  - Right CI crosses left CI vein and beginning of IVC
Arterial Supply to Pelvis

- **External iliac artery**
  - Crossed by ovarian vessels and sometimes the ureter
  - Small lateral branch to psoas – nodal dissection
  - Deep circumflex iliac artery
  - Inferior epigastric artery (medial and distal to deep circumflex iliac artery)
  - Deep circumflex iliac vein crosses EIA – inferior border of pelvic node dissection

Distal pelvic vessels

Arterial Supply to Pelvis

- **Internal iliac (hypogastric) artery**
  - 4 cm from origin, divides into
    - Posterior trunk
      - Iliolumbar a.
      - Lateral sacral a.
      - Superior gluteal a. – terminal branch
    - Anterior trunk
Arterial Supply to Pelvis

- **Internal iliac (hypogastric) artery** – anterior trunk
  - **Common trunk**
  - Umbilical a., uterine a., vaginal a., superior vesical a.
  - Obturator a.
  - Inferior vesical (vaginal) a.
  - Middle rectal a.
  - Internal pudendal a.
  - Inferior gluteal a.
Anatomy of the Pelvis

Venous Drainage of Pelvis
- Largely follows arterial supply
- No umbilical vein
- Usually duplicate uterine veins!
- CI vein is distal to artery – vulnerable!
- Artery/vein relationship is offset – care during dissection, varies right to left
- 20% of patients have accessory obturator vein before crossing superior pubic ramus

Lymphatic Supply to Pelvis
- External iliac (8-10)
  - Lateral, superior, and medial to external iliac artery and vein
- Obturator
  - All nodes in obturatory fossa above and below obturator nerve
- Hypogastric (internal iliac)
  - Medial and inferior to internal iliac artery

Lymphatic Supply to Pelvis
- Lateral and medial common iliac lymph nodes (4-6)
  - Behind and on sides of CI artery
  - Drain pelvic wall lymphatics
  - Direct channels from adnexa, uterus, and cervix do exist
**Right paravesical space dissection**

**Left paravesical space**
- Anterior wall: superior pubic ramus
- Medial wall: bladder & vagina
- Lateral wall: ext. iliacs, obturator fossa, levator ani
- Posterior wall: cardinal ligament

**Left pararectal space**
- Anterior wall: cardinal and uterine
- Medial wall: rectum & ureter
- Lateral wall: internal iliacs
- Posterior wall: sacrum

**Left pararectal space dissection**

**Left paravesical space dissection**
**Vascular contents of space of Retzius**

- Veins of Santorini (in the floor)
- Obturator neurovascular bundle
- Aberrant obturator artery and vein
- External iliac artery and vein

**Retrorectal (Presacral) Space**

- Rectum
- Sacrum/coccyx
- Uterosacral ligaments
- Levator ani (floor)
- Right CI artery
- Left CI vein
- Right ureter

**Vascular structures in presacral space**

- Middle sacral artery
- Middle sacral veins
- Sacral venous plexus

**Accessing the Presacral Space**

- Sigmoid colon is retracted to the left
- Peritoneum is incised in the midline over the sacral promontory
- This avoids injury to the common iliac vessels
- Visualize ureters
Lateral pelvic wall dissection

Ureter crossing iliacs & interiliac node

Principles of Safe Dissection to Avoid Hemorrhage

- Safe initial entry – patient position
- Safe insertion of trocars – anterior abdominal wall
- Know anatomy well – enter retroperitoneum in “triangle”
- Open spaces – they are avascular

Control of hemorrhage

- Do not panic
- Do not panic
- Do not panic
Control of hemorrhage

- Hold pressure
- Discuss with anesthesiologist and team
  - IV access, blood availability, staffing
- Access to bleeding site
  - Enough visualization, may have to dissect more
- Low threshold for conversion
  - Don’t need much to make a quick lap and put pressure on the site

Control of hemorrhage

- Pressure: 4x4, fatty flap, grasper
- Products
- Clips
- Suture

Thank You!
Objective

- Review mechanisms and prevention of common nerve injuries in Pelvic Surgery including
  - Brachial Plexus Injury
  - Cutaneous nerves of the anterior abdominal wall
  - Bladder
  - Obturator
  - Femoral
  - Peroneal

Disclosures

- I have no financial relationships to disclose

Nerve Injury - Remember!!!!

- The patient is paralyzed
- The patient is immobile
- The patient feels no pain
- The procedure may be long

Malpractice Claims for Nerve Injury

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<th>% Female</th>
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<td>50%</td>
<td>49%</td>
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<tr>
<td>Ulnar</td>
<td>75%</td>
<td>23%</td>
<td>50</td>
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<tr>
<td>Brachial plexus</td>
<td>40%</td>
<td>58%</td>
<td>41</td>
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<td>Nerve Root</td>
<td>29%</td>
<td>71%</td>
<td>37</td>
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<tr>
<td>Spinal Cord</td>
<td>52%</td>
<td>48%</td>
<td>54</td>
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<tr>
<td>Other</td>
<td>42%</td>
<td>58%</td>
<td>40</td>
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</table>
Malpractice Claims for Nerve Injury

Incidence - 0.16%
-3200 cases
-Arms abducted
-Trendelenburg

Proper Positioning is KEY to preventing Brachial plexus and Ulnar Nerve Injury

Mechanism of Stretch

Pressure on shoulder and contribute but is NOT the major factor

Abduction and Trendelenburg much is very bad, especially in the obese patient

Nerve Strain by Position

Increase in strain in the median nerve

Preventing Brachial plexus and Ulnar Nerve Injury

Loosely tucked by side

Padding ulnar surface

Thumb up

Nerve Injury during Gynecologic Surgery (Abdominal and Laparoscopic)
Prospective Study of Nerve Injury

- Prospective study of 616 gynecologic surgery pts
- Pre-existing neuropathy in 1.9%
- New neuropathy developed in 1.8% (95% CI 1.0 - 3.2%)
  - 5 femoral
  - 5 lateral cutaneous
  - 1 ilioinguinal
  - 1 saphenous
  - 1 genitofemoral
  - 1 common fibular
- Complete resolution in 91% at a median of 31 days

Bohrer JC, Obstet Gynecol Surv 65(2):90, 2010

The Lumbosacral Plexus

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Motor Function</th>
<th>Sensory Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iliohypogastric</td>
<td>None</td>
<td>Genital, spermatic, inguinal</td>
</tr>
<tr>
<td>Lateral femoral cutaneous</td>
<td>None</td>
<td>Perineal, lower extremity</td>
</tr>
<tr>
<td>Ilioinguinal</td>
<td>None</td>
<td>Tendinous, cremaster, obturator</td>
</tr>
<tr>
<td>Genital-femoral</td>
<td>None</td>
<td>Deep perineal, tibial</td>
</tr>
<tr>
<td>Common peroneal</td>
<td>None</td>
<td>Peroneal, tibial</td>
</tr>
<tr>
<td>Femoral</td>
<td>chondroepicondylar</td>
<td>Peroneal</td>
</tr>
</tbody>
</table>

Irin W, Obstet Gynecol 103:374, 2004

Nerves of the Pelvis

Bohrer JC, Obstet Gynecol Surv 65(2):90, 2010

The Lumbosacral Plexus

- Iliohypogastric
- Lateral femoral cutaneous
- Ilioinguinal
- Genital-femoral
- Common peroneal
- Superficial peroneal
- Saphenous

Bohrer JC, Obstet Gynecol Surv 65(2):90, 2010
Pelvic nerve injury following gynecologic surgery: a prospective cohort study

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Side</th>
<th>Nerve</th>
<th>Size</th>
<th>Nerve</th>
<th>Scarification</th>
<th>Blanching</th>
<th>Perineal flap</th>
<th>Continuous</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral Femoral Cutaneous Nerve</td>
<td>L</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Genitofemoral Nerve</td>
<td>L</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Ilioinguinal and Iliohypogastric Nerves</td>
<td>L</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>

Lateral Femoral Cutaneous Nerve
- Nerve roots (L2-3)
- Can be compressed by retractor blades
- Presents as anesthesia of anterior-lateral and posterior-lateral thigh

Ilioinguinal and Iliohypogastric
- Occurs in 3.7% of Pfannenstiel incisions
  - Associated with length of incision esp. if past lateral rectus sheath
- Distribution near lower port sites but injury with trocar uncommon
- Most often injured in fascial closure (entrapment) or neuroma from injury
- Diagnosis
  - Sharp burning pain emanating from the incision and radiating to suprapubic area, labia or thigh
  - Paresthesia over the appropriate nerve distribution
  - Pain relief after infiltrating with local anesthetic
  - Symptoms often worse with Valsalva and can be relieved with hip flexion
- Requires weekly injection with analgesic/steroids, neurolysis, or resection

Genitofemoral Nerve
- Often injured removing sidewall masses of pelvic nodes
- Consequences minimal (patch of sensory neuropathy)
Femoral Nerve Injury

- True incidence under reported
- Gynecologic surgery most common cause
- Causes
  - Compression from self-retaining retractors (TAH)
    - 10x higher with ‘self-retaining’ retractors
  - Stretch from hyperextension of the hips (TVH)
  - Dissection (Rare)


Retractor Based Femoral Nerve Injury

Avoid deep blades and lateral tension

Irin W, Obstet Gynecol 103:374, 2004

Femoral Nerve Injury

Avoid extreme flexion of the hip!


Common Peroneal Nerve Injury

This nerve is at risk as it passes close to the lateral aspect of the head of the fibula.

Internal rotation of stirrups will prevent outside pressure on leg.

Prospective Study of Femoral Nerve Injury

• 147 patients at TAH
  • 17 (12%) had some degree of femoral neuropathy
    – 16 (11%) sensory deficits
    – 7 (5%) motor deficits or decreased patellar reflex
  • Lasted 3-65 days
  • Completely recovered in 15 cases (88%)

Obturator Nerve Injury

• Most often injured during obturator node dissection
  – Often due to lack of identification or bleeding
• Mostly motor with injury resulting in hip adductor weakness
• If injured repair with 8-0 to 10-0 nylon to achieve captation without perineurial gaps or tension
  – Physiotherapy should be employed
  – Recovery is often possible

Abnormal Obturator Vessels

Abnormal obturator vessels are present in 25% of cases
Aberrant Obturator Vein

Innervation of the Pelvis and Bladder

Iliohypogastric, Ilioinguinal and Genitofemoral Nerves

Nerves of the Retroperitoneum
Neuro-Anatomy

• Pelvic viscera are innervated via the autonomic nervous system
• Sympathetic fibers
  – originate in the thoracic and lumber segments of the spinal cord and reach the pelvis via the hypogastric plexus
• Parasympathetic fibers
  – originate in sacral nerve roots 2, 3, and 4

Sympathetic Nerves to the Bladder

• Long post-ganglionic nerves
  – T11 and T12
  – L1 and L2
• Pre-sacral (hypogastric nerves)
  – beta-androgenic fibers causing relaxation of detrusor
  – alpha androgenic fibers causing contraction of the urethra
  – Stimulation prevents voiding

Para-sympathetic Nerves to the Bladder

• Motor fibers from the Sacral Nerves
  – S2, S3, and S4
  – course through the pelvic nerve plexus and join the hypogastric nerves to form the vesical plexus
  – Excitement of the Para-sympathetic nerves causes contraction of the bladder resulting in micturition
• Somatic and Sensory innervation also occurs through S2 - S4

Innervation of the Female Reproductive Organs

Sympathetic Trunk

Nerves to the Bladder
Pelvic Nerves

- Hypogastric (Sympathetic)
- Pelvic Nerves from Sacral Roots 2, 3, 4 (Parasympathetic)

References

- Cheney FW, Anesthesiology 90:1062, 1999
- Romanowski L, Fertil Steril 60:792, 1993
- Winfree CJ, Surg Neurol 63:5, 2005
- Coppieters MW, Anesthesiology 104:1351, 2006
- Bohrer JC, Obstet Gynecol Surv 65(2):90, 2010
- Inn W, Obstet Gynecol 103:374, 2004
- Kvist-Pousen H, Obstet Gynecol 60:516, 1982
Lecture Objectives

- Describe the DeLancy Levels of Support
- Review the Structures of the Uterosacral / Cardinal Ligaments
- Describe the Vaginal Sidewall Attachments Associated with Level II Support
- Describe the Visceral Connective Tissue of the Anterior / Posterior Vaginal Compartments

Pelvic Anatomy Overview

Components of Pelvic Support

- Pelvic Floor musculature
  - Levator Ani muscles
    - Iliococcygeus
    - Pubococcygeus
- Connective tissue supports

Hemi Pelvis

Disclosure

- Consultant: Boston Scientific Corp. Inc., Gynecare
Level I Support

- Uterosacral ligaments
  - Attachment to pericervical ring / vaginal cuff
  - Apical prolapse at risk to occur when ligaments are compromised
  - Surgical treatment approaches: ligament suspension vs. mesh implant

The uterosacral ligaments are comprised of three parts:
- The Proximal Third
- The Middle Third
- The Distal Third

The uterosacral ligaments vary with each third of the ligament:
- The Proximal Third
  - Fuses with the uterine artery
  - Fuses with the uterine artery
  - Fuses with the uterine artery
  - Fuses with the uterine artery
  - Fuses with the uterine artery
- The Middle Third
  - Predominantly connective tissue, few scattered smooth muscle fibers, nerve tissue, and blood vessels
- The Distal Third
  - Predominantly connective tissue, few scattered smooth muscle fibers, nerve tissue, and blood vessels

Medially, the two uterosacral ligaments project out from the wall onto an ovovaginal shelf, narrowing the diameter of the cavity in front of the lower rectum and marking it off as the cul-de-sac of Douglas.

The ureter neighbors the ligament and can be found approximately:
- Proximal third: 4.1 cm laterally
- Middle third: 2.3 cm laterally
- Distal third: 0.9 cm laterally

Pericervical ring
- Collar of connective tissue that encircles the cervix
- Composed of fibroelastic connective tissue
- Stabilizes the cervix between the ischial spines by attaching to all other connective tissues described

Pubocervical septum (or fascia)
- A.k.a.: Vesicovaginal fascia
- Trapezoidal shape
- Contains fibroelastic connective tissue and smooth muscle
- Attaches to the urogenital diaphragm (distally), white line (laterally), pericervical ring and cardinal ligaments (proximally)
- Supports anterior vaginal wall and bladder

Connective Tissue Support

Level I Support:
- Uterosacral / Cardinal Ligament Complex

Level II Support:
- Comprised of visceral connective tissue surrounding vagina
  - Anterior endopelvic fascia
  - Posterior endopelvic fascia

Attachments:
- Proximally: Pericervical ring / vaginal cuff
- Laterally: Pelvic sidewalls (Paravaginal support)
- Distally: Perineal body

Anterior Anterior

Posteroinferior view of the female pelvis with the levator ani muscles removed.

The levator ani muscles include the following:
- Pubococcygeus muscle
- Puborectalis muscle
- Inferior group of the obturator internus muscle

Level II Support:
- Comprised of visceral connective tissue (Anterior, Posterior, Lateral)

Anterior Anterior

Posteroinferior view of the female pelvis with the levator ani muscles removed.

The levator ani muscles include the following:
- Pubococcygeus muscle
- Puborectalis muscle
- Inferior group of the obturator internus muscle

Posterior Rectal Support:
- Comprised of visceral connective tissue (Anterior, Posterior, Lateral)

Anterior Anterior

Posteroinferior view of the female pelvis with the levator ani muscles removed.

The levator ani muscles include the following:
- Pubococcygeus muscle
- Puborectalis muscle
- Inferior group of the obturator internus muscle

Level I Support:
- Uterosacral / Cardinal Ligament Complex

Level II Support:
- Visceral Connective Tissue (Anterior, Posterior, Lateral)
Space of Retzius & Paravaginal Space

- **Muscles**
  - Obturator internus
  - Iliococcygeus (Principle “Kegel” muscle)
  - Piriformis (Neurovascular structures on top of muscle - e.g. Sciatic nerve, inferior rectal artery)
  - Coccygeus (overlies the Sacrospinous ligament)

- **Arcus tendineous fascia pelvica** (ATFP; “Arcuate line”)
  - Line of fascia attachment (overlies attachment of iliococcygeus to obturator internus muscles)

- **Ischial spine**

- **Sacrospinous ligament**

Level II Support

- Anterior fascia

Level III Support

- Perineal body – in a standing patient, it helps to support the vagina and uterus

Pelvic Organ Prolapse

**Proper Work-up**

- **History**
  - How long has it been there?
  - Fell it? Seen it?
  - What size does it seem to be?

- **Baden-Walker**
  - Must be underload

- **POP-Q**
  - Great accessory

**Assessment of Apex**

- Mandatory regardless of technique

**Why did this occur?**

- Pelvic Floor Muscle

**Where is the damage?**

- Pelvic Floor Muscle
- Visceral Connective Tissue

**Where is the tear?**

- Uterosacral ligaments
- Pericervical ring
- Anterior / Posterior compartment
  - Transverse
  - Lateral
  - Midline
Vaginal Support and Uterosacral Ligaments

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Division & Fellowship Director, Women’s Pelvic Health & Continence Center
Clinical Assistant Professor, Dept. OB/Gyn, UTHSC-Houston
Houston, Texas
Ligaments and Anatomy Important in Pelvic Reconstructive Surgery

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Houston, Texas

Disclosure

• Consultant: Boston Scientific Corp. Inc., Gynecare

Lecture Objectives

• Describe anatomy neighboring surgical procedures for each pelvic organ compartment
• Describe the impact of injury to nearby structures on the course of the surgical procedure
The uterosacral ligaments are comprised of three parts:

- The Proximal Third
- The Middle Third
- The Distal Third

The uterosacral ligaments vary with each third of the ligament:

- **The Proximal Third**
  - The weakest 1/3 of the uterosacral ligament
  - Attaches to the deep fascia and periosteum of the sacrum
  - Almost entirely loose strands of connective tissue, intermingled fat; few vessels, nerves, and lymphatics

- **The Middle Third**
  - Fibers interdigitate with the ischial spine
  - Predominantly connective tissue, few scattered smooth muscle fibers, nerve tissue, and blood vessels

- **The Distal Third**
  - Its posterior continuation of tissue forms the cardinal ligament
  - Closely packed bundles of smooth muscle, abundant mediums and small blood vessels, and small nerve bundles

Medially, the two uterosacral ligaments project out from the rectum as crescentic shelves, narrowing the diameter of the cavity in front of the lower rectum and marking it off as the cul-de-sac of Douglas

The ureter neighbors the ligament and can be found approximately:
- Proximal third: 4.1 cm laterally
- Middle third: 2.3 cm laterally
- Distal third: 0.9 cm laterally

---

**Anatomy Neighboring SSL**

- **Bony Structures**
  - Ischial Spine
  - Sacrum

- **Muscle Groups**
  - Iliococcygeus
    - Fusion with Obturator internus
  - Coccygeus
  - Piriformis
  - Nerves / blood vessels overlying muscle

- **Nerves**
  - Major
    - Somatic
    - Pudendal
  - Minor
    - Inferior rectal
    - Levator ani

- **Vascular**
  - Internal iliac
  - Pudendal
  - Inferior gluteal artery

---

**Hemorrhage and Visceral Injury**

- Both are rare
- Hemorrhage may require embolization, transfusion
- GI injury mandates mesh should not be placed*
- Bladder injury may be repaired with mesh subsequently placed**

* No data exist for decision tree

---

Anatomy Neighboring SSL

Space of Retzius & Paravagal Space

What's it Anchored To?

Anterior / Apical Anchors
- Designed to correct posterior compartment defect and/or apical prolapse
- Two styles of apical support
  - Anchor points:
    - Upper arm thru SSL
    - Lateral arm (Elevate) transcoccygeus, near bladder neck
  - [Lower arm - bladder neck (not urethra)]

Pre-spinous vs. Spinous For Apical Support

Prospective Observational Series of 100 patients
(Submitted to Green Journal, 2010)
- Designation of colposuspension fixation point caudad to ischial spines may risk supporting statistically / clinically significant lower percentile of TVL
- Inadequate support more dramatic with fixation point 2.0 cm (one finger breadth) from the ischial spines.
- Suggested clinical benefit to consider suspensory attachment points for the vaginal apex at / above ischial spine

Lotze PM, et al. Descriptive Study of the Location of Ischial Spines in Women Undergoing Gynecologic Surgery
An Assessment of Colposuspension Sites at the Level of the Ischial Spine and Pre-s temporal Points. SGS Poster Presentation, 2008.
Level II Support

Anterior fascia

Pericervical ring

Perineal body

Posterior fascia (Rectovaginal septum)

Paravaginal support (fascia endopelvina)

OI - obturator internus muscle

IC - iliococcygeus muscle

Muscle Insertion Points

Adductor longus muscle

Adductor magnus muscle

Obturator externus muscle

Adductor brevis muscle

Gracilis muscle

Structures Exiting the Obturator Canal

Obturator artery

Obturator nerve

(Note: Only a portion of the nerve is shown. The course of nerve branches continue caudad)

Ligaments and Anatomy Important in Pelvic Reconstructive Surgery

Peter M. Lotze, MD FACOG

Female Pelvic Medicine & Reconstructive Surgery

Division & Fellowship Director, Women’s Pelvic Health & Continence Center

Clinical Assistant Professor, Dept. OB/Gyn, UTHSC-Houston

Houston, Texas
Identifying Retroperitoneal Structures to Stay Safe and Get Out of Trouble

Jubilee Brown, M.D.
Associate Professor
Department of Gynecologic Oncology

I have no financial relationships to disclose.

Objectives

• To utilize the anatomy already reviewed in order to preserve all normal structures even in difficult dissections
• To incorporate known anatomy into complex pelvic surgery in order to reverse a complication
• To view examples of dissection using minimally invasive surgery

Safe Access to Retroperitoneal Structures

• 4 ports
• Atraumatic instruments
• Open peritoneum
  – Landmarks are round ligament, EI artery, bifurcation of CI artery
  – Beware ureter
  – Easiest way if disoriented is to grasp round ligament, lift, and open cephalad

Open peritoneum – transect round ligament or enter next to it

Extend incision along external iliac artery
**Grasp tissue along external iliac artery**

**Identify the ureter**
- Remember the course of the ureter
- Open the retroperitoneum in a safe, lateral location – remember the “triangle”
- Always safe to go lateral and cephalad
- Higher is better
- Adherent to the medial leaf of the peritoneum
- Use more suction, less (no) irrigation

**Trace the ureter throughout its course**

**Avoid nerve injury:**
Isolate superior vesical a. and obturator n.
Governor Arnold Schwarzenegger signed into law **AB 1195** (eff. 7/1/06) requiring local CME providers, such as the AAGL, to assist in enhancing the cultural and linguistic competency of California’s physicians (researchers and doctors without patient contact are exempt). This mandate follows the federal Civil Rights Act of 1964, Executive Order 13166 (2000) and the Dymally-Alatorre Bilingual Services Act (1973), all of which recognize, as confirmed by the US Census Bureau, that substantial numbers of patients possess limited English proficiency (LEP).

**California Business & Professions Code §2190.1(c)(3)** requires a review and explanation of the laws identified above so as to fulfill AAGL’s obligations pursuant to California law. Additional guidance is provided by the Institute for Medical Quality at [http://www.imq.org](http://www.imq.org).

**Title VI of the Civil Rights Act of 1964** prohibits recipients of federal financial assistance from discriminating against or otherwise excluding individuals on the basis of race, color, or national origin in any of their activities. In 1974, the US Supreme Court recognized LEP individuals as potential victims of national origin discrimination. In all situations, federal agencies are required to assess the number or proportion of LEP individuals in the eligible service population, the frequency with which they come into contact with the program, the importance of the services, and the resources available to the recipient, including the mix of oral and written language services. Additional details may be found in the Department of Justice Policy Guidance Document: Enforcement of Title VI of the Civil Rights Act of 1964 [http://www.usdoj.gov/crt/cor/pubs.htm](http://www.usdoj.gov/crt/cor/pubs.htm).

**Executive Order 13166, “Improving Access to Services for Persons with Limited English Proficiency”,** signed by the President on August 11, 2000 [http://www.usdoj.gov/crt/cor/13166.htm](http://www.usdoj.gov/crt/cor/13166.htm) was the genesis of the Guidance Document mentioned above. The Executive Order requires all federal agencies, including those which provide federal financial assistance, to examine the services they provide, identify any need for services to LEP individuals, and develop and implement a system to provide those services so LEP persons can have meaningful access.

**Dymally-Alatorre Bilingual Services Act** (California Government Code §7290 et seq.) requires every California state agency which either provides information to, or has contact with, the public to provide bilingual interpreters as well as translated materials explaining those services whenever the local agency serves LEP members of a group whose numbers exceed 5% of the general population.

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