ICS Teaching Module: Analysis of voiding; Pressure flow test (Basic module)

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ICS teaching module

- This teaching module should be used together with the manuscript:
- 'ICS teaching module: Analysis of Voiding; Pressure Flow Analysis' published in: Neurourology and Urodynamics

- The manuscript provides the scientific background and the evidence base of pressure flow analysis as well as the references.
- This teaching module contains expert opinion recommendations to compensate for lacking evidence where necessary. Expert opinions are marked with 'eo' in the title of the slide.

- Reference to this presentation and teaching module:
- Neurourol Urodynam 2014 #### (33) ###

- This teaching module contains 25 slides and can, only in its complete form, freely be used for teaching purposes.

Normal lower urinary tract function

- Bladder filling begins (Storage LUT function -phase)
- Nervous system maintains relaxed detrusor
  - and ensures low intravesical pressure
- Distension activates muscle stretch receptors
  - Perception (proprioception) of fullness develops
- Cortical determination of desire to void
- Voiding (Voiding LUT function -phase)
  - Until bladder emptied
- Bladder filling, again

Normal voiding

- Voiding is desired (and socially acceptable)

- Pelvic floor relaxes by will..
  - …subsequently and autonomically the..:
- …urethral sphincter relaxes and (antagonistic) detrusor-dome contracts;
- Detrusor pressure forces the (relaxed) bladder neck, the urethra and pelvic floor to open;
- Urine flow begins;
- Detrusor contraction ends;
- Urethral sphincter and pelvic floor contraction resume.

Control of lower urinary tract function

- Central control and influence
  - Cognition
  - Social
  - Emotional
- Central & peripheral pathways
  - Afferent (sensory)
    - Somatic
    - Autonomic/visceral
  - Efferent (motor)
    - Somatic
    - Autonomic/visceral
- While testing: (sub-) conscious central influence may (in comparison to storage phase) play a larger role in voiding function.[eo]

General principles of urodynamic testing*

Well informed patient

- Appropriate environment
  - Physical (warm, least uncomfortable position...)
  - Emotional (adequate draping, private...)

- Antiseptic procedure
  - Urinary tract infection as a result of urodynamic testing should be prevented
    - (Not 'corrected' with prophylactic antibiotics)

* See also: Basic module 'cystometry'

Voiding: pressure flow test(s)

- Because the pressure flow test may be more influenced through the patient's emotion:
  - Ask patient (after voiding):
    - 'Was this voiding -almost- as usual?'
    - 'Was the bladder 'uncomfortably' full?'
  - You have:*
    - Indicated on cystometry: first sensation of filling
    - Indicated on cystometry: normal desire to void
    - Indicated on cystometry: strong desire to void > end of filling AND
    - Indicated on cystometry: permission to void
      - The 'permission to void' separates the storage and voiding LUT phases!
  - Compare with free (without catheter) flow!

* See also: Basic module 'cystometry'

Voiding: pressure flow test(s)

- Negative influence on voiding:
  - Uncomfortably large intravesical volume at the start of voiding*eo*
  - Very unrepresentative urgency at the start of voiding*eo*
  - Extreme inhibition of overactive detrusor contractions before the start of voiding*eo*
  - Rectal catheter hindering pelvic muscle relaxation

Voiding: Pressure flow test(s)

- Be aware that the transurethral catheter:
  - Causes (some) passive effect
    - May be obstructive (esp. when stricture exists)
    - May ‘stent’ kinking urethra in female
  - Causes active effect (hinders normal behaviour)
    - alters voiding sensation
      - Anaesthetic (lidocaïne) gel
    - (fear for) pain during voiding
  - May –partially- slip out

Set up for the test

- (ICS-) Good urodynamic practice:
  - See also ICS module: Cystometry

- Ensure balanced intravesical and intra abdominal (intra rectal) pressure recording.

- Couch (pressures balance) check before and after voiding.

- Ensure correction of flow curve for the systematic delay between (recorded) flow and pressure.
  - depending on the meatus to flowmeter distance
  - before a pressure flow analysis is done

Set up for the test

- Best possible (= most comfortable for patient), position during voiding.
- Flowmeter as close as possible to the meatus.
  - Minimize time delay between flow at meatus and entering flowmeter
- No hindering of stream between funnel and beaker or spinning disk.
  - (e.g. No (long) tube between funnel and beaker or disk.)
- Use thin transurethral catheter.
- Use thin rectal catheter.
- Tape catheters alongside meatus / anus.

Mechanics of voiding

- Detrusor pressure (cmH2O) generates flow (ml/s)
  - Intravesical pressure minus intra-abdominal pressure
- Urethra (normally) functions as a tube…
  - with passive distension (until Qmax)
  - and passive collapse (after Qmax)
- Flow (Qmax) is limited by the 'flow controlling zone' (FCZ)
  - The FCZ is the virtual (! by definition) point in the urethra that gives the highest resistance to flow
  - Increased resistance drives detrusor to higher pressures to generate flow

- Urethral catheter (8F) causes ±10cm H2O increase of detrusor pressure
  - (Systematic) increase of measured outlet obstruction.
  - Should be corrected for if suprapubical catheter is used.

Mechanics of voiding: phases

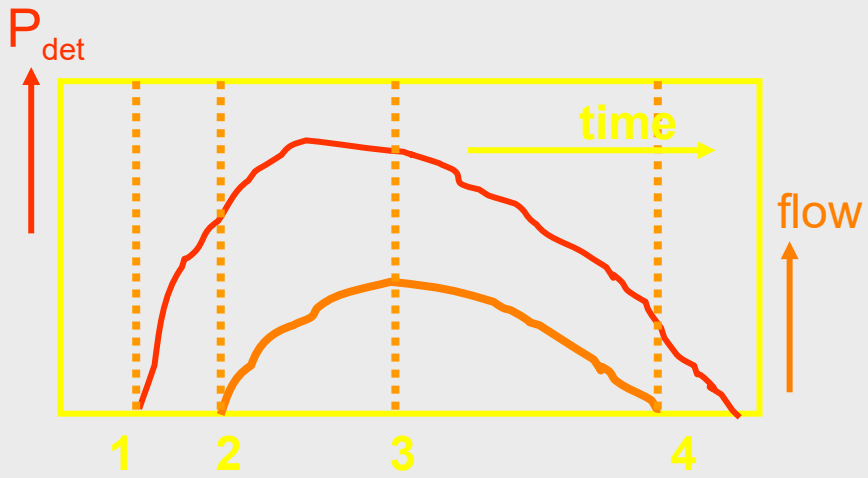
Start of pressure flow = end of storage: Indicated by 'permission to void'.

After voluntary pelvic floor relaxation after

- Permission to void *

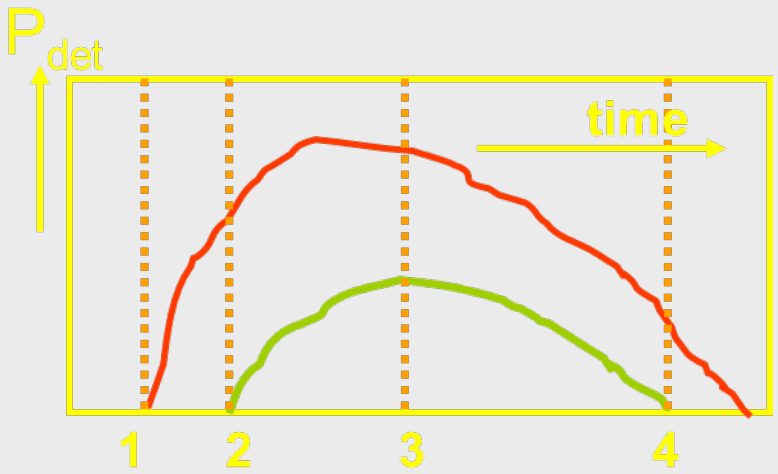
The voiding reflex starts and:

- Detrusor pressure rises (1)
- Outlet relaxes and becomes distended
  - Passive distensible….
- 'Detrusor opening pressure' when flow starts (2)
- 'Maximum flow' when distension is maximal (3)
  - Limited by FCZ
- Steady state /balanced forces until...
- Outlet collapses
  - ... collapsible tube
- 'Closing pressure' (end of flow) (4)



Voiding phases

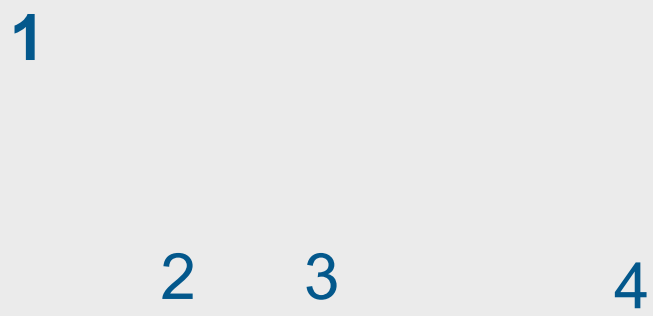
start of voiding = detrusor pressure rise (see graph): 1 >>
>> distension of outlet = opening pressure>start of flow: 2 >>
>> maximum flow = beginning of 'steady state outlet'*: 3 >>
>> end of flow = collapse of outlet: closing pressure: 4



* During a normal voiding there exist a balance between the forces outside and inside the bladder outlet (urethra) between 3 and 4.

ICS terms

- Pre -micturition pressure (1)
- Opening detrusor pressure (2)
- Opening time
- Maximum detrusor pressure
- Maximum flow (3)
- Detrusor pressure at maximum flow (3)
- Closing detrusor pressure (4)
- Minimum voiding detrusor pressure
- Flow delay time



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- Minimum voiding detrusor pressure
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- Detrusor pressure at maximum flow (PdetQmax) and maximum flow (Qmax) are, in combination, the most relevant for the analysis of LUT voiding function

Provisional ICS method for definition of obstruction

- Easy way to grade pressure-flow result*:
- On the basis of:
  - Detrusor pressure at maximum flow (PdetQmax) and maximum flow (Qmax)
- calculate $P_{det}Q_{max} - 2 \times Q_{max}$ (#)
  - (pressure at maximum flow minus 2 times maximum flow rate)
  - use cmH2O for pressure & ml/s for flow rate

Provisional ICS method for definition of OBS

* See also ICS modules: Pressure flow testing: Advanced analysis

Provisional ICS method for definition of obstruction

- p-ICS method is ‘clinically calibrated’ for elderly male patients with an enlarged prostate
  - if p-ICSmethod < 20: No BOO
  - if p-ICSmethod >40: BOO
  - if p-ICSmethod 20 to 40: Equivocal/ intermediate

  - Might be interpreted for male patients with an enlarged prostate as*: (eo)

    - No BOO: des-obstruction will not change the voiding very much
    - BOO: des-obstruction will likely be effective to improve voiding
    - Equivocal: the result of 'des -obstruction‘ is not predictable

    (50% chance of symptomatic improvement)

* this does not take filling phase abnormalities into account

Quality control

- Before:
  - Is the patient adequately informed and instructed?
  - Is anything changed after the indication for UDI testing was settled?

- During:
  - Are sterile catheters and filling medium used?
  - Are antiseptic procedures applied?
  - Is the patient clothed/covered as much as possible?
  - Is the patient comfortably positioned?
- (Especially if male:) Preferred position for voiding?
  - Has everyone who is unnecessary left the site of testing?

- After:
  - Is the patient instructed to drink ± 0,5-1liter immediately after the test?

Quality control (p/Q analysis)

- Ask the patient:
  - Was this voiding more or less as usual / as at home?
    - If not: clinical urodynamic diagnosis may be irrelevant
      - E.g: Not beïng able to void does frequently (but not always) not represent the real function and is therefore situative during UDI

- Observe the tracings (of the entire cystometry)
  - Are the pressures in the physiological range
  - Are the intravesical and intra abdominal pressures reacting synchronous on patients' movements and coughing (balanced pressures), also after the voiding?
  - Is permission to void adequately marked /indicated?

Quality control (continued)

- Observe pressure and flow:
  - Is the time lag (meatus to flowmeter) adequately corrected?
    - May be a standard time correction per institute
  - Are flowrate artefacts visible/correctable/corrected?
  - Are pressure artefacts visible/correctable/corrected?
    - (compare cough -pressure- test before and after voiding)
  - Is post void residual urine measured?
  - Is it possible to make an adequate, complete and relevant diagnosis of lower urinary tract voiding function?
  - If not: repeat the test

- Is a pressure flow plot analysis needed? *
  - Quantification of BOO may be less reliable with (severe) underactive contraction
  - Is a physiologically plausible pressure flow 'loop' recognizable?
  - Can the lower pressure border be recognised?
  - Did automated analysis produce plausible and valid results?

* See ICS modules: Pressure flow testing: Advanced analysis

Clinical Quality

- Patients unable to void because of the test situation:
  - Might be not unexpected ('shy voiders / shy bladder/ paruresis')
    - Allow more time; ensure absolute privacy; dim the lights
    - Allow something (cold water) to drink
    - (Sound of) running tap –water
  - Some contraction is seen but no, or very little voiding:
    - not acontractility, not representative, BOO impossible to 'calibrate'*
  - No contraction is observed and no voiding:
    - If patient is usually able to void:
      - not definite acontractility; not representative*
- *patients tend to start straining; usually not productive and not representative!

- Formal pressure flow analysis and diagnosis (outlet or contractility) of voiding (other than 'shy') is impossible now.

Clinical Quality: Pressure flow analysis

- For (elderly) men (with a larger prostate):
  - Pressure flow (relation and) analysis is straightforward
  - Clinically applicable limits for (grading of outlet properties) exist

- For young men, women and children: (eo)
  - Basic principles of voiding and p/Q analysis are known and applicable
  - Universally agreed clinical grading of outlet properties does not exist

- Dynamic outlet obstruction /dysfunctional voiding: (eo)
  - No (standard) grading of outlet dynamics is available
  - No urodynamic (pressure flow relation) criteria

- Neurogenic dyssynergia or neurogenic dynamic outlet obstruction: (eo)
  - No (standard) grading is available
  - No urodynamic (pressure flow relation) criteria
    - However (detrusor) Leak Point Pressure is relevant

Pressure flow analysis: concluding

- Flow relates to pressure and is determined (or limited) by outlet properties
  - Representative voiding and clinically relevant pressure flow analysis depends on good urodynamic practice and properly ascertained patient cooperation
  - A very unrepresentative voiding and -or significant underactive detrusor contraction limit the validity of the pressure flow analysis
- Pressure flow starts: after permission to void
- Bladder outlet obstruction can be graded by:
  - p-ICS-method = $P_{det}Q_{max} – 2 \times Q_{max}$

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