Urodynamics Made Easy: ENHANCING the CLINICAL IMPORTANCE OF URODYNAMIC

- Timothy B. McKinney, MD, PhD, FPMRS
- Medical Director - Laborie

Professor and Chief of Female Pelvic Medicine and Reconstructive surgery

Drexel University College of Medicine

Philadelphia, Pennsylvania
Objectives

1. Understand the Importance of Urodynamic

2. Understand new thinking on where urodynamic and patient outcomes are going. A look at the present and future.

3. Application of air charged catheter technology (weightless) vs. Water transducer catheters (weighted) for UDS studies. Tips and Tricks
AH-CHOO!
Introduction

- Urodynamics is the general term for the study of the storage and voiding function/dysfunction of the lower urinary tract.

- Urodynamics is the **only objective diagnostic test** to clinically assess a patient suffering from lower urinary tract (LUT) dysfunction.

- Primary Goal of UDS:
  - Reproduce the patient’s symptomatic complaints
  - Provide a pathophysiological explanation by correlating symptoms with findings.
Who needs it?

- Stress urinary incontinence
- ANY PTS GOING TO SURGERY FOR INCONTINENCE/PROLAPSE
- Urge incontinence
- Urinary retention
- Neurological impairment
  - (Spinal cord injuries, Multiple Sclerosis, Peripheral neuropathy, Parkinsonism, myelo-meningiocele, etc)
- Voiding dysfunction
  - Any Patient especially in children
- Recurrent urinary tract infections

Remember - the same symptoms can be the result of completely opposite causes
Indications

- Incontinence:
  - recurrent incontinence in whom surgery is planned.
  - mixed urge and stress symptoms.
  - associated voiding problems
  - pt with neurologic disorders
  - pt with mismatch between signs and symptoms.

- Prolapse

- Uncomplicated Stress Incontinence alone showed no benefit on outcomes in 2 studies, however, only represents 5% of incontinence patients and ICS recommends UDS before all surgical intervention. The studies are being challenged as biased.
Indications (cont.)

- **Outflow Obstruction:**
  - pt with LUTS, at least pressure flow study.

- **Neurogenic bladder:**
  - all neurologically impaired patients with neurogenic bladder dysfunction.

- **Children with voiding dysfunction:**
  - kids with daytime urgency and urge incontinence, recurrent infection, reflux, or upper tract changes.
Value study

• RCT trial - no outcome gain on pure uncomplicated SUI by doing UDS

• Had 25% dropout rate post sling

• Showed that only 62.1% success of sling if voiding dysfunction pre-existed vs 78.3% if not. This in itself is reason to do urodynamics

• Prejudice for retropubic sling before UDS and had a bias away from UDS before starting the study

• No quality control on UDS done in their labs

Dutch Study

- **Underpowered** to draw conclusions of no clinical benefit of UDS before Sling for uncomplicated SUI

- In the arm of study that they did UDS- had less voiding dysfunction after sling- **9.6%**

- If No UDS done they had **25%** post op voiding dysfunction

- Biased to not use UDS and only did retropubic Slings

- No quality control on UDS done in their labs

Value of Urodynamics

- Only Objective means of Correlating symptoms with findings
- Gold standard For Men and Children for LUTS
- Accurate diagnosis
  - 15-40% wrong Dx without UDS testing
  - 25-30% multiple diagnoses after UDS
- Allows Fine tuning of treatment- More hands on with Patient
- Define neurological abnormalities and dyssynergias
Value of Urodynamic - challenges to Value study

- UK Kings Hospital Audit for deviation from NICE recommendation

- Only 109 straight stress incontinence/1240 pts with LUTS = 8.8% Qualified for NICE criteria of straight GUSI

- 27% no GUSI, 7.3% storage disorder, 5.5% voiding disorder, (40%)

- After UDS, 40% had no GUSI and only 2 of those 40 required surgery, only 56% of the GUSI group needed surgery

- Cost analysis, doing UDS saved 58,000 pounds

Angie Rantell, IUGA abstract, Naughty or NICE, Nice, 6/15
Value of Urodynamics

• 740/2053 (36%) had uncomplicated SUI as suggested by ValUE trial criteria

• UDS resulted in 1276/2053 (62.2%) had different diagnosis than just symptoms alone

• 304/740 pts for planned surgery didn’t require SUI surgery after UDS (41%)

• Voiding dysfunction UDS diagnosis in 394 Pts and 99/740 (13.4%) of uncomplicated SUI

Value of Urodynamics

- VLPP >60 cmH2O, MUCP >40 cmH2O are predictive of efficacy of Sling Surgery and voiding dysfunction after Davila, et al, int Urogyn J. 2008-, 19:97-102

- Pure GUSI on symptoms after UDS 20% didn’t need surgery.

  Degusu, et al, Urology 2009, 74; 278-81

- Pure SUI patients had on UDS a 2nd diagnosis of DO and changed treatment from surgery to anti-muscarinics. 62% change in diagnosis with UDS

  Serati et al, BJUInt, 2013,112: E344-50
The Influence of Urodynamics on Treatment Outcome

220 patients
UDS reports in 90% of patients notes

80%
Surgeon acted on U.D. recommendations
72% cured or improved

14%
Surgeon ignored U.D recommendations
36% cured or improved
Value of Urodynamics

- Myers, Rardin from Brown University in a recent publication looked at overall probability that urodynamic data would change treatment -

  - Medical treatments was 26.9% (95% confidence interval (CI), 18.6%, 37.2%)

  - Surgical treatments = 45.5% (95% CI, 37.8%, 53.4%).

- Misdiagnosis or Wrong Diagnosis in 25% of cases without UDS - Jenson et al - review of 29 papers

- Decreased flow rate, PVR, and straining to void on voiding pressure study play a predictive role in voiding dysfunction after surgery for Stress incontinence leading to retention.
Clinical roles of UDS

- Characterization of detrusor function
- Evaluation of bladder outlet, ISD (retropubic sling vs. obturator sling), BOO in men and women,
- Ability to tell the difference between obstruction with risk of kidney damage from retrograde flow vs atony
- Evaluation of voiding function
- Diagnosis and characterization of neuropathy.
Complex Cystometry

Pressure is our main tool in evaluating LUTS

1-What we’ve lost through the years with Water technology is that we only look at bladder pressures during filling phase not urethra concomitantly.

UDS has become ONE-DIMENSIONAL

2-Urethral pathophysiology- either urethra gives out with funneling leading to detrusor contraction, DO or urethral wobbling +/- 15 cm H2O off of baseline with spasming and relaxation giving Frequency/urgency syndrome and pain from cramping of the muscles in the urethra is able to be monitored by continuous dual monitoring during UDS
Pressures in urodynamics

\[ p_{\text{ves}} = p_{\text{det}} + p_{\text{abd}} \]

Figure courtesy Derek Griffiths, PhD

"\( p_{\text{abd}} \) measured in rectum - has to be fluid-filled to work

\( p_{\text{ura}} \) (pressure in empty collapsed tube - what's that?)
The accuracy of urodynamics pressure measurement with water-filled systems

Aim
Water-filled catheters are the ICS recommended method for pressure measurement in urodynamics. Poor technique, however, results in low quality measurements. This study aims to quantify the inaccuracy of measurement in water-filled systems, with a view to recommending better practice. Fast moving, dynamic signals are not part of this study, being dealt with elsewhere.

Methods
Papers examining quality of measurements were reviewed, and technical data from manufacturers gathered. Measurements from urodynamic equipment were analysed to quantify inaccuracies. The total possible error was estimated by the root sum of squares of individual errors.

Results

<table>
<thead>
<tr>
<th>Measurement factor</th>
<th>Source of error</th>
<th>Error (cmH₂O)</th>
<th>Method of mitigation / Recommended good practice</th>
<th>Final potential error on pdet (cmH₂O)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calibration error</td>
<td>Reference signal not exact</td>
<td>(0.9) 1.3</td>
<td>Minimise noise when calibrating. Do not use internal calibration</td>
<td>1.3</td>
</tr>
<tr>
<td>Position error</td>
<td>Height of transducers not at symphysis pubis</td>
<td>(3) 0</td>
<td>Set reference level with care</td>
<td>0</td>
</tr>
<tr>
<td>Dome empty when zero set</td>
<td>Full dome has atmosphere at tap, not at transducer face</td>
<td>(2.5 – 4.0) 0</td>
<td>Zero when dome full</td>
<td>0</td>
</tr>
<tr>
<td>Dome off when zero set</td>
<td>Placing dome adds pressure offset</td>
<td>(10 – 50) 0 – 40</td>
<td>Mount dome before setting zero</td>
<td>0</td>
</tr>
<tr>
<td>Tap not level with dome</td>
<td>Full dome has atmosphere at tap, not at transducer face</td>
<td>(2.5 – 4.0) 0</td>
<td>Use tap for reference level, or keep dome and tap horizontal</td>
<td>0</td>
</tr>
<tr>
<td>Body density assumptions</td>
<td>Water-filled systems assume body density = water density</td>
<td>(0.4, 0.6) 0.2</td>
<td>Cannot be mitigated</td>
<td>0.2</td>
</tr>
<tr>
<td>Subtraction error on strain</td>
<td>pabd is not exactly perivesical pressure</td>
<td>(6) 6</td>
<td>Better position of rectal balloon, caution with Valsalva / straining pressures</td>
<td>0</td>
</tr>
<tr>
<td>Digitisation</td>
<td>Limited resolution of digital systems</td>
<td>(0.3) 0.4</td>
<td>Cannot be mitigated</td>
<td>0.4</td>
</tr>
<tr>
<td>Nonlinearity / hysteresis</td>
<td>Imperfect transducers</td>
<td>(0.3) 0.4</td>
<td>Cannot be mitigated</td>
<td>0.4</td>
</tr>
<tr>
<td>Temperature</td>
<td>Transducer output varies with temperature</td>
<td>(3.7) 0</td>
<td>Calibrate regularly at temperature of use</td>
<td>0</td>
</tr>
<tr>
<td>Zero drift</td>
<td>Transducer zero point varies with time</td>
<td>(1.3) 0</td>
<td>Warm up transducer before use, recheck zero during long tests</td>
<td>0</td>
</tr>
<tr>
<td>Live signal variation</td>
<td>Reference points on trace not at true resting pressure</td>
<td>(5) 5</td>
<td>Ensure markers are placed away from artefacts</td>
<td>0</td>
</tr>
<tr>
<td>Air in system, faeces, tube compliance</td>
<td>Reduces pressure transmitted</td>
<td>Unknown, variable</td>
<td>Regular checks for good pressure transmission</td>
<td>0</td>
</tr>
</tbody>
</table>

**Total of potential errors:** (9.6) 8.0

This study was funded by a grant from Andromeda, Digitimer and Laborie.

Conclusions
Water-filled systems, while being the recommended method, are subject to a potential inaccuracy of up to 8.0cmH₂O on pdet. Good practice can reduce this inaccuracy to a tolerable level, i.e. 1.4 cmH₂O. Particular care must be taken with calibration, zeroing and setting reference levels.

References
Fluid filled catheters for pressure sensing - drawbacks

- Time consuming calibration and set-up
- Re-zeroing with position changes
- Point sensors- unidirectional or bidirectional
- Hydrostatic headpressure, caloric changes, flow rate artifact, bubbles and kinks in line
- External transducer preparation
- Inaccuracy in urethral pressures
- Can’t continuously monitor urethral pressures during filling phase
Attenuation of pressure by 25 cc air bubble
## Benefits of Air-Charged Catheter

<table>
<thead>
<tr>
<th></th>
<th>Water</th>
<th>T-DOC Air-Charged Catheters</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>User Experience:</strong></td>
<td>![User Experience Image] (convenience)</td>
<td>![User Experience Image] (T-DOC)</td>
</tr>
<tr>
<td></td>
<td>![User Experience Image] (plug and play)</td>
<td></td>
</tr>
<tr>
<td><strong>Clinical:</strong></td>
<td>![Clinical Image] (accuracy)</td>
<td>![Clinical Image] (artifact)</td>
</tr>
<tr>
<td></td>
<td>![Clinical Image] (weather)</td>
<td></td>
</tr>
<tr>
<td><strong>Cost / Procedure time</strong></td>
<td>![Cost Image] (clock)</td>
<td>![Cost Image] (clock)</td>
</tr>
<tr>
<td></td>
<td>![Cost Image] (time)</td>
<td></td>
</tr>
<tr>
<td>T-DOC</td>
<td>VS Water</td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>----------</td>
<td></td>
</tr>
<tr>
<td>Reduces Urodynamic procedure time by approximately 20 minutes.</td>
<td>Set-up adds substantial time to overall procedure.</td>
<td></td>
</tr>
<tr>
<td>Does not require recalibration during procedure.</td>
<td>Needs to be recalibrated with patient repositioning, requiring transducer height adjustments.</td>
<td></td>
</tr>
<tr>
<td>The only Urodynamic catheters that provide “circumferential” pressure sensing, providing the most accurate readings.</td>
<td>Measures on point which can lead to inconsistent, unreliable pressure readings.</td>
<td></td>
</tr>
<tr>
<td>Air-column is relatively weightless and not affected by confounding hydrostatic pressure errors.</td>
<td>Mass of water adds unwanted weight and pressure errors with patient motion errors, change in height, air bubbles, and chloric changes with expanding water columns.</td>
<td></td>
</tr>
<tr>
<td>Provide cleaner subtracted pressures.</td>
<td>Rectal artifact is common when using fluid-filled catheters.</td>
<td></td>
</tr>
<tr>
<td>Economical to use, cuts additional costs for added supplies.</td>
<td>Additional costs for syringes, tubing, clumsy external transducers, stopcocks, etc.</td>
<td></td>
</tr>
</tbody>
</table>
Water artifacts

- Air bubbles
- Kinking of the tubes
- Movement artifacts
- Rectal placement with balloon too close to rectal sphincter - can get sphincter involved also variation on inflation volume in balloon to give desired pressures.
- Weighted medium- affected by gravity
Reference point of the pubic symphysis

- Setting the height of the pressure dome is arbitrary—guesstimation

- Looking from 4-5 foot away from machine to pt to get reference point

- Obese patients hard to tell the symphysis

- Supposed to reference the bladder level

- Have to adjust height with every movement of the patient due to gravity influence and can
Complicated setup with multiple lines to domes.

- Too many variables to worry about that you forget what your testing for
- Too many artifacts to sift through to distinguish true clinical significance of tracings.
- Too difficult for the average lab
Disposables

Urethra-Cystometry

9021P1261 - 3 lumen Vesical Catheter - 10F

9021P1091 - 1 lumen Abdominal Catheter - 8F

9021O1172 - Infusion Set for Pump

9021O1231 - Perfusion Set 3 (3 capillaries)

3 x 9022K1211 - Disposable Pressure Transducers

1000 ml STERILE WATER BAG

5 cm
Water column continuity problems

- Drip speed 2 drops / second
- Maintaining pressure on bag or column of 300mmHg
- If run Faster get turbulence artifact
- Under pressure
- If use the manual shut off its very subjective
- Can make drip speed adjustment that can change CM/H2O from 0-90 if too fast
- All different techniques making data variable including no drips just refill when you loose pressure from the lines
Water and Microtip are Point sensing rather than circumferential and area of pressure

- Only looking at 1-2 points in measuring urethral pressures with water
- Could be looking at urethral crests (0 pressure) or scar tissue (high pressure) when average pressure is normal
- TDOC Air-Charged measure an area of pressure and are circumferential gleaning the average pressure
- TDOC can be left in the urethra during filling phase to look at urethral pathophysiology, Water can not!!!
Good Urodynamic Practices for reproducability with Air

1- attach catheters to appropriate cable connection before touching patient

2- insert the catheters into the patient with the cable in open position to atmosphere (gets out excess air in catheter from manufacturing - prevents overdistention of balloon

3- place the Pves cath. In Females- 8-10 cm for 7FS, 12-14 cm for 7FD. Male: Shaft of penis + 8cm

4- Pabd: rectally place 10-15 cm therefore above the prostate and in culdesac of Douglas in women.
5- Zero to atmosphere then charge the catheters. Make sure all signals are intact with cough or valsalva

6- check for equal transmission of pressure to Pabd/Pves. May adjust Pabd moving catheter back and forth - this makes room if up against stool and usually rectifies the problem. If too much parastalsis may move closer to 10cm mark. Pabd has a stylet that allows kinking to right angle that doesn’t interfere with pressure and helps to see if catheter shifts in outward direction

7- if Pdet is Neg but there is equal transmission then can make Pabd=Pves since Pves is our reference point rather than the symphasis

8- run study
Using Air Charged Urodynamic Transducer: the Equalize Button

- Available on virtually all systems
- Recognizes Pves as sole absolute pressure for testing – our reference point like pubic symphasis
- Sets Pabd = Pves, rendering Pdet 0 (alternative labels include Pequalize or P equalize)
- I recommend using it judiciously; after making basic adjustments such as position of air-charged abdominal catheter - 10-15 cm, if high pressure adjust in and out several times to create a pocket in the stool if present
Quality Control: Calibrating Your Transducers
Calibrating Transducers

- Transducers change pressure/flow into electrical signal; calibration is the process of verifying accuracy of these measurements.

- All systems require regular checks to ensure accurate calibration; some systems have software that guide you through calibration (Server X tab), others can be calibrated by technician/engineer from manufacturer and some are stable from the factory if calibrated to the technology used- Air or water.

- Check calibration by moving fluid filled line (water-charged catheter) into column or placing air-charged catheter calibrator chamber with pressure gauge.
Reproducibility of Urethral Pressure Measurements: Standard Deviations

![Graph showing the reproducibility of urethral pressure measurements using different methods.](image-url)
Comparison of Fiberoptic, Microtip, Water and Air-charged Pressure Transducer Catheters for the Evaluation of Urethral Pressure profiles

Table 1. Catheter Values

<table>
<thead>
<tr>
<th>Catheter Type</th>
<th>Range of Values</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Transducer</td>
<td>8.0 – 51.0</td>
<td>26.29</td>
<td>15.41</td>
</tr>
<tr>
<td>Microtip</td>
<td>14.0 – 54.0</td>
<td>24.21</td>
<td>9.36</td>
</tr>
<tr>
<td>Fiberoptic</td>
<td>0 – 42.0</td>
<td>17.18</td>
<td>12.27</td>
</tr>
<tr>
<td>T-DOC Air-Charged</td>
<td>36.0 – 40.0</td>
<td>37.23</td>
<td>1.30</td>
</tr>
</tbody>
</table>
Comparison of Air-Charged and Water-Perfused Urodynamic Pressure Measurement Catheters

- Damaser, 2009-JNU and U- attenuation only occurred between 5-8HZ for air.

- Engineering study in rigid / non compliant chamber (not a physiological compliant model like a bladder) measuring pressure simultaneously.

- Water-filled catheters acted as an underdamped system, resonating at 10.13 ± 1.03 Hz and attenuating signals at frequencies higher than 19 Hz. They demonstrated significant motion and hydrostatic artifacts.

- Air-charged catheters acted as an overdamped system and attenuated signals at frequencies higher than 3.02 ± 0.13 Hz. They demonstrated significantly less motion and hydrostatic artifacts than water-filled catheters.

- Although air-charged systems filter higher frequencies, most urodynamic events occur at lower frequencies, (0.5-3 Hz) allowing the air-charged catheters to preserve the overall shape of the signal.

Cooper, Fletter, Zaszczurynski & Damaser, 2011, J. neuourology and urodynamic
COWACC study - 2014

- Comparison of Water and Air-Charged Transducer Catheters in the Evaluation of Urodynamiic and Urethral Pressures
- Women >21 years requiring urodynamic testing
- Single site
- N=50
- Single catheter technique
TDOC Dual Pressure Catheter

Air-charged pressure

Water pressure
Figure 1. Average differences in cough measurements between WP and AC catheters. The error bars represent standard deviation. The differences in measurements are significantly larger when the bladder is at 0 fill volume (p<0.0001, one way ANOVA).
Figure 2. Average differences in valsalva measurements between WP and AC catheters. The error bars represent standard deviation. The differences in measurements are significantly larger when the bladder is at 0 fill volume (p=0.0007, one way ANOVA)
Figure 5. Comparison of measurements during valsalva maneuvers using WP and AC catheters. Trendline equation comparing measurements when the bladder has 50mL of saline or more shows an $R^2$ value of 0.9743.
Figure 6. Bland-Altman plot comparing the differences between AC and WP valsalva measurements with at least 50mL volume infused into the bladder. Average difference is 3.15 cmH2O (n=402) with a standard deviation of 4.72 cmH2O. Dashed lines represent 2 standard deviations from the average difference.
Figure 3. Comparison of measurements during coughs using WP and AC catheters. Trendline equation comparing measurements when the bladder has 50mL of saline or more shows an R2 value of 0.943.
Figure 7. Bland Altman plot representing difference between peak AC and WP cough and valsalva pressures.
Figure 7. Filling cystometry tracing at an infused volume of 460 ml. The top row contains two tracings overlaid representing WP (blue ‘Pves_water’) and AC (red ‘Pves_air’).
Figure 4. Bland-Altman plot comparing the differences between AC and WP cough measurements with at least 50mL volume infused into the bladder. Average difference is 0.25 cmH2O (n=457) with a standard deviation of 8.82 cmH2O. Dashed lines represent 2 standard deviations from the average difference.
Air and Water Pressures at Peak Flow During Void

\[ y = 0.9981x + 0.6507 \]
\[ R^2 = 0.9901 \]
Air and Water Pressures at Peak Flow During Void

Average difference = 0.5
Limits of Agreement: -6.9 to 7.9
SD = 3.7
2SD = 7.4
N = 30
Sample graph showing $P_{ves}(air)$ and $P_{ura}$-water during a Void Pressure Study

$P_{ves}$ (Air)  $P_{ura}$ (Water)
Figure 1. MUP and MUCP correlation between AC and WP measurements representing 23 patients and 67 UPPs. Infused volume = 200mL.

\[ y = 1.0625x + 10.411 \quad R^2 = 0.9558 \]

\[ y = 1.0517x + 10.584 \quad R^2 = 0.9601 \]
Figure 3. Bland Altman plot representing the difference between the MUCP of consecutive UPPs plotted against the average of the two measures representing 44 comparisons of intra-method (AC & WP) reproducibility.
Figure 4. Three UPPs performed at a bladder volume of 200mL. The top row contains two tracings representing WP (blue ‘Pura_water’) and AC (red ‘Pves_air’).
Out of 49 patients, 6 presented with possible ISD (low MUCP values), summarized here. H2O overcalled ISD

<table>
<thead>
<tr>
<th>Patient File#</th>
<th>AC MUCP</th>
<th>WP MUCP</th>
<th>AC LPP</th>
<th>WP LPP</th>
<th>ISD Dx</th>
</tr>
</thead>
<tbody>
<tr>
<td>030</td>
<td>Border</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes according to H2O MUCP</td>
</tr>
<tr>
<td>039</td>
<td>No</td>
<td>Border</td>
<td>No</td>
<td>No</td>
<td>No</td>
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<tr>
<td>042</td>
<td>Yes</td>
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<td>Yes</td>
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<tr>
<td>077</td>
<td>Border</td>
<td>Yes</td>
<td>Border</td>
<td>Border</td>
<td>Possible ISD</td>
</tr>
</tbody>
</table>


Common Questions on TDOC

1- What is the diameter of TDOC? All catheters are 7 french, however, at the balloon after inflation its about 8 french. This should not effect leaks or leak point pressures anymore than Water Catheters-balloon is in bladder not urethra.

2- The “charged balloon” is not 13 french unless done inappropriately- charging outside body giving the catheter the manufactured air and charged air. Also a rare problem was a cable from GI from Clinical innovations got misused in the urodynamic market giving a larger “air- Charge”

3- Can TDOC be used for nomograms- Schaffer/Chess, etc.- yes, TDOC is 7 french
Common Questions on TDOC

4- For pediatrics- Virtually 100% of US children's labs use TDOC 2nd to the decrease in time of the study and decreased movement artifact. We are developing a 5 french pediatric catheter with filling up to 50 cc’s.

5- Are urethral measurements as accurate with air as water- They are more accurate and reproducible due to the circumferential and area average pressure achieved - studies ongoing.

Saw in 1st paper comparing all technologies. Urethral pressures taken with water has been diminished so much that a majority of urologists ignore that data. We have lost a lot of value of urodynamics by just extrapolating function of the urethra by measuring bladder pressures. It’s a coordinated effort between bladder and urethra and needs to be placed back into evaluation of UDS-Increase the Importance of urodynamic.
Common Questions on TDOC

6- Ambulatory use of TDOC - Being worked on to improve. A simple solution to diffusion of air out of balloons by osmotic activity is to recharge during a lengthy study. A coating of the balloons like with IUPC’s will elevate that affect.

7- How often can you reuse the charger cable. - If used properly-( cover it after use and before cleaning) they can be used thousands of times. Mine alone have been used in over 2000 UDS.

8- Abdominal Pressure being higher than water. - because of reference point of water being the symphasis. The area of the Pabd H2O is sitting lower than the symphasis by 5-10 cm. Our reference point is the Pves pressure sensor which is more consistant
FUTURE OF URODYNAMIC: Urethral Pressure Pathophysiology

• Source/ origination of all incontinence?

• Was too difficult to detect in the common lab due to poor technology, therefore, ALPP and UPP only since water can’t do continuous monitoring of urethral pressures during the filling phase.

• Continuous Static urethral pressure monitoring = WATCHDOG

1. Unstable Urethral Pressure (UUP), Detrussor Sphincter Dysynergia, UPP, Matchup with EMG changes
Package: \{ LPO = Leak Point Detector \} Together with TFO:

Continuous Monitoring System of metal gasses during CMG.
Definition of urethral Instability and urethral hypertension

- Variations off of baseline + or - 15 cmH2O
- Urethral pressure baseline greater than 120 cmH2O with frequency/urgency or retention symptoms
- Urethral pressure decrease followed by detrusor instability.
Urethral instability
19 Y/O female

- Chief c/o frequency/urgency and no urge incontinence - Now in a psychiatric ward for suicide precautions - attempt x2
- Frequency = Q 15-30 min
- Nocturia = Q 20 min.
- Progressively worse over last 5 years but existing all her life.
- No other significant medical history
- PE unremarkable
- PVR minimal
19 year old female

- Urodynamics showed urethral instability without DO
- Failed anticholinergics and all prior therapies by several urologists
- Flomax (Alpha Blocking) failed
- No IC on cystoscopy with Biopsy
- Brought to Or for interstim placement from Psychiatric ward
19 year old female
Post-OP

- Slept through the night
- Frequency Q 4-5 hours
- Discharged from the Psych Hospital and now finished Nursing School
Study Objective:

- Urodynamic indicators for success were looked at.
- A retrospective chart review of all InterStim sacral nerve stimulation patients for possible predictive value of success were done.
- **Urethral instability**, a sacral nerve neurological pathology, (urethral pressure variations of greater than 15 cmH₂O pressure off of baseline during filling phase) was the most common finding.
APPLICATION OF URETHRAL INSTABILITY AS A PROGNOSTIC TOOL TO PREDICT THE SUCCESS OF INTERSTIM SACRAL NERVE STIMULATION

- Retrospective study
- 26/30 implants with 86.66% success rate
- 23/26 successes had urethral instability - 88.4%
- 2 successes had poor UDS study with urethral sensor in bladder: ? Could have been UI.
- 1 failure with no UI
- 3 failures with UI had also had (2) Severe IC and (1) bad diabetes/atony with retention, obesity and renal insufficiency on diuretics
Prospective study: 15/15 successes with UI as sole diagnostic findings on urodynamics.

11 Pts with IC and urethral instability with failed conservative tx

10/11 had successful implants with interstim with reversal of symptoms of IC
Algorithm for frequency and urgency without detrusor instability:

- If urodynamics + urethral instability and normal bladder capacity, go to medical therapy, (anticholinergic) with dietary changes, alpha adrenergic blocking agents (Hytrin/Flomax, Rapaflo), alpha adrenergic (Pseudofed/zyrtec) and biofeedback/Estim. with bladder drills; if fails go to Interstim.

- If urodynamics - negative for urethral instability, go to cystoscopy with biopsy and hydrodistension and treatment for I.C. (18/18)

- If urodynamics + urethral instability, go to medical therapy for I.C. and UI. If fails go to Interstim.
InterStim® Continence Control Therapy
Making UDS more Important: Continuous Urethral monitoring is the future

- **UDS discovered** Urethral instability appears to be directly correlated with interstim success
- Interstim appears to down regulate the Sacral reflex arc
- Repeat post-op urodynamics x10 now showed resolution of urethral instability
- A prospective study showing disappearance of UI
- Seeing UI, *anticholinergics don’t work* - use Alpha blockers, biofeedback/ E stim, or SNS instead.
- **UDS only way to detect this phenomena.**
More on the Importance of UDS

• Choices on type of incontinence surgery
  1. ISD : retropubic sling (TVT), fascia lata/rectus fascia sling
  2. GUSI: obturator sling, Burch/MMK

• Monitoring sling tension during placement - making sling tensioning a Science rather than an ART.
  1. Know when to stop tightening
  2. Know where mid urethral sling incision needs to be made
  3. If retention 2nd to sling- know where the incision should be made.
LEAK POINT PRESSURE

• Performed as part of CMG

• Sitting position, 150 and 200 ml volume

• Size of catheter critical - 7-8 French or less

• Value - difference between resting bladder pressure and pressure at which straining causes leakage around the catheter

• ISD - < 60 cm H₂O

• Normal - > 100 cm H₂O
**High Valsalva Leak Point Pressure**

115 cmH₂O

75 cmH₂O

15 cmH₂O

Resting Bladder Pressure

140 cmH₂O

150 cmH₂O

L

L

Bladder Pressure at Leak
-Restig Bladder Pressure

VLPP

125 cmH₂O

135 cmH₂O

1st Valsalva

140 cmH₂O

-15 cmH₂O

2nd Valsalva

150 cmH₂O

-15 cmH₂O

**Low Valsalva Leak Point Pressure**

115 cmH₂O

75 cmH₂O

15 cmH₂O

Resting Bladder Pressure

55 cmH₂O

65 cmH₂O

Bladder Pressure at Leak
-Restig Bladder Pressure

VLPP

40 cmH₂O

50 cmH₂O

1st Valsalva

55 cmH₂O

-15 cmH₂O

2nd Valsalva

65 cmH₂O

-15 cmH₂O
Valsalva leak point pressure
Urethral pressure profilometry

- MUCP < 20 cm H2O = ISD
- MUCP > 20 cm H2O but < 40 cmH2O = Grey zone
- MUCP > 40 cmH2O = Normal

- MUP > 120cm H2O Urethral High Pressure
UPP: Incompetent Sphincter
Lateral deviation of TVT needles

Inferior epigastric vessels

Obturator vessels

Ext. iliac vessels

Lateral deviation of TVT needles
Complications Associated with TVT: FDA Database 02-04

- Bowel Injury - 19 (4 deaths)
- Vascular Injury - 30
  - External Iliac Vessels
  - Femoral Artery
  - Obturator Artery
  - Inferior Epigastric Artery

http://www.fda.gov/cdrh/maude.html
Complications associated with TVT (FDA MAUDE*)

- Bowel injury - 7 (2 deaths)
- Vascular injury (2 deaths)
  - Hematoma - 17
  - External iliac artery - 6
  - Femoral artery - 3
  - Obturator artery - 1
  - Inferior epigastric artery - 1

*Source—http://www.fda.gov/cdrh/maude.html
Trans-Obturator Approach
TVT Verses TOT
Objective Results

- TVT: 84%
- TOT: 90%

- Cure
- Improved
- Failed
Trans-Obturator Approach
Complications

- Bleeding > 200 ml
  0.0%

- Bowel injury
  0.0%

- Nerve injury
  0.0%

*Porges, unpublished*
Conclusions

- Sling is appropriate for patients with urodynamically diagnosed stress incontinence.
- Urodynamic testing for urethral function defines the type of sling to be used:
  - ISD either a TVT or fascia lata compressive sling - more risk to surgery.
  - GUSI > 100 cmH2O ALPP= obturator sling - less risk.
  - Bad urethra - “compressive” sling.
  - Not so bad urethra - “tension-free” sling - obturator.
UPP for MUP before and during sling tensioning
Future of urodynamics - predictive outcome data

- Creating a nomogram on urodynamics using parameters in Voiding Pressure Study to understand outcomes and know what sling tension to give.

- Normal: MUP = GUSI: should be no increase in pressure after sling tightening. Should be right at the point pressures will not increase. Therefore, MUP 35 before, MUP after 35

- ISD: If normal VPS Pdet Max don’t exceed sling tension above 35 cm H2O. If poor bladder contractility- 30cmH2O

- MUP before sling can determine where incision and sling needs to be placed. Ie, true mid urethra.

- IF Pt has low Pdet max on VPS, slow max flow rate, high PVR, abdominal voiding, obesity- ? What tension should we give to sling. Know where to look to cut sling if retension

- Retrospective and prospective study underway
CLINICAL IMPORTANCE OF URODYNAMICS - Conclusions

1- ONLY OBJECTIVE MEANS OF DETERMINING VOIDING DYSFUNCTION

2- GOLD STANDARD FOR MALE AND CHILDREN WITH LUTS

3- IMPORTANT IN IDENTIFYING PROPER SURGICAL PROCEDURE- decrease risk of interventions

4- I SAY SO!!!

5- ICS says so!

6- understanding pathophysiology of voiding dysfunction

7- DO NO HARM!!! RISK TO PATIENT

8- Medicolegal issues

9- Urethral Instability can’t be diagnosed without UDS