PELVIC FLOOR ULTRASOUND

How, When, Why

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Disclosures

- **Professor Hans Peter Dietz**
  - Generosity of permitting educational use of his materials

- **Advisory Board Member, Jan 16-17, 2018**
  - GE Ultrasound, Women’s Health
Objectives

- Background

- Pelvic Floor Dysfunction
  - Urinary (UI) & Fecal Incontinence (FI)
  - Pelvic Organ Prolapse (POP)
  - Levator ani trauma
  - Suburethral Slings

- Conclusion
Pelvic Floor Dysfunction

- Umbrella term to cover disorders such as POP, UI, FI descending perineal syndrome (DPS)

- Etiology multifactorial related weakened +/or ineffective support structures. Risk factors include:
  - **Vaginal multiparity** (prolonged 2\textsuperscript{nd} stage labor), **advanced age**
  - Hysterectomy, CT disorders, obesity, hypoestrogenism, radiation
  - Chronic increased intrabdominal pressure
    - Weight lifters, obesity, chronic pulmonary disease
Pelvic Floor Imaging - Choices

- Transperineal ultrasound (TPUS)
- MRI dynamic with defecography
  - Relatively expensive, limited access with defecography
- Fleuroscopic Techniques - Traditional
  - Requires opacification bladder, vagina, bowel to visualize all compartments, limited access to defecography. Challenges radiation/prep required
- Endoanal ultrasound (gold standard AS)
Pelvic Floor US Imaging: Why Now?

- Inexpensive, well tolerated
- Multicompartmental, FOV smaller than MR
- * Suburethral slings are not well seen CT/MR
- High resolution rapid acquisition detailed info
  - Stored volumes/cine sets, tomographic slices and multi-planar images, 3D for UG hiatus & LA
  - Increased comfort with software (3D-4D in OB)
  - Real-time (cine-loop) ability gauge stress maneuver, can sit partially upright, immediate feedback
Pelvic Floor US Imaging: Why Bother?

- Affect 50% women by age 50 worldwide with societal costs in billions for UI, millions for POP
  - 1/10 have surgery by age 70
  - 1/3 require repeat surgery due to failures

- Project huge increased demand for services related to increased longevity and access to less invasive treatment options

Wu JM et al. Predicting #women who will undergo incontinence & prolapse surgery, 2010 to 2050. AJOG 2011;205(3):230
Clinical Context

- Symptoms may be variable based on affected compartment(s)
  - Pain, urinary and fecal incontinence, constipation, difficulty in voiding, a sense of pressure, and sexual dysfunction & dyspareunia

- Diminished self-image and quality of life
Compartment Pelvic Floor

- **Anterior** - Bladder, urethra
- **Central** - Uterus-cervix-vagina
- **Posterior** - Anal sphincter and rectum
**Technique:** Empty bladder, dorsal lithotomy, covered transducer placed between labia, minimum pressure in order to permit full pelvic organ descent.

**Basic Anatomy:** Diagram

*PS = Pubic Symphysis*
Anatomy Review: Increase Depth
 Technique: Basic Valsalva Real-Time
Urinary Incontinence

- Women more susceptible
  - **Anatomy**: Urethra shorter thus less resistance to outflow when bladder contracts
  - **Life style Risks**: Vaginal Delivery/2\textsuperscript{nd} stage labor prolonged
Urinary Incontinence: Types

- **Stress**: (SUI)
  - Involuntary loss of urine due to increase intrabdominal pressure
    - Cough, laugh, sneeze
    - Sphincteric defect / hypermobility urethra

- **Urge urinary incontinence**: (UUI)
  - Detrusor overactivity associated with detrusor thickness > 5mm or damage to innervation of the bladder

- **Overflow**: Leakage
Anterior Compartment: UI & Prolapse

Often combined

- PVR, bladder wall thickness (detrusor)
- Bladder neck: open, funnel, descend
- Urethra: rotate, descend, hypermobile (> 30 degrees), RVA > 120°, funnel proximal 1/3
- Does cystocele develop?
  - Due tear/stretch pubocervical fascia or levator ani
  - MRI grading relates distance bladder and PCL
  - mild (<3.0 cm), moderate (3.0–6.0 cm), or severe (>6.0 cm).

- Significant POP can mask SUI, hinder urethral hypermobility
Prolapse Assessment

- Line between pubic symphysis-anorectal angle
  - Plane minimum dimension
  - No anchor point but reproducible

- Key—Proper push/Valsalva which is **time dependant**
  - May take 4-5 seconds to reach final organ descent
  - Rehearse in real-time with patient watch screen
Plane of Minimum Dimension

Basic Anatomy: Diagram

PS = Pubic Symphysis
Case

24 year old, nullip, continent
Findings: Bladder neck remains closed but descends
Urethra rotates horizontal
Small cystocele develops

Rest

Strain

Case

Classic Stress Urinary Incontinence
Retrovesical angle now > 120 degrees

Case

Classic Stress Urinary Incontinence
Less common
Bladder neck remains in place
Voiding dysfunction rather than SUI
Association with levator ani trauma
Posterior Compartment

- **Anal continence**
  - Normal anorectal angle 90-130 degrees rest
  - Normal anorectal junction above or at level PS

- **Pelvic Organ Prolapse**
  - Perineal hypermobility & descent rectal ampulla

- **Rectovaginal septum (RVS) defect**
  - Rectocele - diverticular outpouching anterior wall rectum into vagina or descent into cul-de-sac: sigmoidocele, enterocoele, peritonocele (fat),

- **Rectal intussusception**
  - Anal sphincter trauma
Technique: Center anterior then move to posterior with maximum effort
- Measure rectocele depth to anterior wall of rectum, > 1-1.5 cm

Findings:
- Rest normal ARA which is above PS
- Strain develop rectocele, obtuse ARA, descent rectal ampulla
- Note bladder neck opens with strain
Defects in Rectovaginal Septum

Case

SIGMOIDOCELE

ENTEROCOLE
What's Abnormal?

Normal Reference

Posterior Compartment
Rectal intussception
3 grades depend on extent rectal exteriorization at end defecation:
1. Intra-rectal minimal involvement rectal wall restricted to anal canal
2. Extend beyond anal canal (prolapse thru anus)
3. Exteriorization rectum
Grade 3 rectal intussception with exteriorization rectum
Pelvic Organ Prolapse (POP)

- 9% women clinical symptoms
- 30% undergo repeat operation
- Negative impact on quality of life including sexual function
- LA avulsion from pubic bone or pelvic sidewall is associated with POP
  - LA avulsion is associated with vaginal delivery
Pelvic Organ Prolapse

- **Abnormal descent vagina** involving anterior wall, posterior wall and/or apex
  - Beneath line between PS & Ano-rectal junction (TPUS)
  - Due to protrusion of adjacent pelvic organs
    - Cystocele
    - Vaginal prolapse or procidentia (uterus)
    - Defect in rectovaginal fascia permit prolapse in anterior wall rectum (rectoceles) enteroceles, sigmoidoceles
  - Important to assess all compartments prior to surgery
Pelvic Floor & Plane
Minimum Dimension

- 2D line between pubic symphysis-anorectal angle
  - No anchor point but reproducible
Pelvic Organ Prolapse (Posterior)

Line from PS to ARA at rest.....
Multicompartmental POP, post hysterectomy
Role: 3D & Volume Rendered

- Key
  - Circumference urogenital hiatus
  - Levator Ani Trauma
  - Slings and Things
Pelvic Floor: Levator Ani muscles
Display Modes: MPR/Rendered

Render Plane is plane minimal dimension from inferior pubic symphysis to anorectal angle - Orient caudal to cranial

Puborectalis medial thick, ileococcygeus lateral/thinner

Courtesy Dr. Dietz
Urogenital Diaphragm

- Largest natural hiatus in body
  - Mean 16 cm young nullip
  - Mean 25 cm overall

- Most caudal layer pelvic floor
  - Composed of CT and peroneus muscle run from ischial rami to perineal body and EAS
  - Perineal body is site attachment for endopelvic fascia, UG diaphragm, bulbocavernosus muscle and puborectalis muscle
Urogenital Hiatus : Circumference
Rendered View in Plane minimum Dimension

Hiatal biometry high reproducibility, obtain oblique angle easier than with MR

Ballooning mild 25-30; moderate 30-35; marked 35-40; severe ≥ 40 cm²
Puborectalis sling including levator ani

“H” configuration normal vagina

Pubic symphysis

Courtesy Dr. Dietz
Levator Ani Avulsion

- Common post vaginal delivery (10-35% incidence)
  - Forceps increase risk ~ 3x
- Result in:
  - Reduction contraction strength
  - Increased risk prolapse (ant/central) 2-3x
  - Increased risk prolapse recurrence post surgery
- May not affect SUI or FI

Courtesy Dr. Dietz
- Direct sign: avulsion of LA
- Indirect sign: disruption of “H” configuration vagina with posterior displacement vaginal fornix
Levator ani (puborectalis) avulsion: TUI Display

2.5mm slice intervals:
- Complete Avulsion: all three central slices, namely (plane of the minimal hiatal dimensions) plus the two above.
- Partial avulsion: any of 3-8 slices abnormal.

? clinically important diagnosis.


Images courtesy Dr. Dietz

Case

RHS LA defect with muscle retraction
“Mini surgeries”

Continence maintained at midurethra
- Not bladder neck!
- Related to failure pubourethral ligaments.
- Suburethral slings best seen on TPUS
- TOT may have an advantage if associated levator ani avulsions

MUS is the most effective treatment for SUI.

The Role of Mid-urethral Slings in 2014: Analysis of the Impact of Litigation on Practice
Colby E. Perkins et al Current Bladder Dysfunction Reports 2015 vol 10 pp39-45
Sagittal
- Mesh midurethral level

Transverse
- Relatively straight extends lateral out thru obturator foramen
Case: Evaluate TOT on 2D Coronal
Present: Voiding Dysfunction
- Gap typically 10-15mm diameter
- Too tight, Split suburethral sling surgically
History: Persistent post-operative pain
Technique: Using coronal reformats with CT style slicing through volume.
Findings: TVT mesh fragmented right, possibly in right urethral wall
And posterior fragment in vagina
History: TVT, post-operative pain
Technique: MPR with rendered view
Findings: TVT eroded into urethra
Complications

- Too tight or too loose
- Mesh erosion rate ~ 9%
- Bleeding pv 31%, Pain 13%
- Voiding dysfunction 21%
- 20% mesh arm dislodge - mesh mobile
  - *Line straight or obtuse, wide gap? not anchored*
- *Dehiscent, fray, migrate, perforate*
Pelvic floor disorders common

TPUS good for

- Pelvic Organ Prolapse
- Levator Ani Avulsions
- Urinary Incontinence, stress
- Assessment mid-urethral slings (MUS)
- Biofeedback pelvic floor contractions
Thank You

Ultrasonography

- Power
- Elastography
- Neovascularity
- Blood Flow
- Surgery without knives
- US Stethoscope of Future
- Super Resolution
- Imaging
- Healing
- Remote Ultrasound
- B Flow Imaging
- Fusion Imaging
- Ultrasound Luminal Gel Agents
- 4D Imaging
- Real Time Volume Imaging
- Ultrafast
- Integration in medical school
- Transducer Technology Revolution
- Quantitative Ultrasound
- Solid State Circuitry
- Focused Ultrasound Therapy
- Contrast enhanced
- Ultrasound guided biopsy
- Robotic Assisted Ultrasound
- Deep Infiltrating Endometriosis
- Staging of Cancer
- encoded pulses
Thank you
References