# URODYNAMICS

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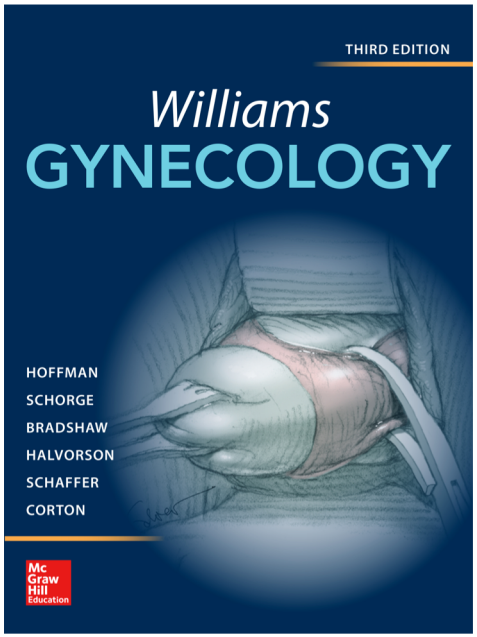
# Objectives

1. To provide a description of the components of urodynamic testing for the evaluation of urinary tract dysfunction and the indications for these tests
2. To provide examples of clinical urodynamic studies to understand how this test contributes to clinical decision-making

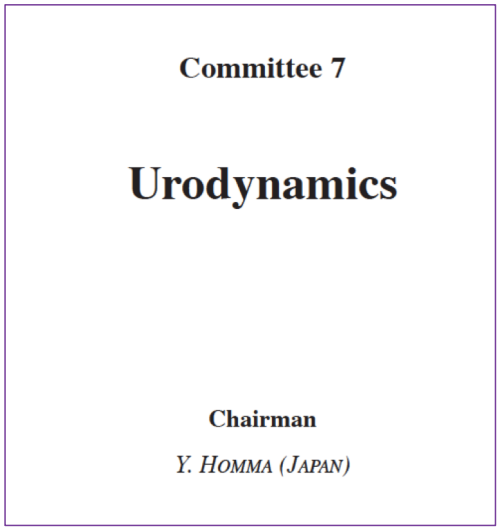
[Digital image]. (2017). Retrieved from http://www.aait.edu.et/school-civil-environmental-engineering/objectives

# Sources


Amir, B., Farrell S. SOGC Committee Opinion on Urodynamics Testing. JOCG. 2008, Aug;30(80):717-721.




Hoffman, B., Schorge J., Bradshaw K., Halvorson L., Schaffer J., Corton M. (2016). William's gynecology. 3rd ed. New York. McGraw-Hill Education.




International Continence Society (ICS)

Homma, Y., Batista, J., Bauer, S., Griffiths, D., Hilton, P., Kramer, G., Lose, G., Rosier, P. Urodynamics. International Continence Society Committee 7.

# Urodynamics

- The bladder is an unreliable witness


**"Perhaps you'd like to reconsider that last answer."**

Unreliable Witness cartoon [Digital image]. (n.d.). Retrieved from https://www.cartoonstock.com/directory/u/unreliable_witness.asp

# Urodynamics

- Urodynamics is an objective tool used to investigate the function of the lower urinary tract
- The goal of urodynamics is to reproduce patient's symptoms

**Urodynamics is used to identify:**

- Bladder outlet obstruction
- Detrusor instability
- SUI
- Impaired detrusor contractility (underactive detrusor muscle)
- Intrinsic sphincter deficiency (ISD)

# Indications for Urodynamics

**SOGC 2008 Committee Opinion on Urodynamics Testing:**

- Indications are controversial

**Indications:**

- Diagnosis is uncertain after initial history and physical exam (III-C)
- Symptoms do not correlate with objective physical findings (III-C)
- Failure to improve with treatment (III-C)
- Clinical trial setting (III-C)
- Planned surgical intervention (repeat incontinence surgery) **(most controversial!)**

**Urodynamics is not required:**

- **Conservative management** of urinary incontinence (III-C)
- Primary surgery for SUI when diagnosis is clear (III-C)

# Indications for Urodynamics

**Table 1. Key to evidence statements and grading of recommendations, using the ranking of the Canadian Task Force on Preventive Health Care**

| Quality of evidence assessment[a] | Classification of recommendations[b] |
|---|---|
| I: Evidence obtained from at least one properly randomized controlled trial. | A. There is good evidence to recommend the clinical preventive action. |
| II-1: Evidence from well-designed controlled trials without randomization. | B. There is fair evidence to recommend the clinical preventive action. |
| II-2: Evidence from well-designed cohort (prospective or retrospective) or case-control studies, preferably from more than one centre or research group. | C. The existing evidence is conflicting and does not allow to make a recommendation for or against use of the clinical preventive action; however, other factors may influence decision-making. |
| II-3: Evidence obtained from comparisons between times or places with or without the intervention. Dramatic results in uncontrolled experiments (such as the results of treatment with penicillin in the 1940s) could also be included in the category. | D. There is fair evidence to recommend against the clinical preventive action. |
| III: Opinions of respected authorities, based on clinical experience, descriptive studies, or reports of expert committees. | E. There is good evidence to recommend against the clinical preventive action. |
| | I. There is insufficient evidence (in quantity or quality) to make a recommendation; however, other factors may influence decision-making. |

[a]The quality of evidence reported in these guidelines has been adapted from The Evaluation of Evidence criteria described in the Canadian Task Force on Preventive Health Care.

[b]Recommendations included in these guidelines have been adapted from the Classification of recommendations criteria described in The Canadian Task Force on Preventive Health Care.

Amir, B., Farrell S. SOGC Committee Opinion on Urodynamics Testing. JOCG. 2008, Aug;30(80):717-721.

# Drawbacks of Urodynamics

- There is a significant controversy about using urodynamics in clinical setting
- Evidence is lacking

**Cochrane review 2002:**

- Insufficient evidence to draw any reliable conclusions whether diagnosis based on urodynamics testing prior to treatment affected outcomes comparing to treatment based on diagnosis from Hx and physical exam
  - Urodynamics did not improve outcomes
- Recommended larger prospective trials

# Controversies of Urodynamics

- **No standardization of normal values and ranges**
- Wide range of physiological values in normal asymptomatic patients

# Controversies of Urodynamics

**Other drawbacks:**

- Invasive, may be embarrassing to pts
- Artificial testing setting → may not be representative of the situation/activity that caused leaking
  - False –ive: patient may have normal urodynamic testing and symptoms during daily activities
  - False +
- Inconsistent reproducibility in the same patient
- Wide range of physiologic values in normal asymptomatic patients
- Not all abnormalities on urodynamics are clinically significant → leakage may not be clinically relevant

# PRINCIPLES OF URODYNAMICS

# Bladder Function

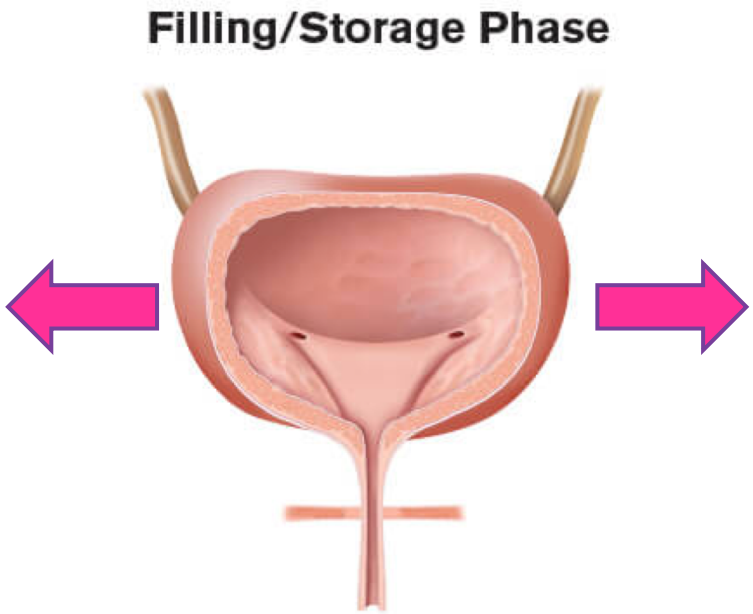
- There are 2 phases of bladder function
  - Bladder filling and storage
  - Bladder emptying
- There are 2 types of urinary dysfunction
  - Dysfunction of storage
  - Dysfunction of voiding

**5 components required for normal bladder filling and emptying:**

- Appropriate bladder sensation
- Normal bladder compliance
- Bladder stability
- Competent ureteral-vesical junction
- Competent closed vesical outlet during rest and ↑ intra-abdominal pressure

# Bladder Filling and Storage

- As the bladder fills, sensation of filling is perceived, and patient feels desire to void
- Urine can be stored at a low and stable pressure due to accommodation of bladde and competence of urethra

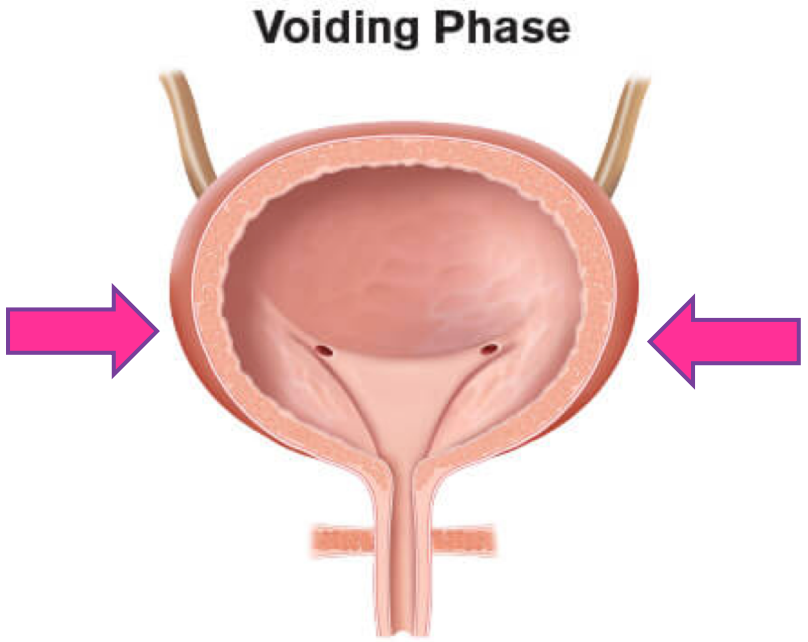



Low bladder pressure
Detrusor smooth muscle relaxed
Urethra contracted

[Digital image]. (n.d.). Retrieved from https://northeastgaurology.com/tag/overactive-bladder/

# Bladder Emptying

- Detrusor muscle contracts and outlet resistance decreases
- Voluntary initiation of micturition, then forceful and continuous flow of residual urine




[Digital image]. (n.d.). Retrieved from https://northeastgaurology.com/tag/overactive-bladder/

**Bladder emptying requires:**

- Coordinated and adequate contraction of detrusor muscle
- Coordinated decrease in resistance at the level of smooth and striated urethral sphincters
- Absence of urethral obstruction

# Components of Urodynamics Testing

1. Screening tests for voiding dysfunction
   - Uroflowmetry
   - Post-void residual (PVR)
2. Bladder function
   - Cystometry
   - Pressure flow studies
3. Urethral function tests
   - Urethral pressure profile
   - Abdominal leak point pressure
4. Electromyography (EMG)

[Digital image]. (2016, July 12). Retrieved from https://erebunimed.com/eng/news.more/191

# Summary of Urodynamics

| | Used to evaluate | For patients with |
|---|---|---|
| Screening tests for voiding dysfunction | | |
| • Uroflowmetry | • Global voiding function<br>• Screen for bladder outflow obstruction, detrusor contractility problems | • Urinary incontinence<br>• Suspect voiding dysfunction |
| • Post-void residual (PVR) | | |
| Bladder function | • Explain abnormal voiding symptoms or abnormal screening (uroflow, PVR) | |
| • Cystometry | • Filling phase: bladder storage, sensation, and compliance, distinguish between SUI and detrusor instability | • Urinary incontinence<br>• Suspect voiding dysfunction |
| • Pressure flow studies | • Voiding phase: distinguishes between underactive detrusor and bladder outlet obstruction | |
| Urethral function tests | | |
| • Urethral pressure profile | • Urethral closing forces | • Suspected intrinsic sphincter deficiency (ISD) |
| • Abdominal leak point pressure | • Urethral competence against pressure in the bladder (due to detrusor or abdominal forces) | • Suspected intrinsic sphincter deficiency (ISD)<br>• Suspected neurogenic lower urinary tract dysfunction |
| Electromyography | • Coordinated relaxation of pelvic floor musculature during voiding | • Suspected dyssynergic/dysfunctional voiding<br>• Research |

# Case #1

50yo G2P2 presents with mixed urinary incontinence

**Urinary Hx:** both SUI and urge incontinence
- Daytime frequency of 7 episodes/day, nocturia of 0-1 episodes/night
- Uses pads, sometimes floods her pads
- <1 UTI per year

**Fluid intake:** 5 cups H2O, 2-3 cups caffeine, no alcohol, no pop

Smoker >1/2ppd

**GI:** Normal bowel function, no fecal incontinence

**Sexual Hx:** not sexually active due to problems on her partner's side

**Prolapse Hx:** no bulge symptoms, no difficulty emptying bladder, no pelvic pain or back pain

**Therapies tried:** Anterior repair for SUI in distant past; oxybutinin 2.5mg PO BID for 1 month without effect

**OBHx:**

SVDx2, largest infant 7lbs 4oz

**Gyne Hx:**

TAH, left oophorectomy for menorrhagia

Anterior repair for SUI

**PMHx:**

**Medical conditions:**
- HTN
- Anxiety and depression, treated since age 17
- Mixed urinary incontinence

**Meds:**
- Conjugated estrogens 0.625mg daily
- Seroquel 200mg QHS (atypical antipsychotic)
- Ramipril/hydrochlorothiazide 5mg/25mg daily

**Allergies:** NKDA

**Surgeries:** anterior repair, TAH+ left oophorectomy, booked for neck surgery due to old #

**Fx:** non-contributory

**Sx:** Homemaker, married, smokes >1/2ppd, denies alcohol or recreational drug use

**O/E:**

Grade 0 anterior, apical, and posterior prolapse

4/5 pelvic floor muscle strength

Collection of Cartoon Woman Cliparts [Digital image]. (n.d.). Retrieved from http://clipart-library.com/cartoon-woman-cliparts.html

# SCREENING TESTS FOR VOIDING DYSFUNCTION

**Components of urodynamics:**

1. **Screening tests for voiding dysfunction: uroflowmetry, post-void residual (PVR)**
2. Bladder function: cystometrogram, pressure flow study
3. Urethral function tests: urethral pressure profile, abdominal leak point pressure
4. Electromyography

# Summary

| | Used to evaluate | For patients with |
|---|---|---|
| Screening tests for voiding dysfunction | | |
| • Uroflowmetry<br>• Post-void residual (PVR) | • Global voiding function<br>• Screen for bladder outflow obstruction, detrusor contractility problems | • Urinary incontinence<br>• Suspect voiding dysfunction |

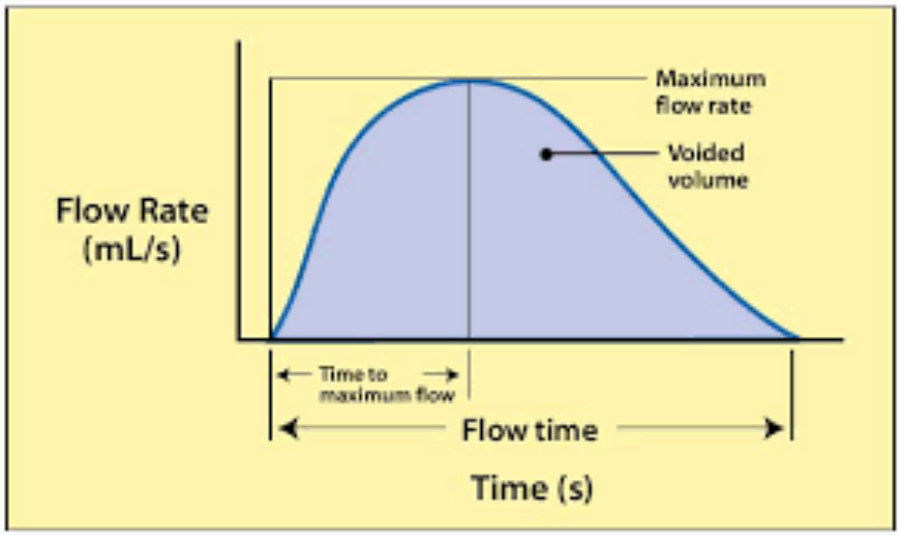
**Screening vs diagnostic tests:**

- Screening: combination of uroflowmetry and PVR has 70% specificity for voiding dysfunction
- If abnormal screening results → perform cystometry and pressure-flow studies

# Uroflowmetry

- Measures volume of urine passed per unit time
  - Units: mL/sec

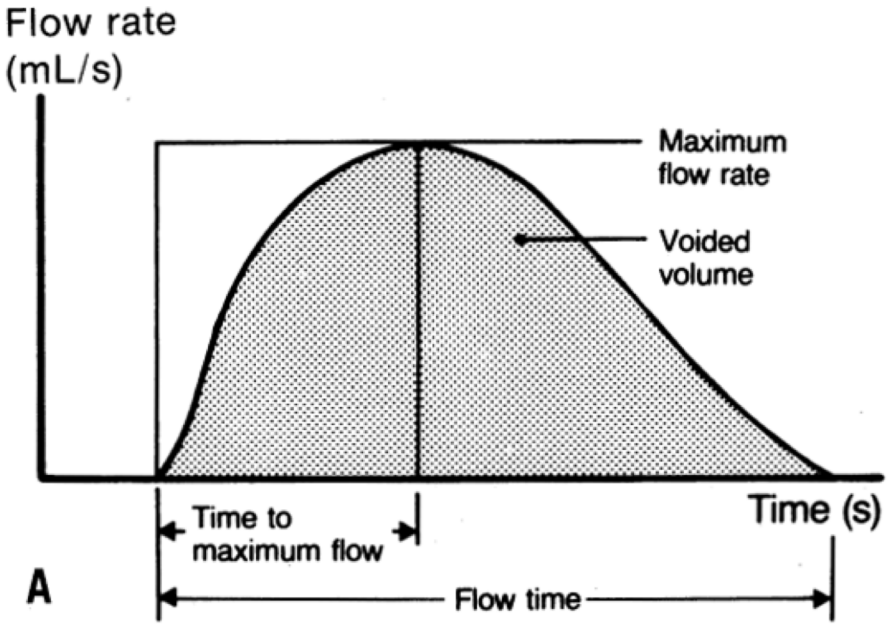

[Digital image]. (n.d.). Retrieved from https://patients.uroweb.org/de/ich-bin-ein-patient/harninkontinenz/beurteilung-und-diagnose-der-harninkontinenz/




Dejhan, R., & Yimman, S. (n.d.). [Digital image]. Retrieved from https://ieeexplore.ieee.org/document/7022392/

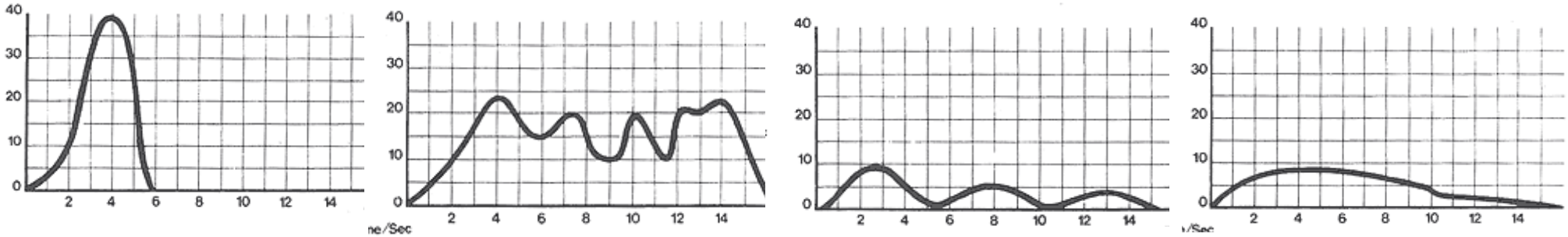
# Normal Uroflow

| | Normal (SOGC 2008) |
|---|---|
| Uroflow pattern | • Bell-shaped, smooth |
| Voided volume | • >200mL |
| Qave (average flow rate) | • >15mL/sec |
| Qmax (maximum flow rate) | • 20-36mL/sec |
| Flow time (from initiation to completion of urination) | • 15-30sec |

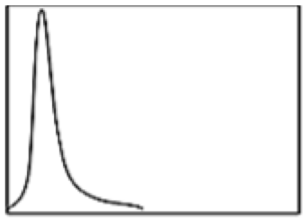



Sand, P. (n.d.). Normal uroflowmetry study demonstrating a normal bell-shaped pattern ( A) and an abnormal screening uroflowmetry study [Digital image]. Retrieved from http://www.glowm.com/section_view/heading/Diagnostic Procedures in the Evaluation of Female Urinary Incontinence and Voiding Dysfunction/item/55

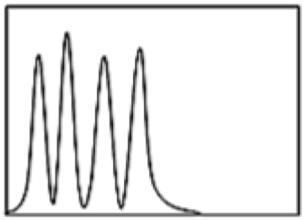
# Abnormal Uroflow Patterns



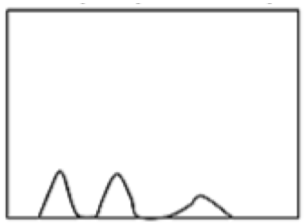

Graphic representation of various uroflow patterns [Digital image]. (n.d.). Retrieved from http://www.womenshealthsection.com/content/print.php3?title=urog013&cat=4&lng=english



**Superflow/tower pattern**
- Poor urethral resistance



**Intermittent multiple peak (stoccato) pattern**



**Intermittent interrupted (fractionated) pattern**

**Plateau pattern**
- Detrusor outlet obstruction

Abnormal urine flow patterns can be helpful in identifying underlying causes of voiding dysfunction. A tower curve pattern may be seen in patients with an overactive bladder, a plateau curve in patients with bladder obstruction, a plateau or staccato curve in patients with dysfunctional voiding, and an interrupted curve in patients with an underactive bladder. [Digital image]. (2011). Retrieved from https://somepomed.org/articulos/contents/mobipreview.htm?14/54/15205

# Post-Void Residual (PVR)

- Volume of urine remaining in the bladder after completion of voiding
- Measured using a sonographic bladder scanner or transurethral catheterization

FIGURE 23-12 Handheld bladder scanner aids estimation of bladder volume.

Hoffman, B., Schorge J., Bradshaw K., Halvorson L., Schaffer J., Corton M. (2016). William's gynecology. 3rd ed. New York. McGraw-Hill Education.

| | Normal (SOGC 2008) |
|---|---|
| PVR | • <100-150mL<br>• Voiding 75-80% of total bladder volume |

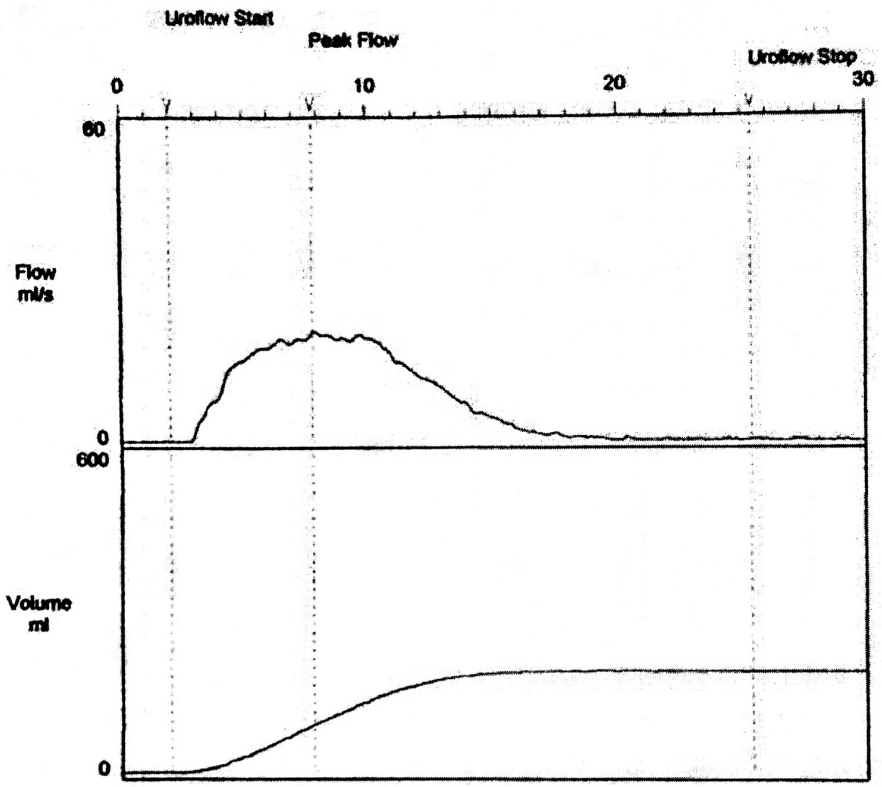
↑ **PVR:**
- Urinary retention
- Recurrent UTI
- Urethral obstruction (ex. pelvic mass, anterior vaginal wall prolapse, TVT/TOT that is too tight)
- Neurologic dysfunction, poor detrusor contractility (ex. DM)
- False + with bladder scanner→ large fibroids, pelvic mass

↓ **PVR:**
- SUI

# Case #1

## Uroflow, PVR

Collection of Cartoon Woman Cliparts [Digital image]. (n.d.). Retrieved from http://clipart-library.com/cartoon-woman-cliparts.html



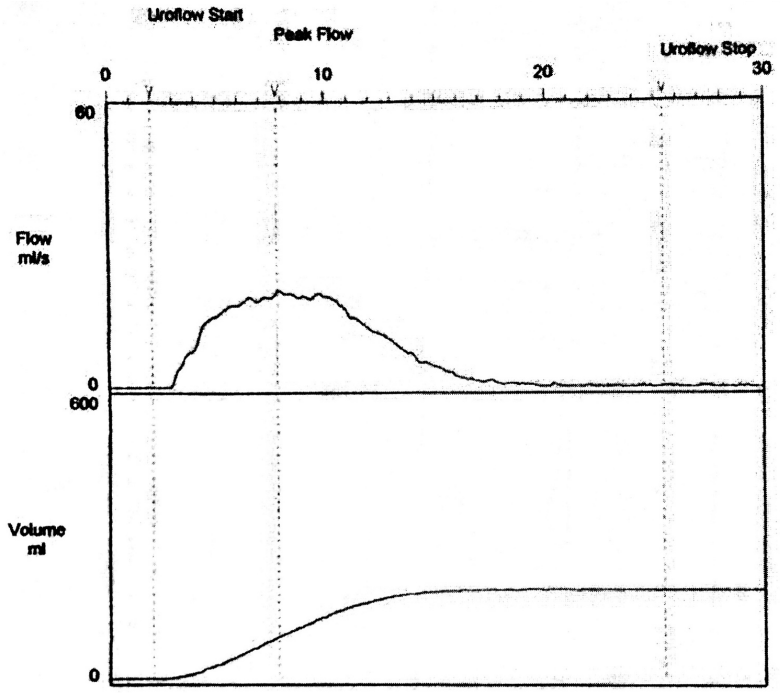

**Voiding Summary**

| | Value | | Dev (Female) |
|---|---|---|---|
| Maximum flow: | 20.9 | ml/s | 24 % |
| Average flow: | 10.5 | ml/s | -5 % |
| Voiding time: | 23.5 | mm:ss.S | -43 % |
| Flow time: | 18.0 | mm:ss.S | |
| Time to max. flow: | 5.9 | mm:ss.S | 25 % |
| Voided volume: | 190.0 | ml | |
| Flow at 2 seconds: | 8.2 | ml/s | |
| Acceleration: | 3.5 | ml/s/s | |
| VOID: | 20/190/0 | | |
| Residual Volume: | 3 | ml | |

# Case #1

## Uroflow, PVR

Collection of Cartoon Woman Cliparts [Digital image]. (n.d.). Retrieved from http://clipart-library.com/cartoon-woman-cliparts.html




| | Case #1 | Normal (SOGC 2008) |
|---|---|---|
| Uroflow pattern | • Bell-shaped, smooth (N) | • Bell-shaped, smooth |
| Voided volume | • 190mL (slightly ↓) | • >200mL |
| Qave (average flow rate) | • 10.5mL/sec (↓) | • >15mL/sec |
| Qmax (maximum flow rate) | • 20.9mL/sec (N) | • 20-36mL/sec |
| Flow time (from initiation to completion of urination) | • 18.0sec (N) | • 15-30sec |
| PVR | • 3mL | • <100-150mL<br>• Voiding 75-80% of total bladder volume |

- Slightly decreased voided volume and average flow rate
- Small PVR

# BLADDER FUNCTION TESTING

**Components of urodynamics:**

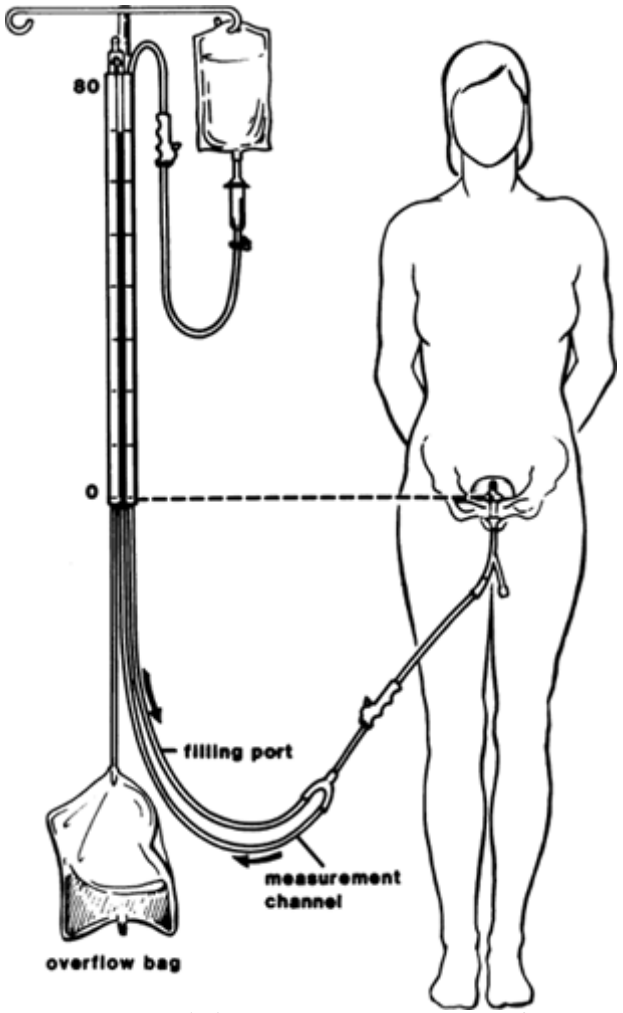
1. Screening tests for voiding dysfunction: uroflowmetry, post-void residual (PVR)
2. **Bladder function: cystometry, pressure flow studies**
3. Urethral function tests: urethral pressure profile, abdominal leak point pressure
4. Electromyography

# Summary

| | Used to evaluate | For patients with |
|---|---|---|
| Bladder function | • Explain abnormal voiding symptoms or abnormal screening (uroflow, PVR) | |
| • Cystometry | **Filling phase:**<br>• Bladder storage, sensation, and compliance<br>• Distinguishes between SUI and detrusor overactivity | • Urinary incontinence<br>• Suspect voiding dysfunction |
| • Pressure flow studies | **Voiding phase:**<br>• Distinguishes between underactive detrusor and bladder outlet/outflow obstruction | |

# Cystometry

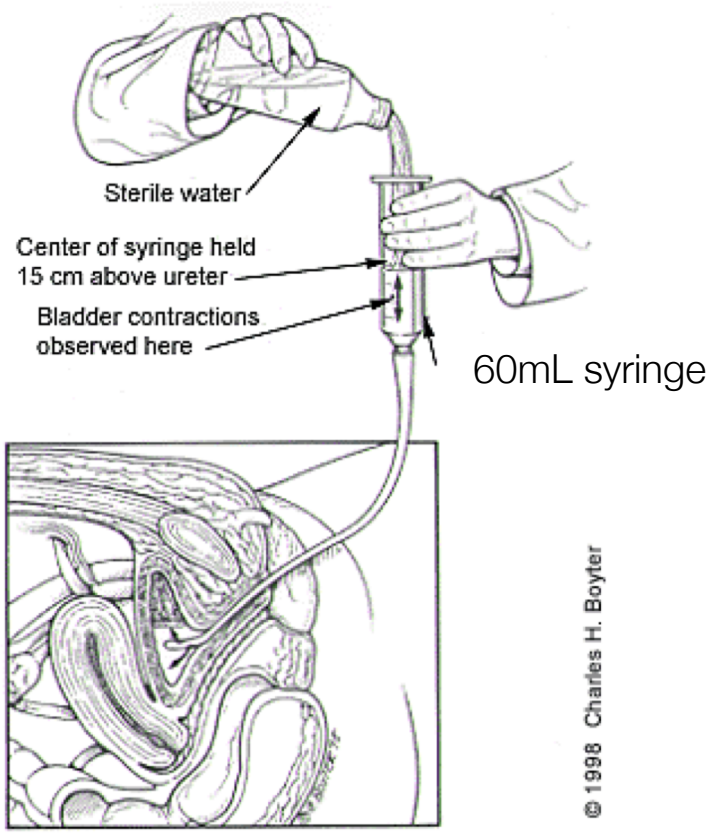
- Evaluates passive filling
- May be simple or multichannel




Sand, P., Brubaker, L., & Novak. (1991). A simple manometric cytometry unit that can be used to perform incremental, retrograde cystometry [Digital image]. Retrieved from http://www.glowm.com/section_view/heading/Diagnostic Procedures in the Evaluation of Female Urinary Incontinence and Voiding Dysfunction/item/55

# Simple Cystometrics

- Performed by a gynecologist
- Can detect SUI and detrusor overactivity
  - Limitation: cannot assess for instrinsic sphincter deficiency (ISD)




Boyter, C. [Digital image]. (1998). Retrieved from https://clinicalgate.com/urodynamic-testing-simple/

**Looking for:**
- First sensation to void
- Desire to void
- Bladder capacity

| | Normal (SOGC 2008) |
|---|---|
| First sensation to void | • 100-200mL |
| Normal desire to void | • 150-350mL |
| Maximum cystometric (bladder) capacity | • 300-600mL (William's: 300-700mL) |

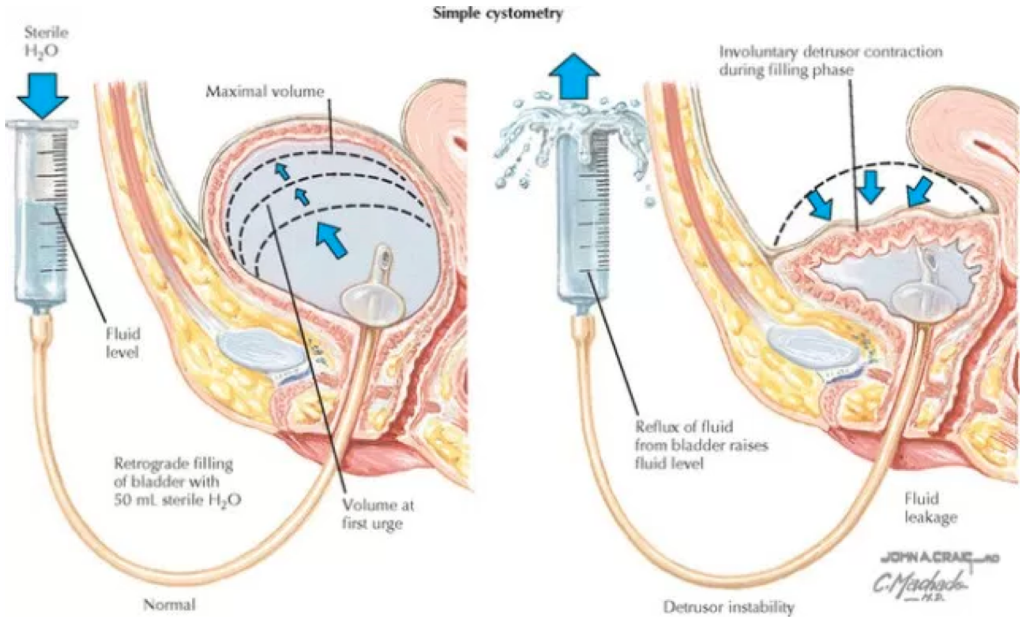
# Simple Cystometrics

**Detrusor overactivity:**

- During filling phase, looking for changes in the fluid meniscus inside of syringe
- Abrupt meniscus elevation without Valsalva/cough due to detrusor contractions

**SUI:**

- When bladder capacity is reached, pt performs Valsalva/coughing while standing → leakage indicates SUI




[Digital image]. (2015, May 31). Retrieved from https://clinicalgate.com/urodynamic-testing-simple/

# Multi-Channel Cystometrics

- Performed by a urogynecologist
- Produces cystometrogram

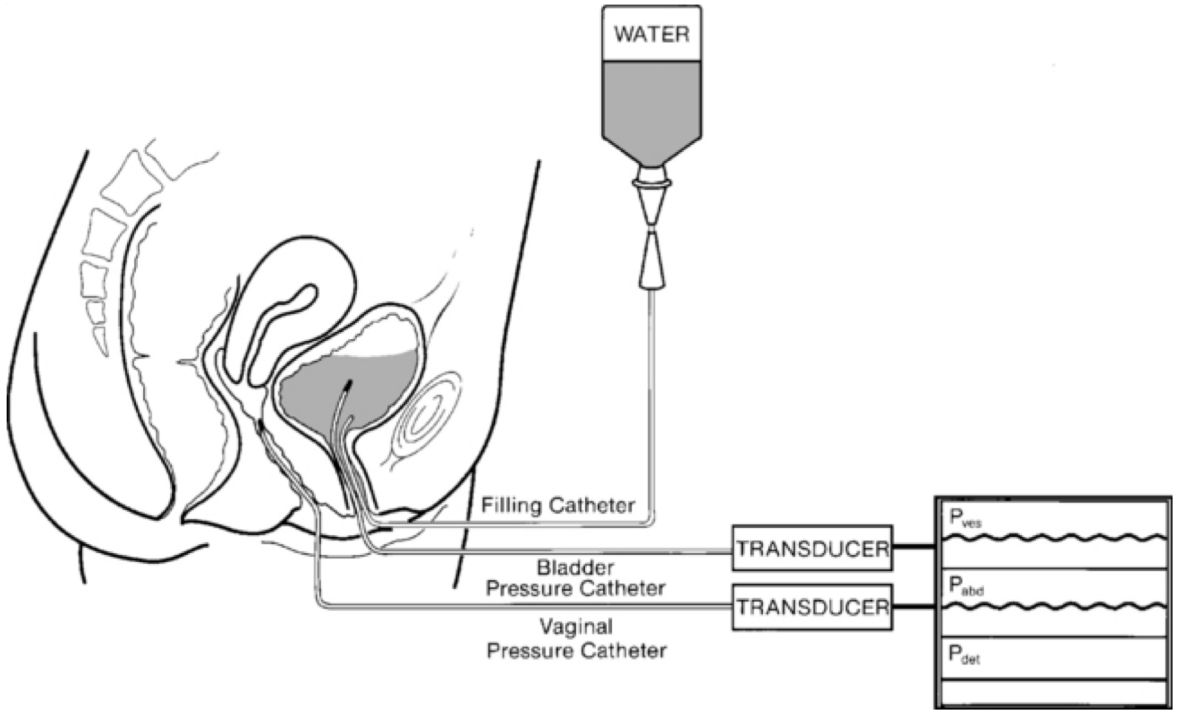
Electrically adjustable urodynamic chair (Courtesy of Albyn Medical) [Digital image]. (2017, September 23). Retrieved from https://abdominalkey.com/invasive-urodynamics/


Urodynamic system

[Digital image]. (2017, July 5). Retrieved from https://abdominalkey.com/urodynamics-the-practical-aspects/

# Multi-Channel Cystometrics

- 1st catheter is placed into the bladder→ measures **intravesical pressure ($p_{ves}$)**
- 2nd catheter is inserted into vagina (rectum if advanced POP) → measures **abdominal pressure ($p_{abd}$)**
- **Calculated detrusor pressure ($p_{det}$)**



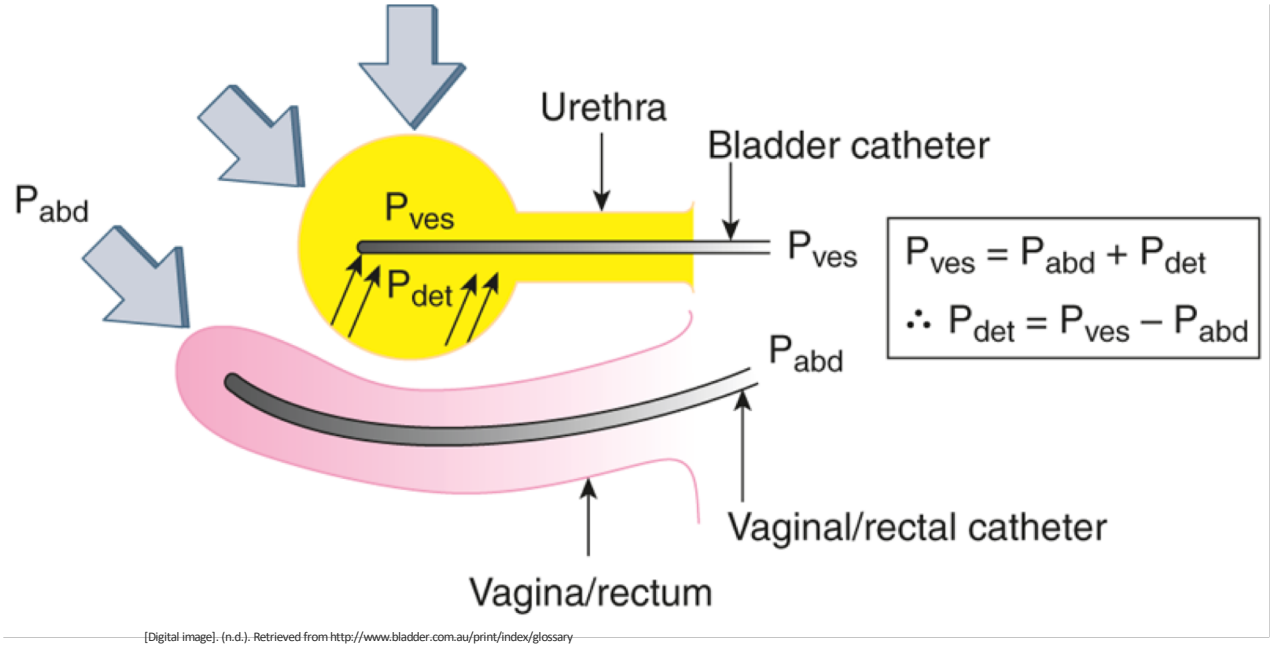

Subtracted cystometry. Intravesical and intra-abdominal pressures are measured, and true detrusor pressure is electronically derived (Pves – Pabd). Pves, Bladder pressure; Pabd, abdominal pressure; Pdet, detrusor pressure. [Digital image]. (2016, March 11). Retrieved from https://plasticsurgerykey.com/urodynamics-cystometry-and-urethral-function-tests-2/

# Multi-Channel Pressure Recordings

**Intravesical pressure** ($p_{ves}$)
- Pressure in the liquid present within the bladder
- Combination of pressure generated by detrusor muscle of the bladder and pressure from the abdominal cavity
- $p_{ves} = p_{det} + p_{abd}$

**Abdominal pressure** ($p_{abd}$)
- Net effect of forces exerted on the bladder by the surrounding organs of the abdominal cavity
  - Pressure is measured in the rectum/vagina
- Increases with Valsalva

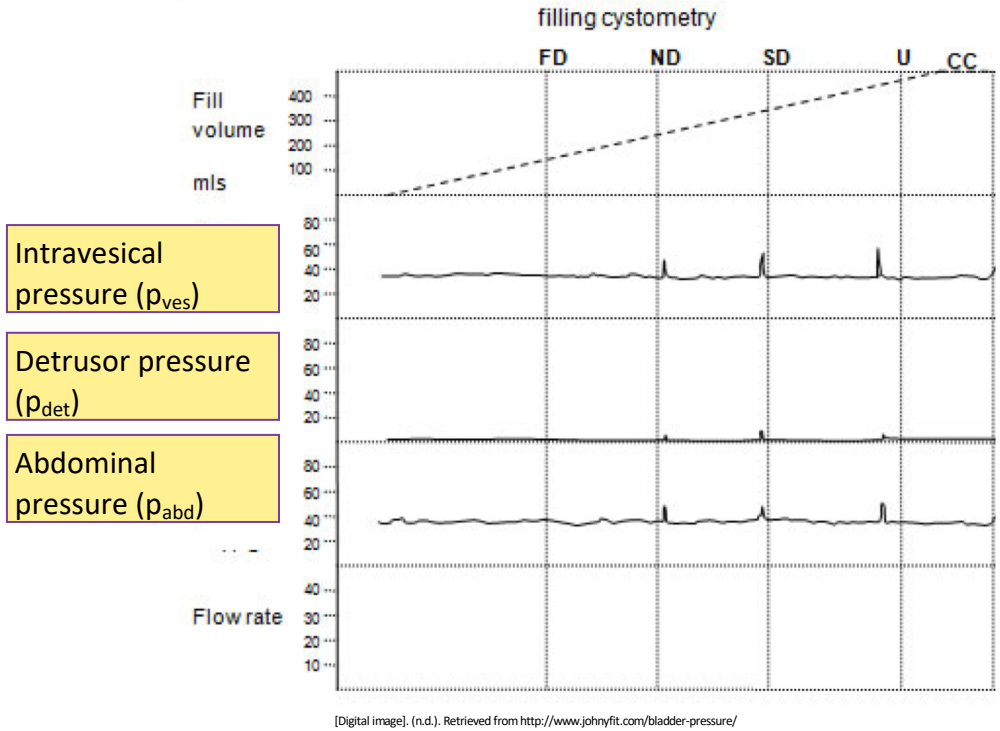
**Calculated detrusor pressure** ($p_{det}$)
- Net force exerted by detrusor muscle on the liquid
- **Detrusor pressure= intravesical pressure- abdominal pressure**
  - $p_{det} = p_{ves} - p_{abd}$
- Not affected by Valsalva




[Digital image]. (n.d.). Retrieved from http://www.bladder.com.au/print/index/glossary

# Filling Cystometry

- Bladder is filled with NS, sterile H2O, or contrast material
- The patient is asked to cough at regular intervals (q50mL) → looking for leakage of urine around the catheter at the external urethral meatus

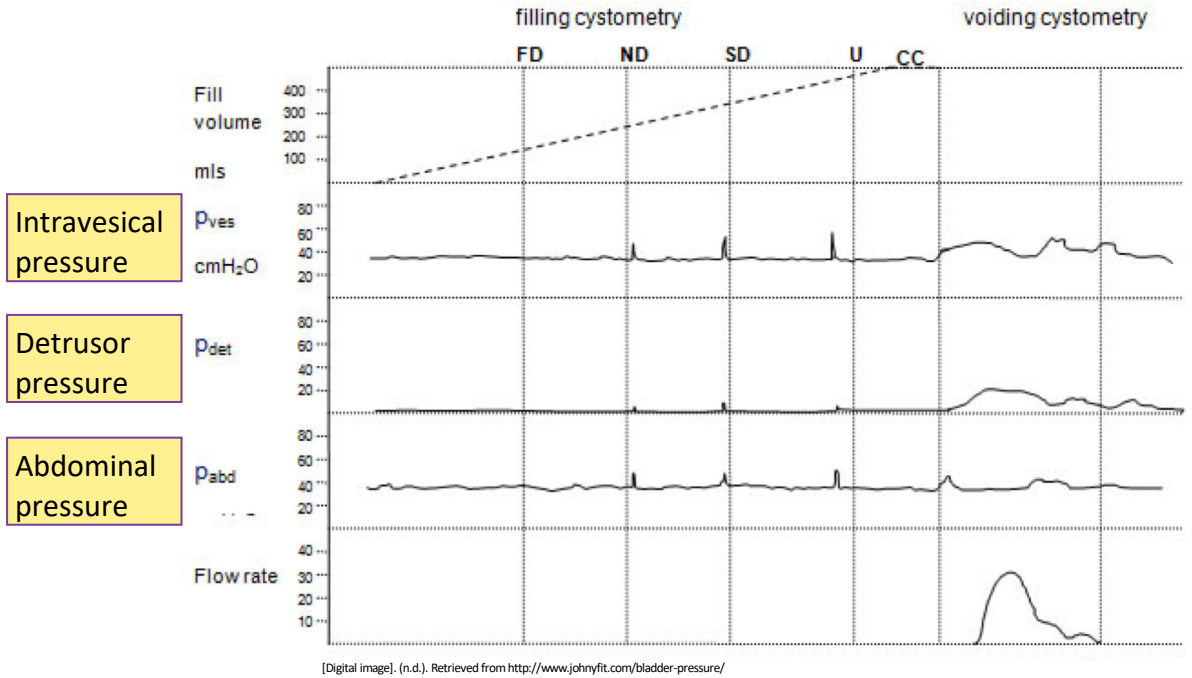



[Digital image]. (n.d.). Retrieved from http://www.johnyfit.com/bladder-pressure/

FD = First Desire to Void
ND = Normal desire to void
SD = Strong desire to void
U = Urgency
CC = Cystometric Capacity (permission to void is given)

# Filling Cystometry

**Looking for:**
- FD= first sensation/desire to void
- ND= normal desire to void
- SD= strong desire to void
- U= urgency
- CC- cystometric (bladder) capacity (permission is given to void)
- Saline-infusion flow-rate
- Bladder compliance
- Presence of SUI, detrusor overactivity



[Digital image]. (n.d.). Retrieved from http://www.johnyfit.com/bladder-pressure/

| | Normal (SOGC 2008) |
|---|---|
| First sensation to void | • 100-200mL |
| Normal desire to void | • 150-350mL |
| Urgency | • 250-500mL |
| Maximum cystometric (bladder) capacity | • 300-600mL |
| SUI | • No SUI |
| Detrusor overactivity | • No involuntary detrusor contractions |

**Delayed sensation of bladder fullness:**
- Neuropathy

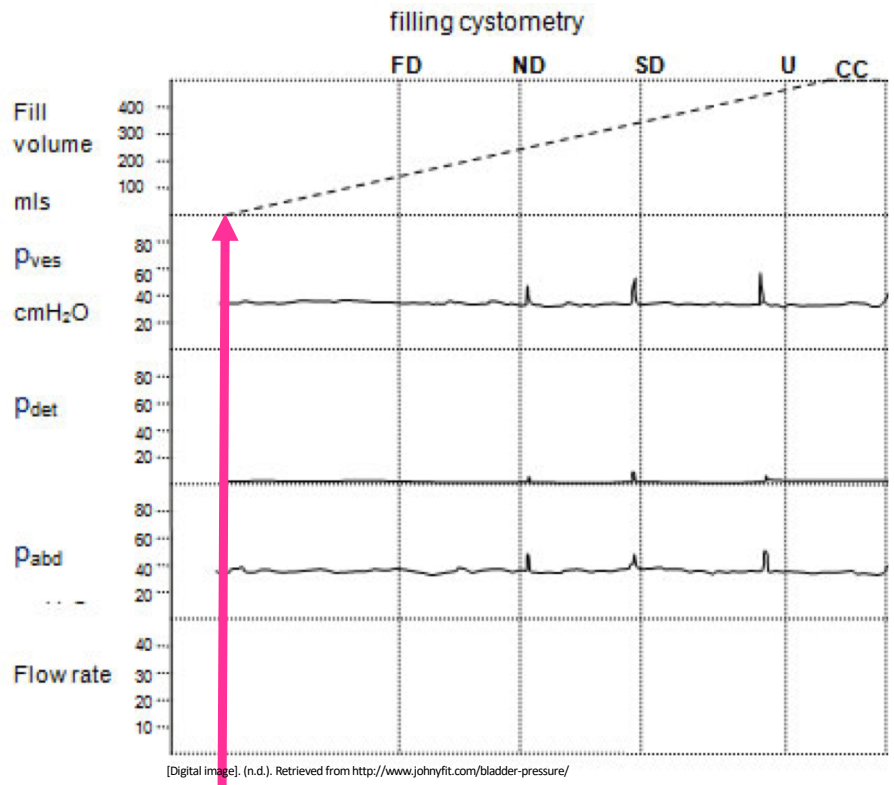
**Extreme bladder sensitivity:**
- Sensory disorders (ex. Interstitial cystitis)

# Bladder Compliance

- Bladder compliance= change in volume/change in detrusor pressure
  - Units: mL/cm H2O

| | Normal (SOGC 2008) |
|---|---|
| Normal bladder compliance | • **Large range of normal: 11-150mL/cm H2O**<br>  • Detrusor pressure: <15cm H2O during filling |
| Low bladder compliance | • Detrusor pressure >15cm H2O and no evidence of detrusor instability; usually combined with low bladder capacity |

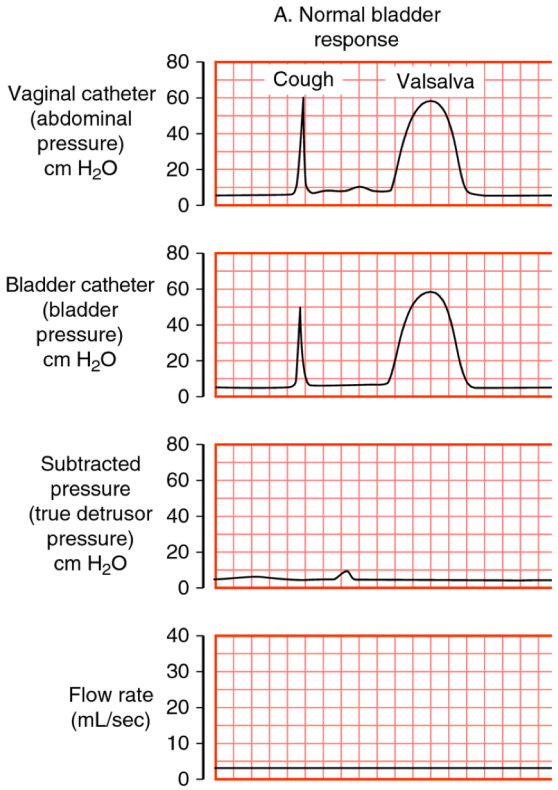
# Normal Cystometrogram




[Digital image]. (n.d.). Retrieved from http://www.johnyfit.com/bladder-pressure/

Filling begins:

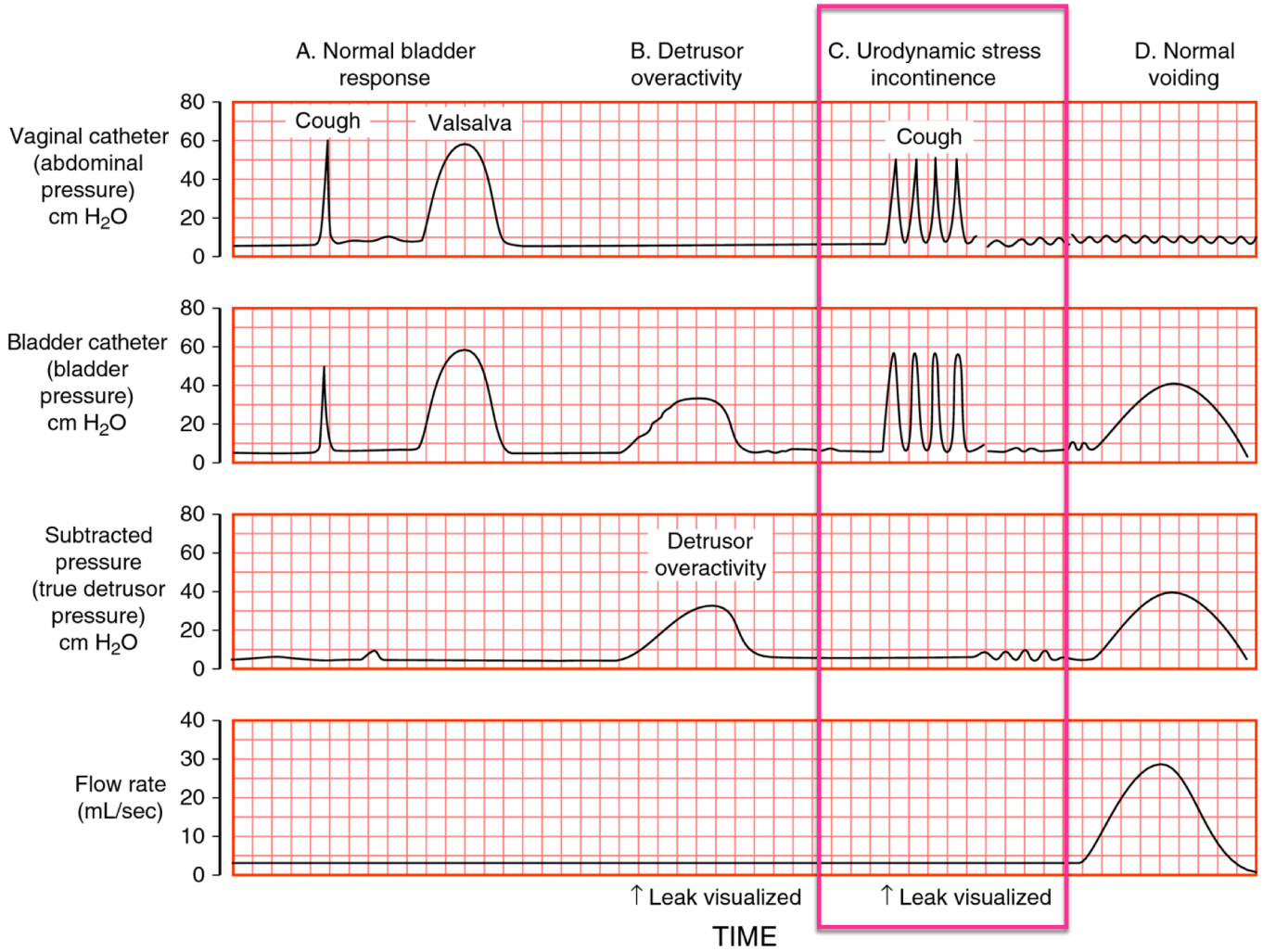
- Bladder is nearly empty
- Fill volume begins to increase




Hoffman, B., Schorge J., Bradshaw K., Halvorson L., Schaffer J., Corton M. (2016). William's gynecology. 3rd ed. New York. McGraw-Hill Education.

- Similar changes should be observed in $p_{ves}$ and $p_{abd}$ → rise in $p_{ves}$ is associated with rise in $p_{abd}$
- Detrusor pressure ($p_{det}$) is nearly 0
- Cough/Valsalva does not increase detrusor pressure

# Urodynamic SUI

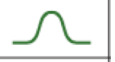





Hoffman, B., Schorge J., Bradshaw K., Halvorson L., Schaffer J., Corton M. (2016). William's gynecology. 3rd ed. New York. McGraw-Hill Education.

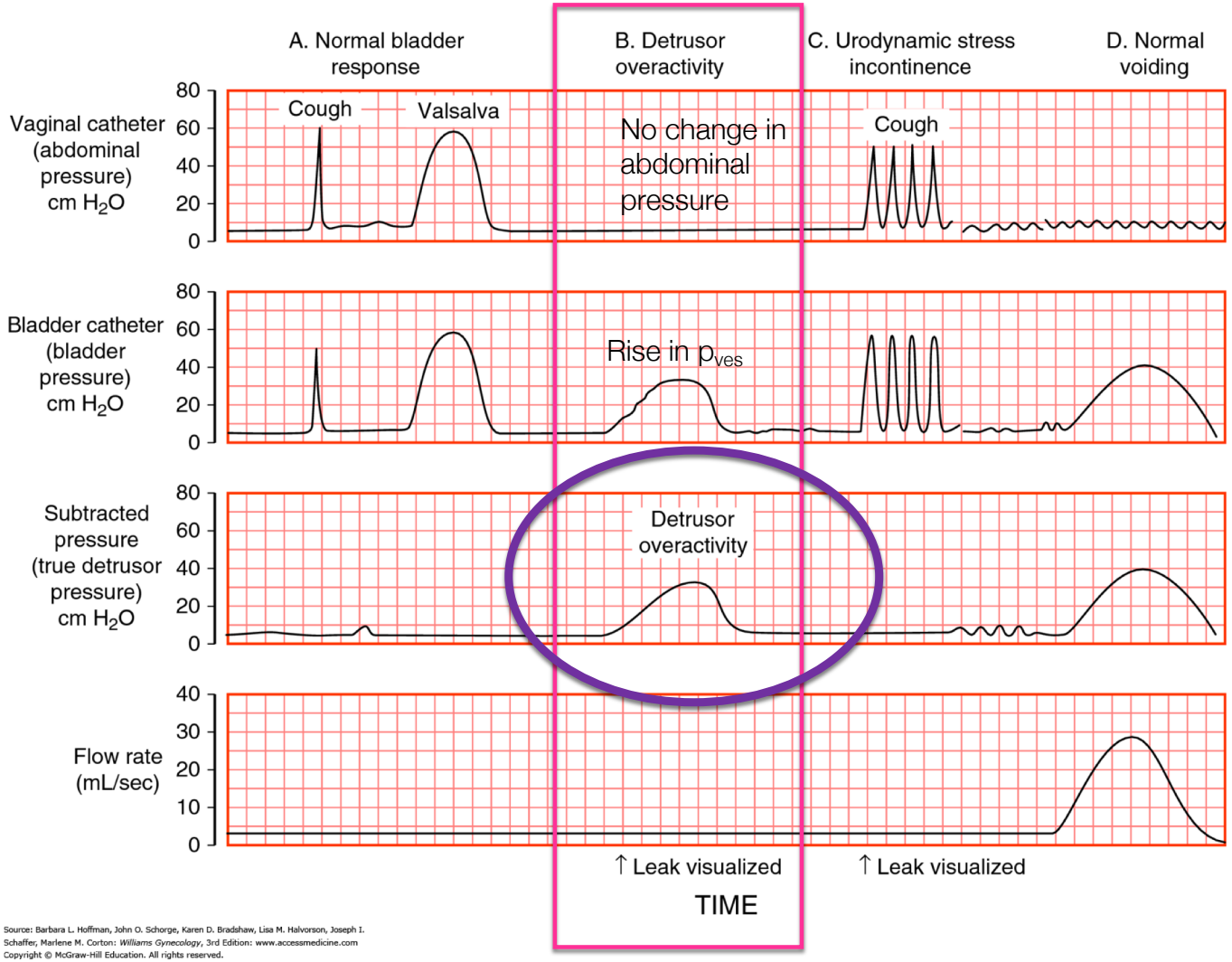
**Urodynamic SUI:**

- Increased abdominal pressure (cough/Valsalva) results in observed urine leakage that is independent of detrusor muscle activity ($p_{det}$=0)

| Clinical scenario | I a. | b. |
|---|---|---|
| $P_{abd}$ (abdominal pressure) [vaginal/rectal catheter] |  |  |
| $P_{ves}$ (bladder pressure) [bladder catheter] |  |  |
| $P_{det}$ (true detrusor pressure) [subtracted/calculated] |  |  |
| Leakage | ⊕ | ⊖ |
| Diagnosis | USI | No USI |

Hoffman, B., Schorge J., Bradshaw K., Halvorson L., Schaffer J., Corton M. (2016). William's gynecology. 3rd ed. New York. McGraw-Hill Education.

# Detrusor Overactivity




Source: Barbara L. Hoffman, John O. Schorge, Karen D. Bradshaw, Lisa M. Halvorson, Joseph I. Schaffer, Marlene M. Corton: *Williams Gynecology*, 3rd Edition: www.accessmedicine.com
Copyright © McGraw-Hill Education. All rights reserved.

Hoffman, B., Schorge J., Bradshaw K., Halvorson L., Schaffer J., Corton M. (2016). William's gynecology. 3rd ed. New York. McGraw-Hill Education.

**Detrusor overactivity:**

- Presence of involuntary detrusor contractions +/- incontinence→ result in increased bladder pressure ($p_{ves}$)
- Abnormal rise in $p_{ves}$ without associated rise in $p_{abd}$ → subtracted $p_{det}$ looks identical to $p_{ves}$
- Also have increased EMG activity

| Clinical scenario | II a. | b. |
|---|---|---|
| $P_{abd}$ (abdominal pressure) [vaginal/rectal catheter] | — | ∩ |
| $P_{ves}$ (bladder pressure) [bladder catheter] | ∩ | ∩ |
| $P_{det}$ (true detrusor pressure) [subtracted/calculated] | ∩ | ∪ |
| Leakage | ⊕ or ⊖ | ⊕ or ⊖ |
| Diagnosis | DO | DO |

Hoffman, B., Schorge J., Bradshaw K., Halvorson L., Schaffer J., Corton M. (2016). William's gynecology. 3rd ed. New York. McGraw-Hill Education.

# Cystometrogram

## Case #1

Collection of Cartoon Woman Cliparts [Digital image]. (n.d.). Retrieved from http://clipart-library.com/cartoon-woman-cliparts.html

**UPP Summary (Pura)**
**UPP Rate: 1.0 mm/s**

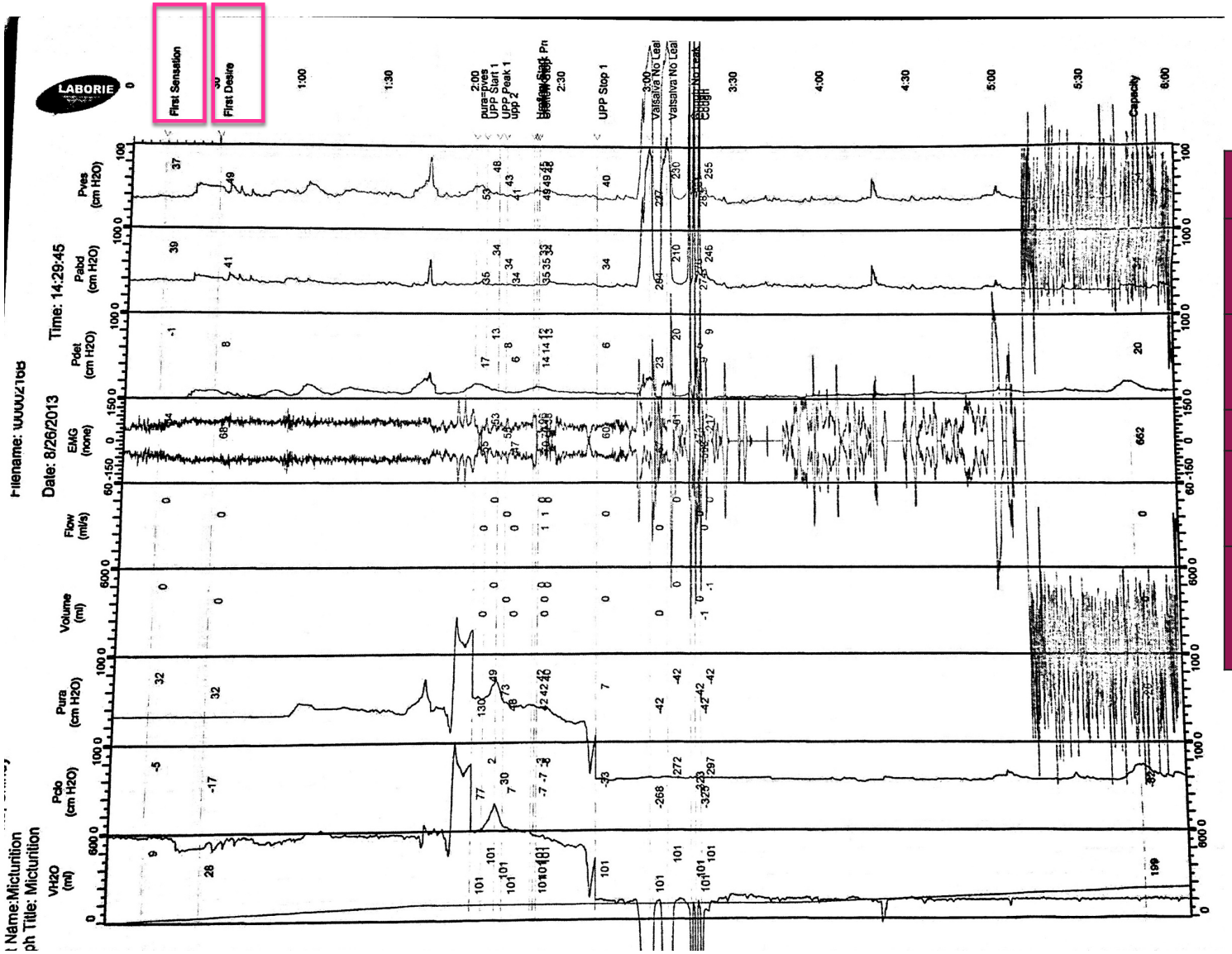
| | Pull 1 | |
|---|---|---|
| Length: | 38 | mm |
| Start: | 2:02.4 | |
| End: | 2:40.5 | |
| Peak Pura: | 73 | cm H2O |
| Obstruction Zone Peak | | cm H2O |
| Length of Cont. Zone: | 4 | mm |
| Area of Cont. Zone: | 247 | cm H2O.mm |

**Event Summary (* = moved event)**

| Annotation | Time | Pves | Pabd | Pdet | EMG | Flow | Volume | Pura | Pclo | IH2O | VH2O |
|---|---|---|---|---|---|---|---|---|---|---|---|
| First Sensation | 11.6 | 37 | 39 | -1 | 54 | 0 | 0 | 32 | -5 | 61 | 9 |
| First Desire | 30.2 | 49 | 41 | 8 | 68 | 0 | 0 | 32 | -17 | 61 | 28 |
| pura=pves | 1:58.8 | 53 | 35 | 17 | 55 | 0 | 0 | 130 | 77 | 0 | 101 |
| *UPP Start 1 | 2:02.4 | 48 | 34 | 13 | 53 | 0 | 0 | 49 | 2 | 0 | 101 |
| UPP Peak 1 | 2:06.7 | 43 | 34 | 8 | 55 | 0 | 0 | 73 | 30 | 0 | 101 |
| *upp 2 | 2:09.3 | 41 | 34 | 6 | 47 | 0 | 0 | 48 | 7 | 0 | 101 |
| Uroflow Start | 2:18.7 | 45 | 33 | 12 | 96 | 0 | 0 | 42 | -3 | 0 | 101 |
| Peak Flow | 2:19.7 | 49 | 35 | 14 | 70 | 1 | 0 | 42 | -7 | 0 | 101 |
| Uroflow Peak Pressure | 2:19.7 | 49 | 35 | 14 | 70 | 1 | 0 | 42 | -7 | 0 | 101 |
| Uroflow Stop | 2:20.6 | 48 | 34 | 13 | 38 | 0 | 0 | 40 | -8 | 0 | 101 |
| UPP Stop 1 | 2:40.5 | 40 | 34 | 6 | 60 | 0 | 0 | 7 | -33 | 0 | 101 |
| *Valsalva No Leak | 2:58.9 | 227 | 204 | 23 | 67 | 0 | 0 | -42 | -268 | 0 | 101 |
| *Valsalva No Leak | 3:04.8 | 230 | 210 | 20 | 61 | 0 | 0 | -42 | -272 | 0 | 101 |
| *Cough No Leak | 3:12.7 | 281 | 276 | 5 | -473 | 0 | 0 | -42 | -323 | 0 | 101 |
| *Cough | 3:14.3 | 283 | 274 | 9 | -503 | 0 | -1 | -42 | -325 | 0 | 101 |
| *Cough | 3:16.2 | 255 | 246 | 9 | -217 | 0 | -1 | -42 | -297 | 0 | 101 |
| Capacity | 5:44.9 | 54 | 34 | 20 | 662 | 0 | 0 | -28 | -82 | 51 | 199 |
| *Valsalva No Leak | 6:16.9 | 217 | 193 | 24 | 149 | 0 | 0 | -21 | -238 | 0 | 210 |
| *Valsalva Leak | 6:22.6 | 206 | 187 | 19 | 61 | 0 | 0 | -30 | -236 | 0 | 210 |
| *Cough | 6:28.9 | 274 | 259 | 14 | 1223 | 0 | -1 | -35 | -309 | 0 | 210 |
| *Cough | 6:30.4 | 227 | 276 | -49 | -1222 | 0 | -1 | -30 | -257 | 0 | 210 |
| *Cough | 6:32.2 | 287 | 297 | -11 | -1222 | 0 | -1 | -24 | -311 | 0 | 210 |
| *Valsalva Leak | 7:59.7 | 227 | 172 | 55 | 401 | 0 | 0 | 123 | -104 | 0 | 210 |
| *Valsalva Leak | 8:11.6 | 220 | 168 | 52 | 299 | 0 | 0 | 89 | -131 | 0 | 210 |
| *Cough | 8:21.9 | 271 | 228 | 43 | 297 | 0 | 0 | 69 | -202 | 0 | 210 |
| *Cough | 8:23.8 | 247 | 221 | 27 | 621 | 0 | 0 | 63 | -184 | 0 | 210 |

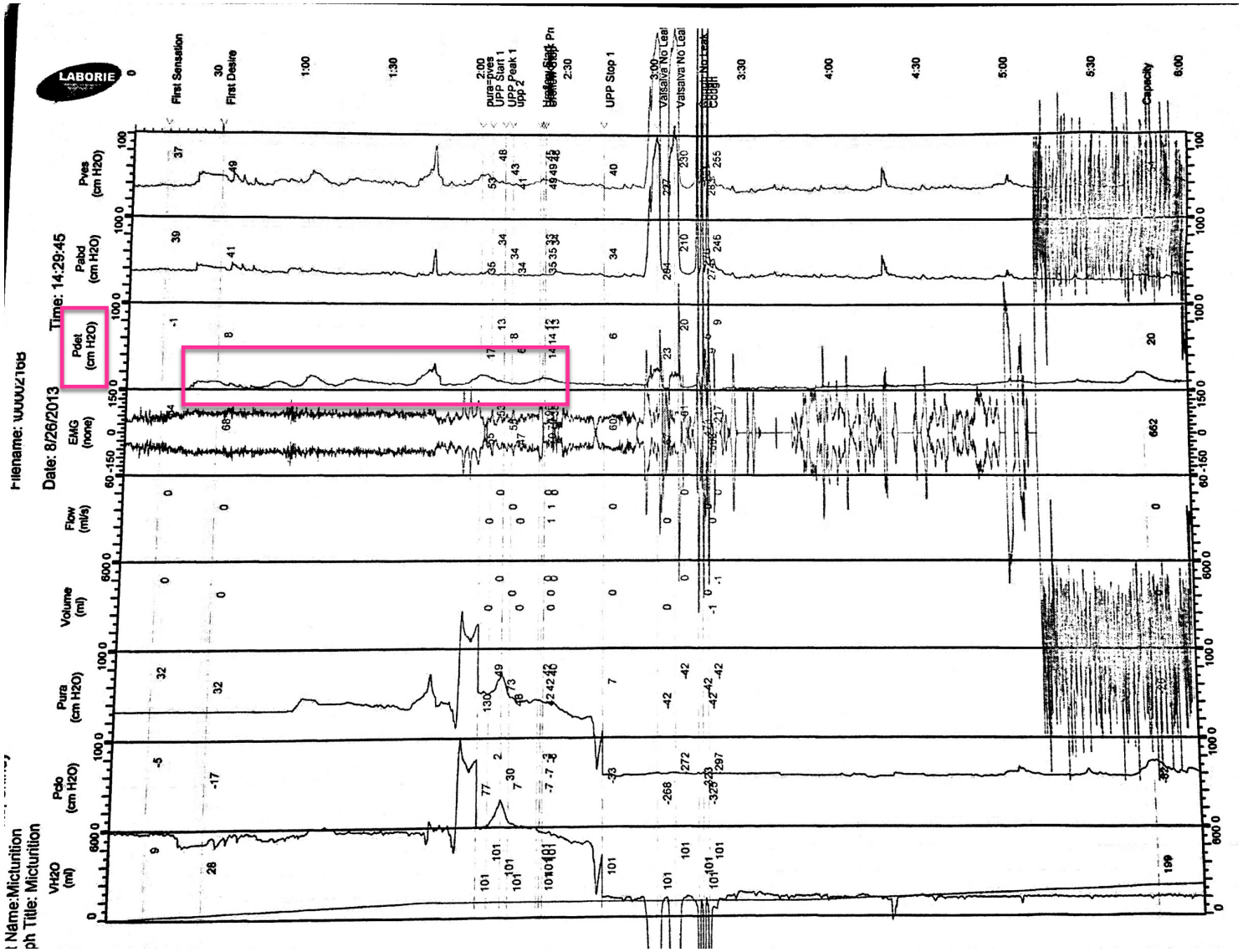
**Compliance Summary**
Manual Range 1 BladComp=14.36

# Case #1




| | Case #1 | Normal (SOGC 2008) |
|---|---|---|
| First sensation to void | 9mL (early) | 100-200mL |
| Normal desire to void | 30.2mL (early) | 150-350mL |
| Urgency | 28mL (early) | 250-500mL |
| Maximum cystometric capacity | 210mL (↓) | 300-600mL |
| Bladder compliance | 14.36ml/cm (↓) | Detrusor pressure: <15cm H2O during filling |

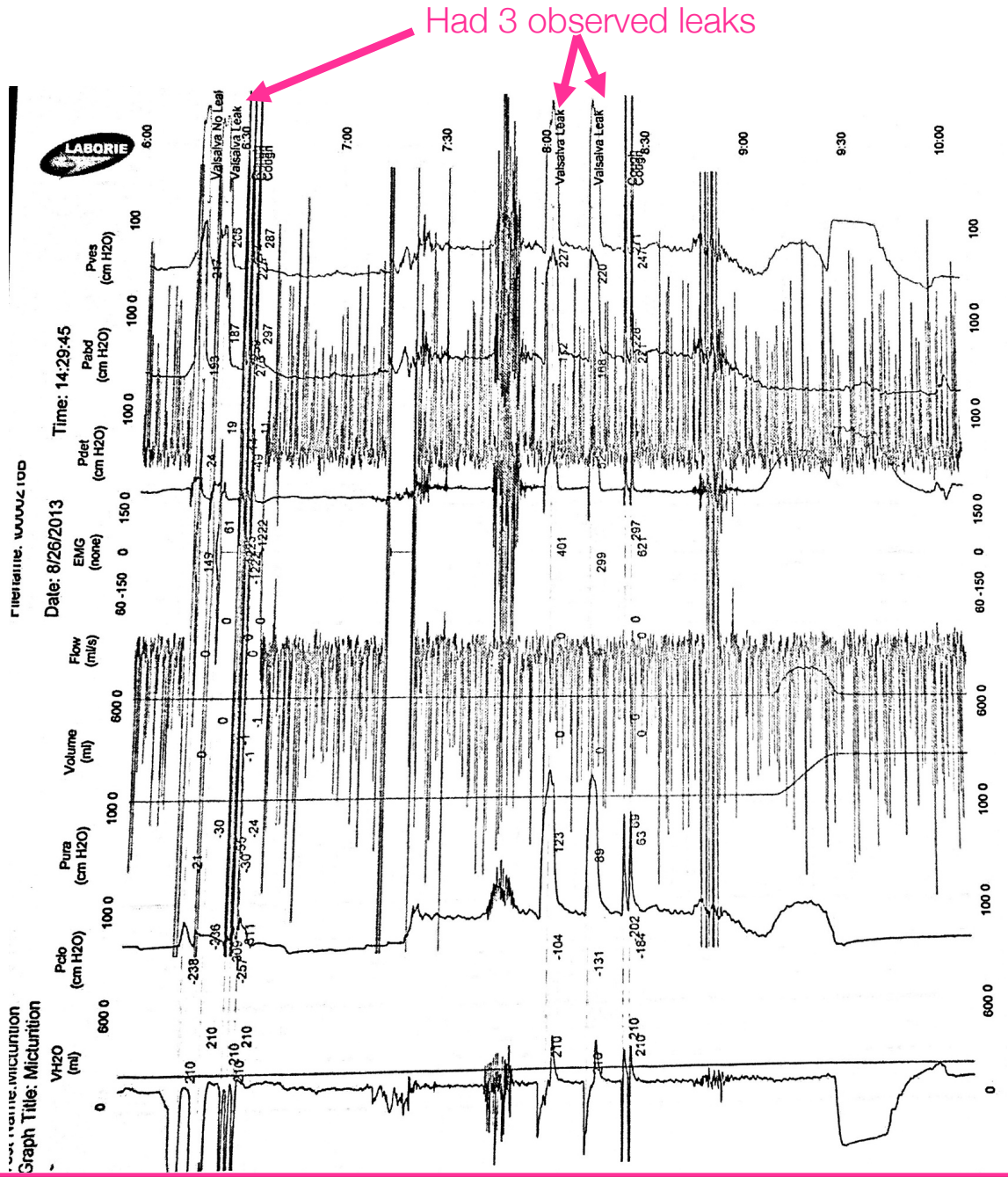
## Evidence of uninhibited detrusor contractions




**Detrusor overactivity:**

- Spontaneous detrusor contractions result in increased bladder pressure ($p_{ves}$) without cough/Valsava
- Abnormal rise in $p_{ves}$ without associated rise in $p_{abd}$ → subtracted $p_{det}$ looks identical to $p_{ves}$
- Also have increased EMG activity

# Case #1

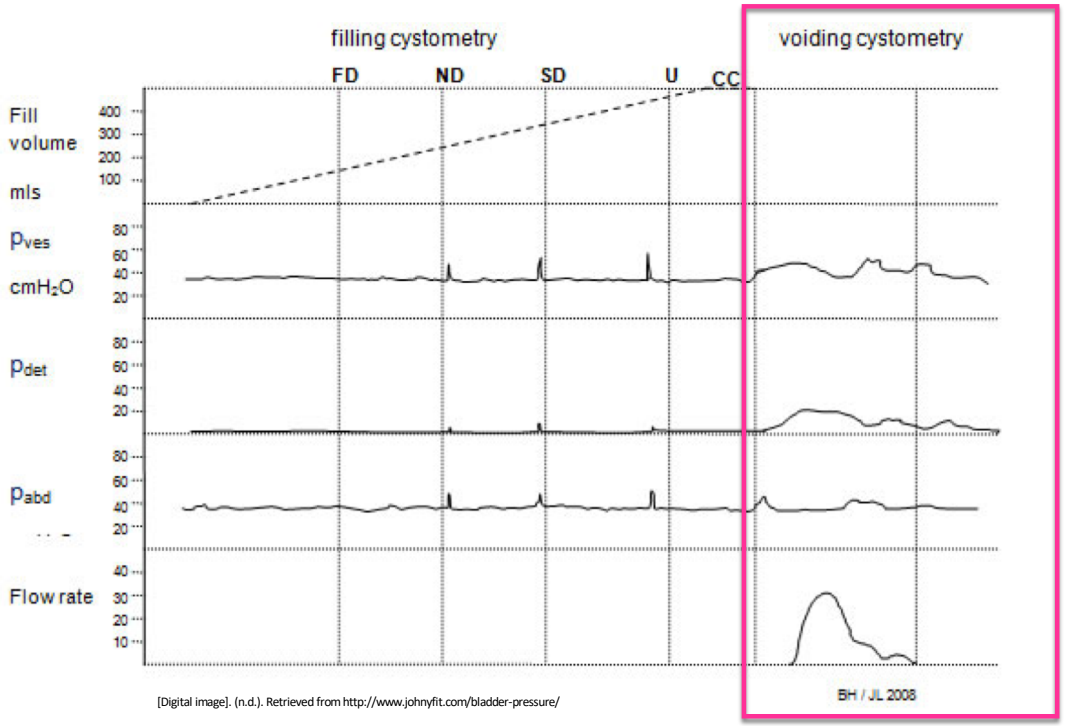



**Urodynamic SUI:**

- Cough/Valsalva results in urine leakage that is independent of detrusor muscle activity

# Pressure-Flow Studies (Voiding Cystometry)

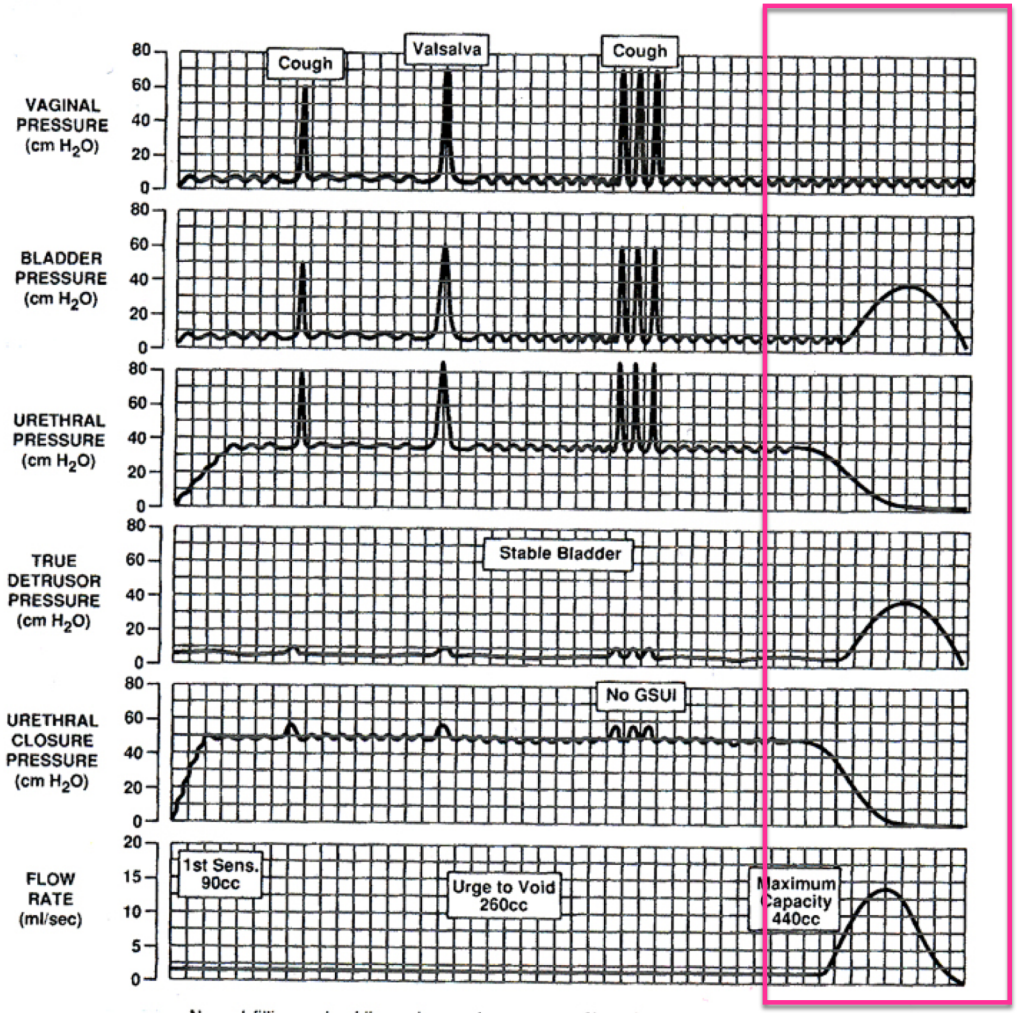
- Used to evaluate the voiding phase
- Useful for patients with incomplete bladder emptying




[Digital image]. (n.d.). Retrieved from http://www.johnyfit.com/bladder-pressure/

- Looking for maximum flow rate, PVR, detrusor pressure at the point of maximum flow rate

# Pressure-Flow Studies (Voiding Cystometry)



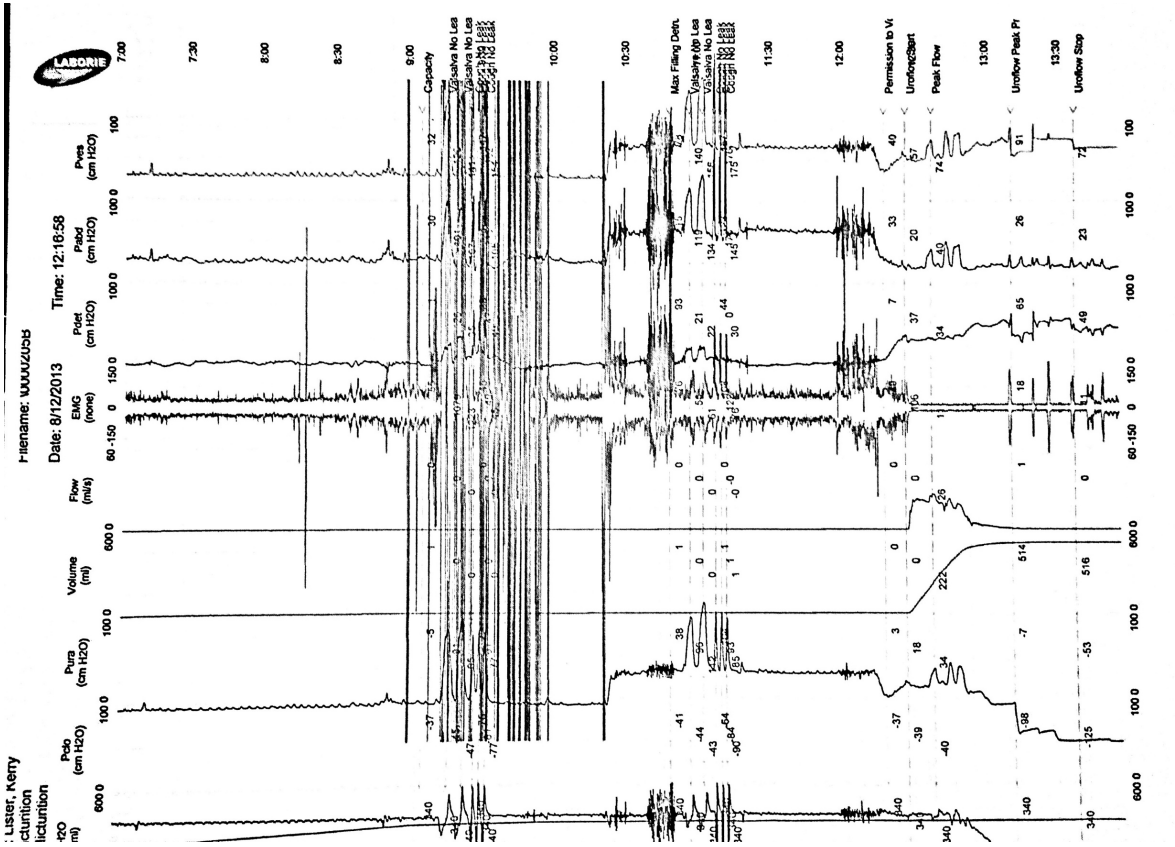

Normal filling and voiding subtracted cystometry. Note that provocation in the form of coughing and straining does not provoke any abnormal rise in true detrusor pressure. At maximum capacity on command, a detrusor contraction is generated and voiding is initiated. *GSUI*, Genuine stress urinary incontinence.

[Digital image]. (2009, February 9). Retrieved from http://www.womenshealthsection.com/content/urog/urog003.php3

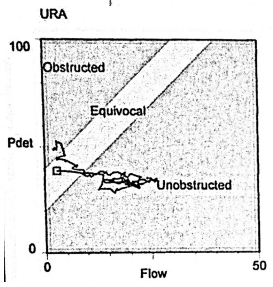
**Normal:**

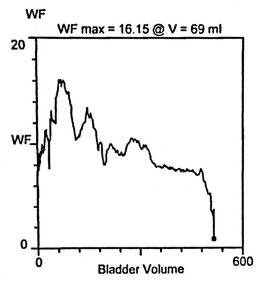
- At maximum bladder capacity or when patient is asked to void, detrusor contraction occurs and voiding begins

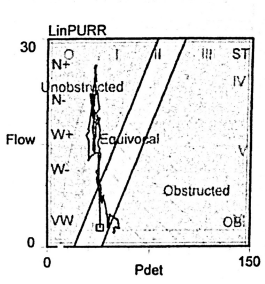
# Pressure-Flow Studies (Voiding Cystometry)




| Voiding Summary | Value | Dev (Female) |
|---|---|---|
| Maximum flow: | 26.3 ml/s | -5 % |
| Average flow: | 11.3 ml/s | -38 % |
| Voiding time: | 1:10.3 mm:ss.S | -161 % |
| Flow time: | 45.5 mm:ss.S | |
| Time to max. flow: | 10.9 mm:ss.S | -4 % |
| Voided volume: | 516 ml | |
| Flow at 2 seconds: | 13.0 ml/s | |
| Acceleration: | 2.4 ml/s/s | |
| Pressure at peak flow: | 35.2 cm H2O | |
| Flow at peak pressure: | 0.4 ml/s | |
| Peak Pressure: | 64.5 cm H2O | |
| Mean Pressure: | 41.7 cm H2O | |
| BOOI: | -17.4 | |
| BCI: | 166.7 | |
| BVE: | n/a | |
| VOID: | 26/520/- | |
| PVR: | n/a | |



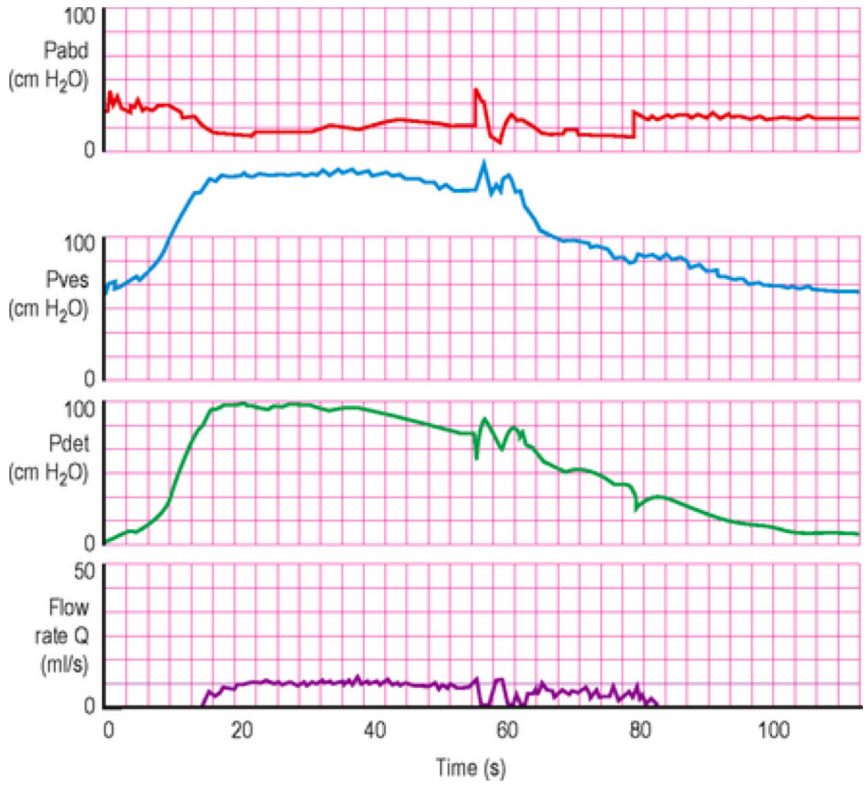



# Pressure-Flow Studies (Voiding Cystometry)

**Bladder outlet/outflow obstruction:**

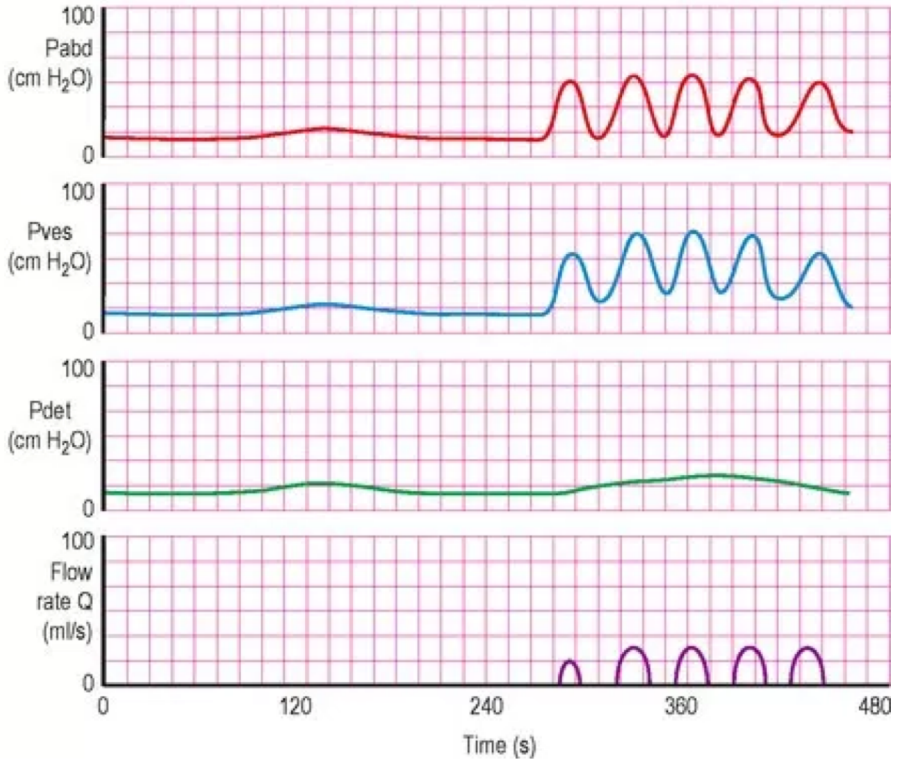
- High maximum detrusor pressure
- High urethral pressure
- Slow urine flow rate




Typical cystometry appearances for bladder outlet obstruction [Digital image]. (2016, July 20). Retrieved from https://abdominalkey.com/voiding-disorders-and-bladder-outlet-obstruction/

**Poor detrusor contractility (underactive detrusor muscle):**

- Low detrusor pressure
- Normal relaxed urethra
- Slow urine flow rate



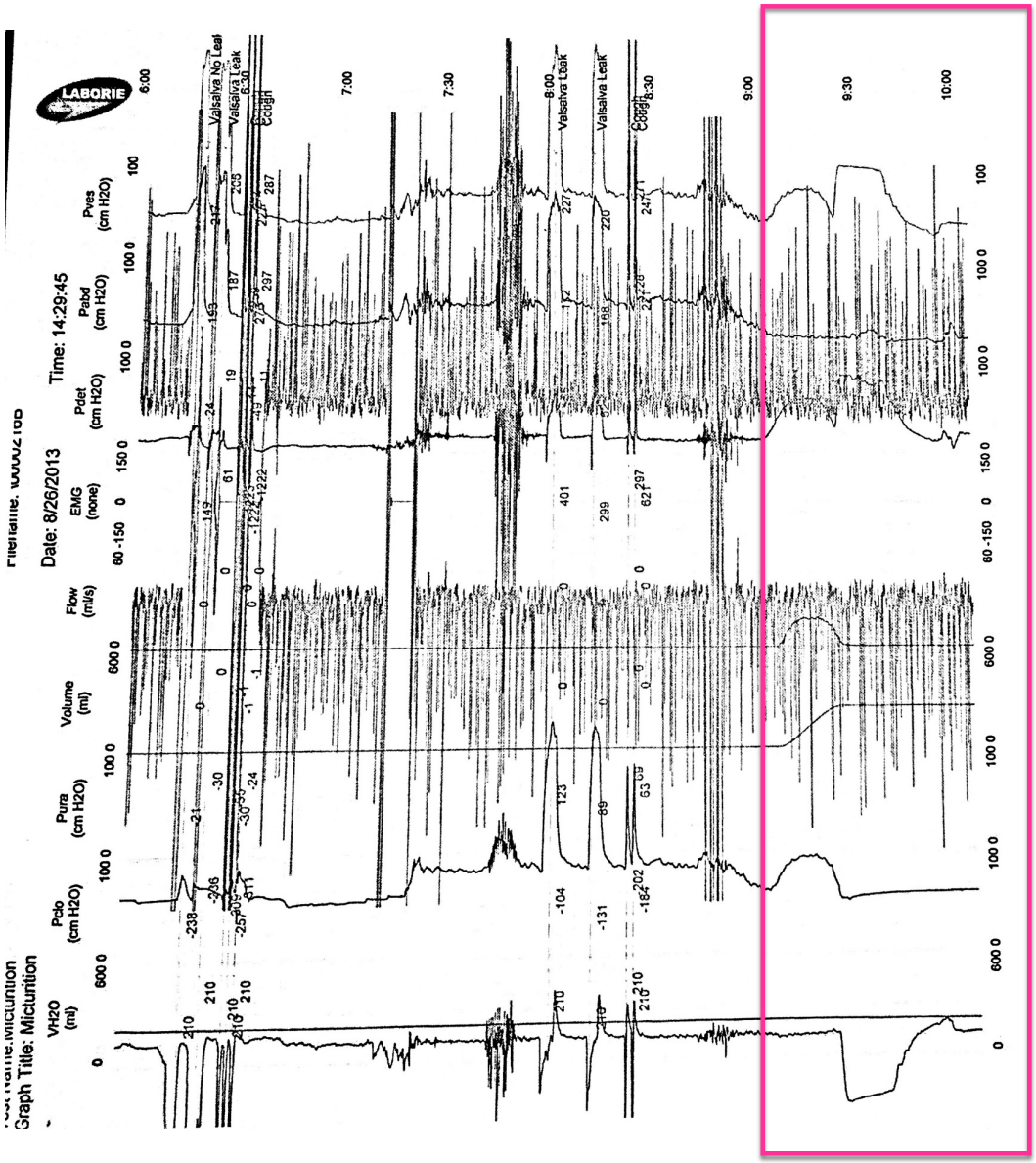

Pressure/flow trace in patient with both detrusor overactivity during filling and BOO during voiding [Digital image]. (2016, July 20). Retrieved from https://abdominalkey.com/voiding-disorders-and-bladder-outlet-obstruction/

## Case #1

Collection of Cartoon Woman Cliparts [Digital image]. (n.d.). Retrieved from http://clipart-library.com/cartoon-woman-cliparts.html

**Mechanism of voiding:** detrusor contraction

Voided: 240mL
PVR: 5mL
Maximum and average flow: not available



## Case #1

Collection of Cartoon Woman Cliparts [Digital image]. (n.d.). Retrieved from http://clipart-library.com/cartoon-woman-cliparts.html

**Findings:**

- Urodynamic SUI
- Low bladder compliance
- Detrusor overactivity
- Urge incontinence

# URETHRAL FUNCTION TESTS

**Components of urodynamics:**

1. Screening tests for voiding dysfunction: uroflowmetry, post-void residual (PVR)
2. Bladder function: cystometry, pressure flow studies
3. **Urethral function tests: urethral pressure profile, abdominal leak point pressure**
4. Electromyography

# Summary

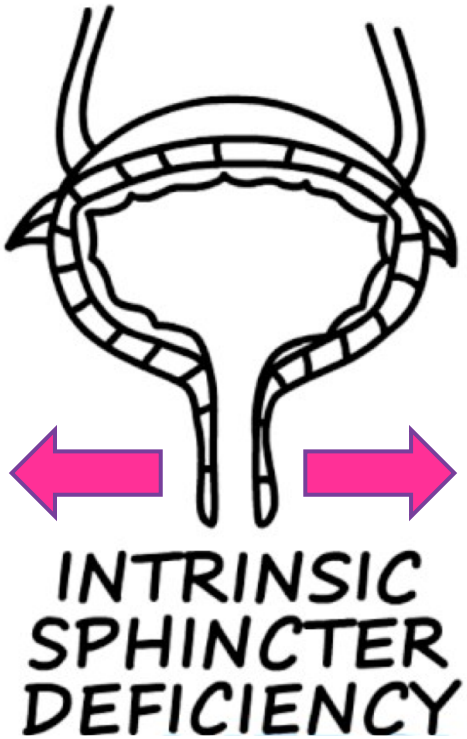
| | Used to evaluate | For patients with |
|---|---|---|
| Urethral function tests | • Used to diagnose intrinsic sphincter deficiency (ISD), neurogenic lower urinary tract dysfunction | |
| • Urethral pressure profile | • Urethral closing forces | • Suspected intrinsic sphincter deficiency (ISD) |
| • Abdominal leak point pressure | • Urethral competence against pressure in the bladder (due to detrusor or abdominal forces) | • Suspected intrinsic sphincter deficiency (ISD)<br>• Suspected neurogenic lower urinary tract dysfunction |

# Urethral Function Tests

- There is no gold standard for measuring urethral function
- Used to diagnose **intrinsic sphincter deficiency (ISD)**
- Include
  1. Urethral pressure profile
  2. Abdominal leak point pressure

# Intrinsic Sphincter Deficiency (ISD)

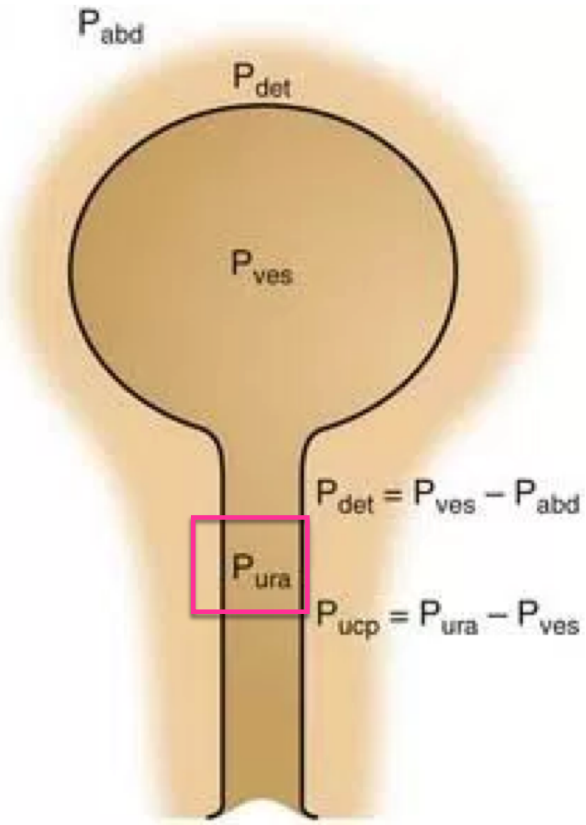
- Urinary incontinence is due to failure of intrinsic urethral sphincter mechanism to maintain normal mucosal coaptation at rest or with minimal exertion




Johnston, S., & Stern, E. (2016, July 20). Obstetrics and Gynecology – Stress Urinary Incontinence [Digital image]. Retrieved from https://www.youtube.com/watch?v=Ir3jC980DCk

# Urethral Pressure Profile

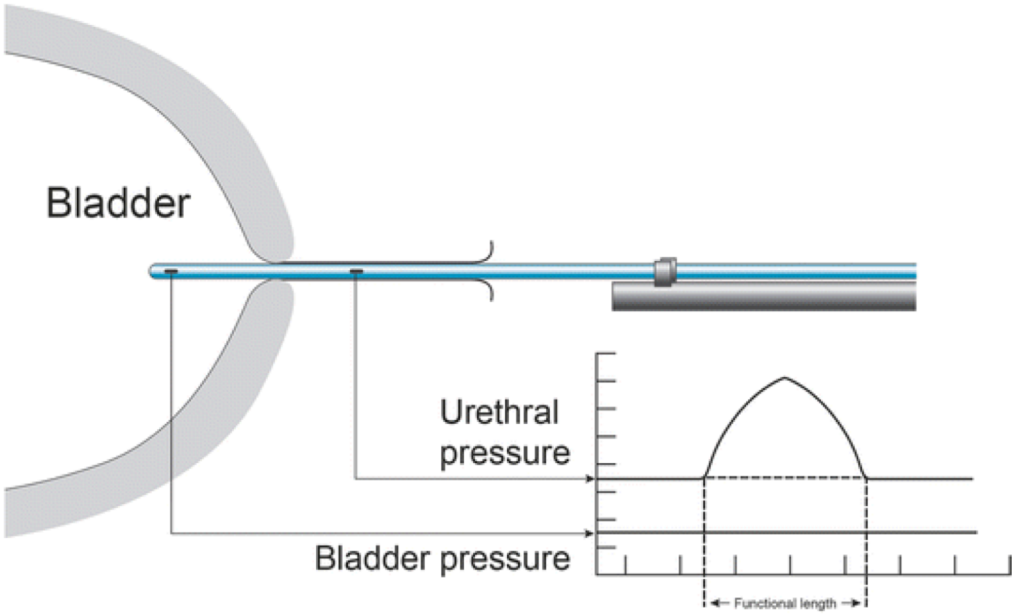
- **Urethral pressure** ($p_{ura}$)- pressure of liquid that is required to force open a collapsed urethra to allow flow of urine
  - During storage phase, urethra is collapsed, $p_{ura}$= 0 cm $H_2O$
  - During voiding phase, urethra opens to allow flow of urine



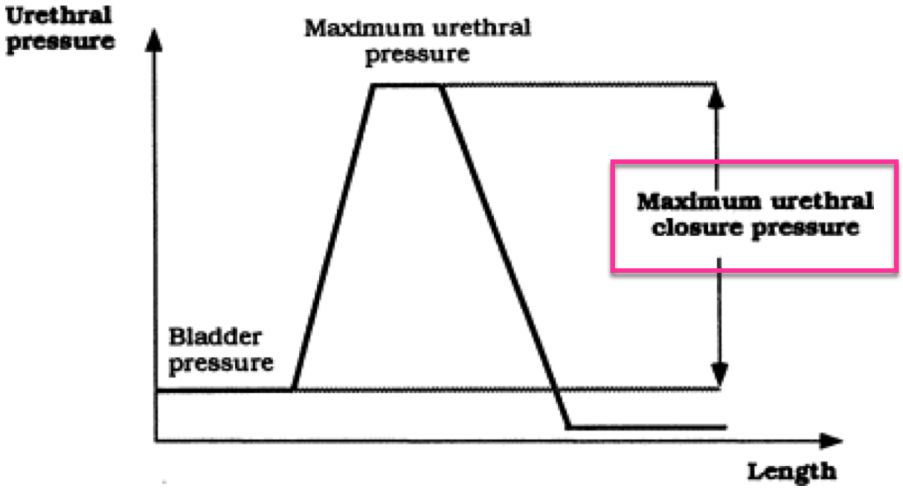

Robain, G., Combrisson, H., & Perrigot, M. (1995). [Digital image]. Retrieved from https://www.sciencedirect.com/science/article/pii/S0022534701669258

# Urethral Pressure Profile

- Urethral pressure varies from point to point within the urethra



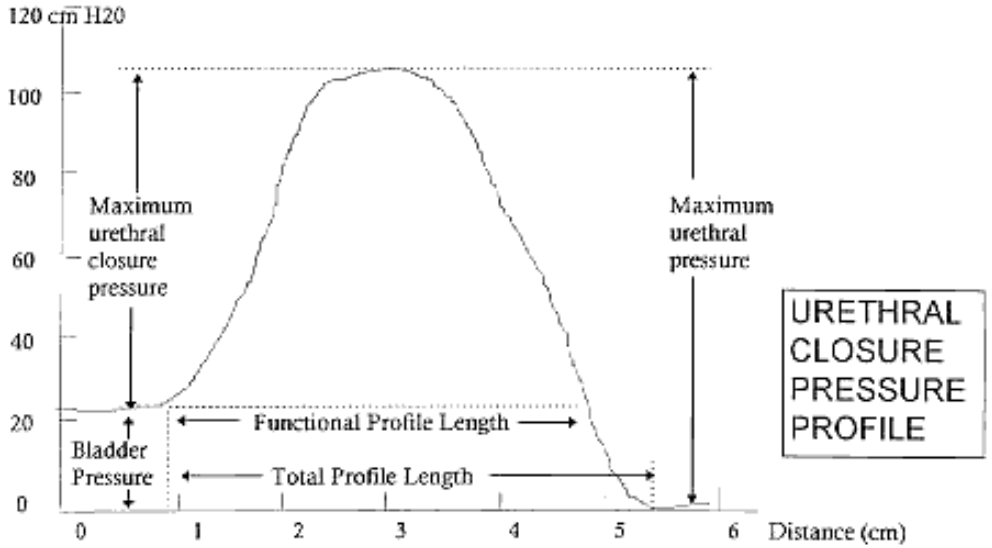

Walters, M., & Karram, M. (2007). [Digital image]. Retrieved from Urethral pressure profile: Illustration showing a normal tracing



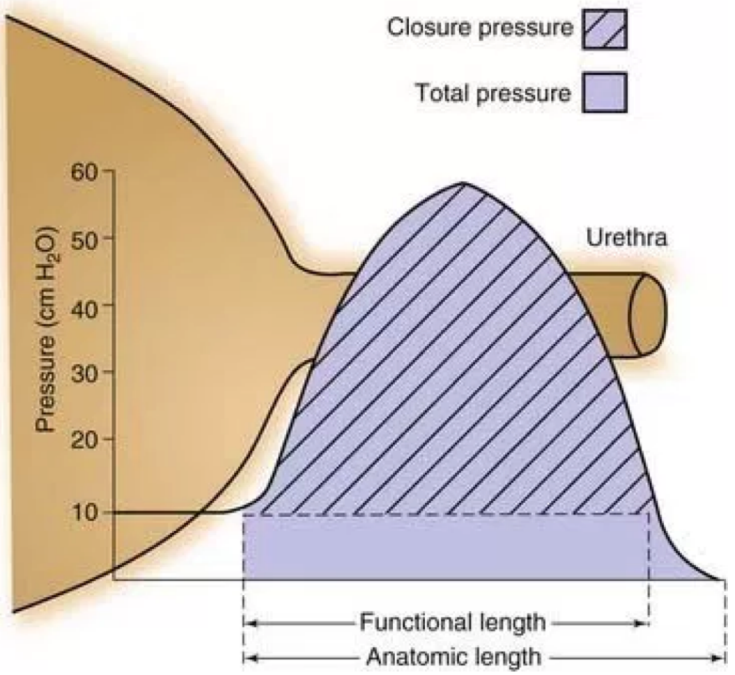

Robain, G., Combrisson, H., & Perrigot, M. (1995). [Digital image]. Retrieved from https://www.sciencedirect.com/science/article/pii/S0022534701669258

# Urethral Pressure Profile

- **Urethral pressure profile-** graph of urethral pressure vs distance along the urethra
- **Functional urethral length**- length of urethra where urethral pressure is higher than bladder pressure




[Digital image]. (n.d.). Retrieved from http://163.178.103.176/fisiologia/renal/objetivo_10/urodynamics.htm

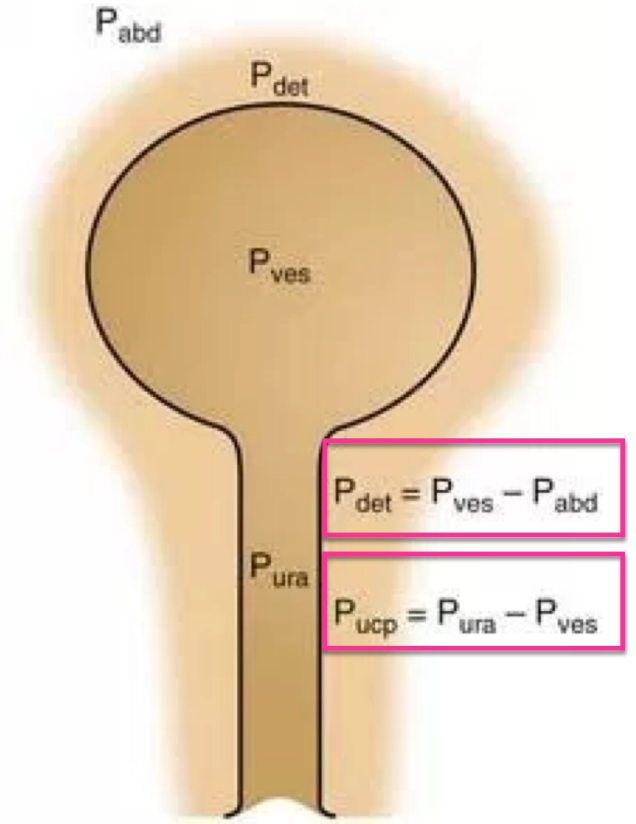



Dell, J., & Fowler, G. (2017). [Digital image]. Retrieved from https://basicmedicalkey.com/urodynamic-testing-multichannel/

# Urethral Pressure Profile

- **Detrusor pressure:** $p_{det} = p_{ves} - p_{abd}$
- **Maximum urethral closure pressure (MUCP)** ($p_{ucp}$)- difference between maximum urethral pressure and bladder pressure
  - $p_{ucp} = p_{ura} - p_{ves}$

| | Intrinsic Sphincter Deficiency (ISD) |
|---|---|
| Maximum urethral closure pressure (MUCP) | • <20 cm H20 |



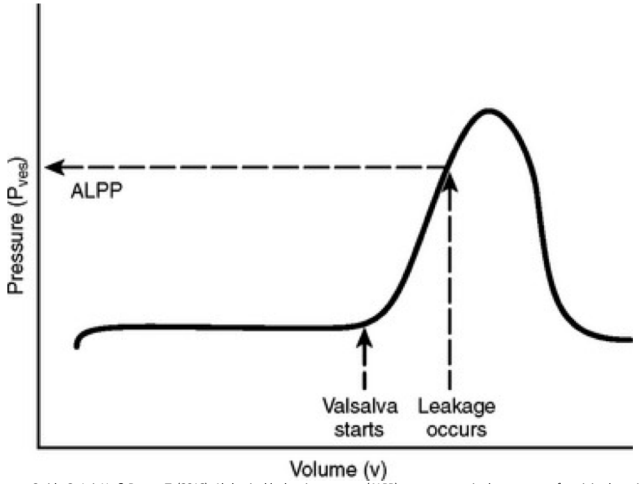

Robain, G., Combrisson, H., & Perrigot, M. (1995). [Digital image]. Retrieved from https://www.sciencedirect.com/science/article/pii/S0022534701669258

# Abdominal Leak Point Pressure (ALPP)

- **ALPP-** bladder pressure created by Valsalva that causes a visible urine leakage

**LPP is affected by:**
- Bladder volume
- Patient positioning
- Catheter size

| | Intrinsic Sphincter Deficiency (ISD) |
|---|---|
| Abdominal leak point pressure (ALPP) | • Leakage of urine at vesicular pressure <60cm H20 |



Smith, C., Lai, H., & Boone, T. (2016). Abdominal leak point pressure (ALPP) measurement in the presence of straining but without detrusor contraction. [Digital image]. Retrieved from https://abdominalkey.com/urodynamics/

# Case #1

## Urethral pressure profile

Collection of Cartoon Woman Cliparts [Digital image]. (n.d.). Retrieved from http://clipart-library.com/cartoon-woman-cliparts.html

**UPP Summary (Pura)**
**UPP Rate: 1.0 mm/s**

| | Pull 1 | |
|---|---|---|
| Length: | 38 | mm |
| Start: | 2:02.4 | |
| End: | 2:40.5 | |
| Peak Pura: | 73 | cm H2O |
| Obstruction Zone Peak | | cm H2O |
| Length of Cont. Zone: | 4 | mm |
| Area of Cont. Zone: | 247 | cm H2O.mm |

| | Case #1 | Intrinsic Sphincter Deficiency (ISD) |
|---|---|---|
| Functional urethral length | • 38mm | |
| Maximal urethral closure pressure | • 15cm H2O (low) | • <20 cm H20 |
| SUI | • SUI demonstrated at 100mL volume | |
| Abdominal leak point pressure | • 187cm H2O | • <60cm H20 |

- Low pressure urethra (poor urethral closing force)
- SUI

# ELECTROMYOGRAPHY (EMG)

**Components of urodynamics:**

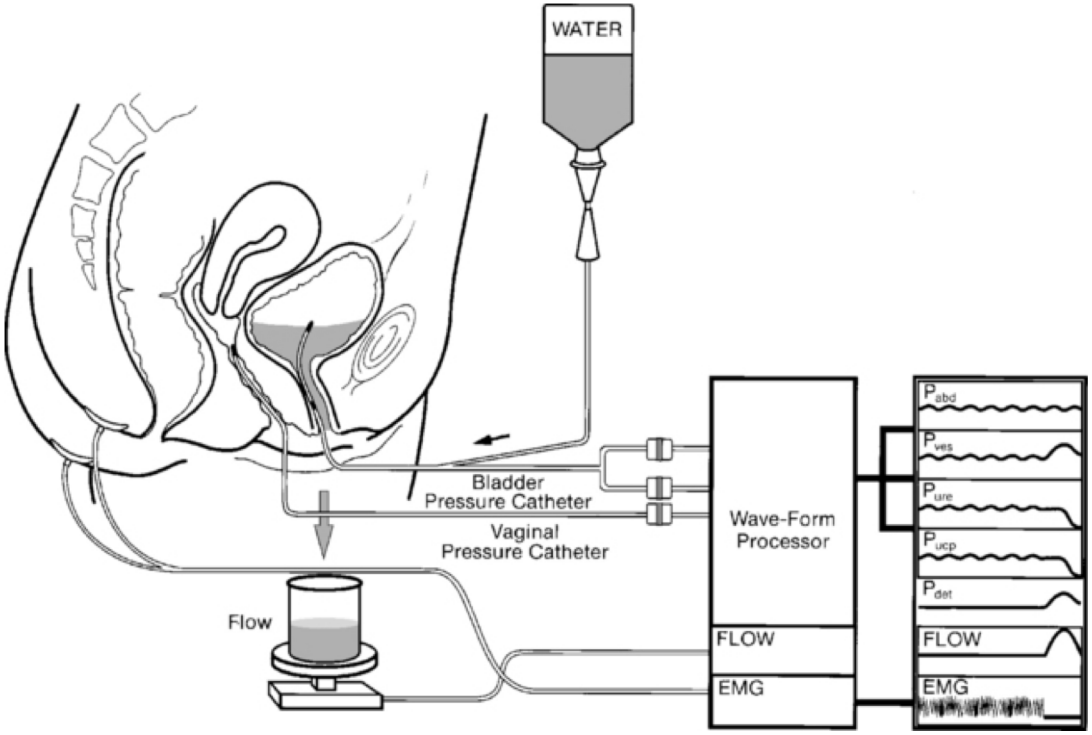
1. Screening tests for voiding dysfunction: uroflowmetry, post-void residual (PVR)
2. Bladder function: cystometry, pressure flow studies
3. Urethral function tests: urethral pressure profile, abdominal leak point pressure
4. **Electromyography**

# Summary

| | Used to evaluate | For patients with |
|---|---|---|
| Electromyography | • Coordinated relaxation of pelvic floor musculature during voiding | • Suspected dyssynergic/dysfunctional voiding<br>• Research |

# Electromyography (EMG)

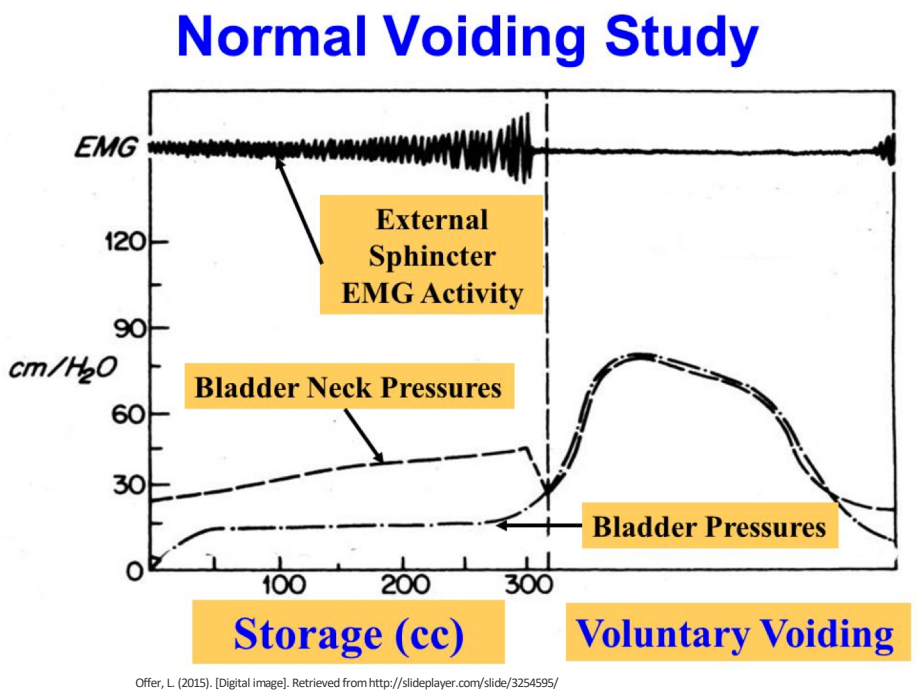
- Evaluates pelvic floor muscle activity during both bladder filling and emptying




Karram, M., & Blaivas, J. (2016, March 10). Subtracted cystometry. Intravesical and intra-abdominal pressures are measured, and true detrusor pressure is electronically derived (Pves – Pabd). Pves, Bladder pressure; Pabd, abdominal pressure; Pdet, detrusor pressure. [Digital image]. Retrieved from https://plasticsurgerykey.com/urodynamics-cystometry-and-urethral-function-tests/

# Electromyography

- During bladder filling, **guarding reflex** is present
- Prior to voiding, **electromyography silence** is present
- During voluntary voiding, both pelvic floor and urethral striated sphincter relax




Offer, L. (2015). [Digital image]. Retrieved from http://slideplayer.com/slide/3254595/

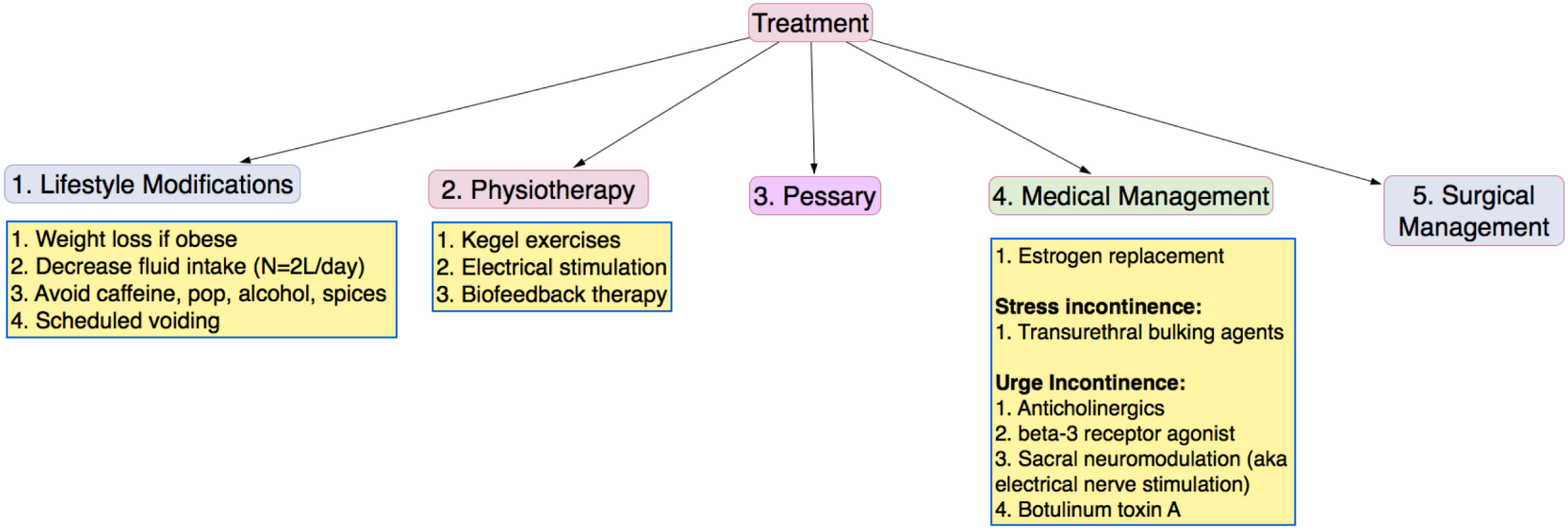
## Impression & Plan

Collection of Cartoon Woman Cliparts [Digital image]. (n.d.). Retrieved from http://clipart-library.com/cartoon-woman-cliparts.html

**Impression:** severe SUI and urge incontinence and low pressure urethra

**Plan:**

- Patient agreed to proceed with reduction of irritants (ex. Caffeine), Toviaz 8mg and Vesicare 10mg
- If therapy is insufficient, then consider surgical management for SUI



# Dr. Jabs' Advice

1. Bladder diary for all
2. Patients need a sophisticated historian rather than sophisticated testing in most circumstances. Ask the right questions regarding what makes them leak.
3. Before doing a stress incontinence procedure, see the stress incontinence. This can be a supine or standing cough test in the office with a full bladder.
4. Think about risk factor for retention: previous surgery, recurrent cystitis, grade prolapse, difficulty voiding on history. Consider an in and out catheter in the office for a post void residual.
5. Beware the woman who can't describe her leak and says she is damp all the time. It may not be urinary incontinence (prolapse fibroid, cervical polyp, vaginal discharge, sweat)

[Digital image]. (n.d.). Retrieved from https://twitter.com/advice

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