EC25: ICS Core Curriculum (Free) ICS Teaching Modules - Urodynamics

Workshop Chair: Peter Rosier, Netherlands
16 September 2016 13:30 - 15:00

Start	End	Topic	Speakers
13:30	13:40	introduction	Peter Rosier
13:40	13:50	Cystometry (Japanese)	Yukio Homma
13:50	14:00	Pressure Flow Analysis	Yukio Homma
14:00	14:10	Pelvic Floor Muscle EMG	None
14:10	14:20	Flowmetry	None
14:20	14:30	Fundamentals of Lower Urinary Tract Physiology	Peter Rosier
14:30	14:40	TBA	None
14:40	14:50	Urodynamics for Geriatric Patients	Adrian Wagg
14:50	15:00	Questions	All

Aims of course/workshop

New ICS Urodynamics Committee Teaching Modules will be presented. Objective of the presentations is to discuss the educational value and relevance of the modules.

Learning Objectives

After this workshop participants should be able to:

1. ICS teaching modules educate the practice of urodynamics and other tests to evaluate lower urinary tract and pelvic floor dysfunction.
2. The modules are presented to educate, but also to evaluate clarity and validity.
3. The modules specifically addresses the practical elements of testing and put evidence into practice

Learning Outcomes

Become aware of good urodynamic practices
Learn the theoretical background of testing for lower urinary tract and pelvic floor dysfunction
Become concerned with education in good urodynamic practice.

Target Audience

Gynecologists, urologists, urodynamicists beginning and interested in urodynamics and diagnosis of lower urinary tract dysfunction.

Advanced/Basic

Basic

Conditions for learning

The workshop is discussion stimulating and interactive with regard to both the validity of the modules as well as their educational value.

Suggested Learning before workshop attendance

Basis literature is ICS-Terminology and ICS -Good Urodynamic Practices

Suggested Reading

- Schäfer W, Abrams P, Liao L, Mattiasson A, Pesce F, Spangberg A, Sterling AM, Zinner NR, van Kerrebroeck P; International Continence Society. Good urodynamic practices: uroflowmetry, filling cystometry, and pressure-flow studies. Neurourol Urodyn. 2002; 21(3):261-74. PubMed PMID: 11948720.
- Abrams P, Cardozo L, Fall M, Griffiths D, Rosier P, Ulmsten U, Van Kerrebroeck P, Victor A, Wein A; Standardisation Sub-Committee of the International Continence Society. The standardisation of terminology in lower urinary tract function: report from the standardisation sub-committee of the International Continence Society. Urology. 2003 Jan;61(1):37-49. Review. PubMed PMID: 12559262.
- Tarcan T, Demirkesen O, Plata M, Castro-Diaz D. ICS teaching module: Detrusor leak point pressures in patients with relevant neurological abnormalities. Neurourol Urodyn. 2015 Dec 23. doi: 10.1002/nau.22947. [Epub ahead of print] PubMed PMID: 26693834.
- Digesu GA, Gargasole C, Hendricken C, Gore M, Kocjancic E, Khullar V, Rosier PF. ICS teaching module: Ambulatory urodynamic monitoring. Neurourol Urodyn. 2015 Nov 23. doi: 10.1002/nau.22933. [Epub ahead of print] PubMed PMID: 26594872.

- Gammie A, D'Ancona C, Kuo HC, Rosier PF. ICS teaching module: Artefacts in urodynamic pressure traces (basic module). Neurourol Urodyn. 2015 Sep 15. doi: 10.1002/nau.22881. [Epub ahead of print] Review. PubMed PMID: 26372678.
- Asimakopoulos AD, De Nunzio C, Kocjancic E, Tubaro A, Rosier PF, Finazzi-Agrò E. Measurement of post-void residual urine. Neurourol Urodyn. 2016 Jan; 35(1):55-7. doi: 10.1002/nau.22671. Epub 2014 Sep 22. PubMed PMID: 25251215.
- Rosier PF, Kirschner-Hermanns R, Svihra J, Homma Y, Wein AJ. ICS teaching module: Analysis of voiding, pressure flow analysis (basic module). Neurourol Urodyn. 2016 Jan; 35(1):36-8. doi: 10.1002/nau.22660. Epub 2014 Sep 11. PubMed PMID: 25214425.

Yukio Homma
Cystometry: in Japanese language

Pressure Flow Analysis: in Japanese language

These modules are published and will now be presented and recorded in Japanese language

Jan Khrut
Pelvic floor muscle EMG

This new module educates the practice of surface EMG during cystometry and pressure flow test of the pelvic floor muscles.

Peter Rosier
Fundamentals of Lower Urinary Tract Physiology

This new module educates the pathophysiology of the lower urinary tract.

Adrian Wagg
Urodynamics for Geriatric Patients

This new module educates the specific requirements for testing of the lower urinary tract in geriatric and frail patients.

Bary Bergmans
Testing of the pelvic floor muscles in physiotherapy

This new module educates specific physiotherapeutic techniques of clinical testing of patients with lower urinary tract dysfunction.

排尿の解析
内圧尿流検査

国際禁制学会
尿流動態委員会

Peter F.W.M. Rosier, Ruth Kirschner Hermanns, Jan Svihra,
Yukio Homma, Alan Wein

文献: **Neurourol Urodynam** 2013 #### (32) ###

ICS 教材

- この教材は、下記の論文と同時に使用すること
  'ICS teaching module: Analysis of Voiding; Pressure Flow Analysis' published in: Neurourology and Urodynamics
- この論文は、科学的背景とエビデンスに基づいた内圧尿流解析 の評価方法を、引用文献とともに紹介している。
- この教材では、エビデンスが不足している部分については、専門家の見解に基づく提案を補足している。専門家の意見が記された箇所には、スライドの標題に'eo'と記載した。
- この発表と教材の引用文献:
  - Neurourol Urodynam 2013 ##### (32) ###
- 本教材は38枚のスライドを含むが、そのまま使用する場合に限り、無償で教育目的に活用してよい。

正常な下部尿路機能

- 膀胱充満が開始する (下部尿路機能の蓄尿相)
- 神経系が膀胱排尿筋の弛緩を維持する
  - 膀胱内圧は低圧を維持する
- 膀胱の伸展が筋肉の伸展受容体を活性化する
  - 膀胱充満感が生じる
- 大脳皮質による排尿の決定
- 排尿 (下部尿路機能の排尿相)
  - 膀胱が空になるまで
- 再度の膀胱充満

正常な排尿

  - 排尿が意図される (そして、社会的に許容される)
- 自らの意思で骨盤底を弛緩させる
  - 引き続き、自動的に
- 尿道括約筋が弛緩し、(相反的に)膀胱排尿筋が収縮する
- 排尿筋圧が、(弛緩した)膀胱頸部、尿道、骨盤底を開口する
- 尿流が開始する
- 排尿筋の収縮が終了する
- 尿道括約筋と骨盤底が再び収縮する

eo

検査中の排尿

- 平常(カテーテルがない状態)の排尿と比較を！
- '適度に' 膀胱は充満していたか?
  - 膀胱内圧測定中に以下の記録を行うこと
    - 初発尿意 (first desire to void)
    - 通常尿意 (normal desire to void)
    - 強い尿意 (strong desire to void) > 充満終了 <
    - 排尿許可(permission to void)
      - 排尿許可が蓄尿相と排尿相を分ける
    - 不快なまでに大きい膀胱容量(または明らかに普段と違う尿意切迫感)は、 排尿を改善しない
- (排尿後に)患者に質問せよ:
  - 「今回の排尿は、(ほぼ)普段通りでしたか？」

検査中の排尿?

- 経尿道カテーテルに注意せよ:
  - (軽度の)受動的な影響を与える
    - 閉塞
  - 能動的な影響を与える (正常な行動を阻害)
    - 排尿時の知覚を変える
      » リドカインゼリー
    - 排尿時の痛み (に対する不安)
  - カテーテルが(途中まで)滑脱するかもしれない

検査の準備

- (ICS-) Good urodynamic practice:
  - *ICS module: Cystometry*を参照
- 調整した膀胱内圧と腹圧(直腸内圧)をの記録を確認せよ
- 排尿前後で咳チェック(圧バランス)
- 記録された尿流と内圧の間の機器のよる遅れに対して、尿流曲線を補正せよ
  - 内圧尿流検査を行う前に
  - 尿道口と尿流測定装置の距離による

検査の準備

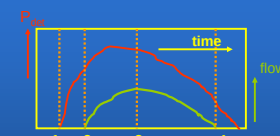
- 可能な最良の(患者にとって最も快適な)排尿姿勢
- 尿道口にできる限り近い尿流測定装置
  - 尿道口と尿流測定装置に入る尿流の時間差を最小限にせよ
- 漏斗と集尿器または回転盤の間に尿流の阻害がない
  - (例: 漏斗と集尿器や回転盤の間に長いチューブがない)
- 細径の経尿道カテーテルを使用せよ
- 細径の直腸カテーテルを使用せよ
- 尿道口、肛門の脇にカテーテルをテープ固定せよ

排尿の力学

- 排尿筋圧 (cmH_2O) が尿流 (ml/s)を生む
  - 排尿筋圧 = 膀胱内圧 – 腹圧
- 尿道は(正常では)管として機能する
  - 受動的に伸展し(Q_{max}まで)
  - 受動的につぶれる (Q_{max}以降)
- 尿流 (Q_{max}) は尿流調整帯(flow controlling zone: FCZ)で制限される
  - FCZとは、尿流に対する抵抗が最大化する尿道内の(定義上は)仮想点
  - 尿道抵抗の上昇は、尿流を発生させるために排尿筋圧をより高める
- 尿道カテーテル (8F) で、排尿筋圧は 約10cm H_2O 上昇する
  - 測定される出口部閉塞は(システム上)増大
  - 恥骨上カテーテルを使用すれば補正される

排尿の力学:段階別

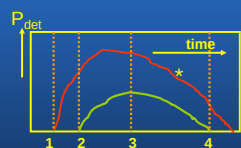
随意的な骨盤底の弛緩の後に
排尿反射が生じ、そして:



- 排尿筋圧が上昇 (1)
- 排出路が弛緩し伸展
  (受動的な伸展)
- 開口時排尿筋圧 (Detrusor opening pressure)
  :尿流開始時の圧 (2)
- 最大尿流量 (Maximum flow) : 排出路の伸展が最大となる時 (3)
  - FCZに制限される
- 力の均衡がとれ、安定した状態が続き、
- 排出路が閉鎖する (管がつぶれる)
- 閉鎖時圧 (Closing pressure) (尿流の最後) (4)

排尿相

排尿開始 = 排尿筋圧上昇 (グラフ参照): 1 ⇒
⇒ 排出路の伸展 = 開口時圧⇒尿流の開始: 2 ⇒
⇒ 最大尿流量 = 排出路の安定状態の開始*: 3 ⇒
⇒ 尿流の終了 = 排出路の閉鎖 : 閉鎖時圧: 4

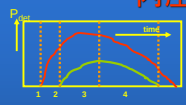


* 正常な排尿では、3から4の間は排出路(尿道)の内外の圧力は平衡状態にある

ICSの用語

- 排尿前圧 (Pre -micturition pressure) (1)
- 開口時排尿筋圧 (Opening detrusor pressure) (2)
- 開口時間 (Opening time)
- 最大排尿筋圧 (Maximum detrusor pressure)
- 最大尿流時排尿筋圧 (Detrusor pressure at maximum flow) (3)
- 閉鎖時排尿筋圧 (Closing detrusor pressure) (4)
- 最小排尿圧 (Minimum voiding detrusor pressure)
- 尿流遅延時間 (Flow delay time)

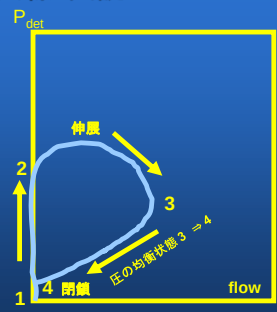
内圧尿流曲線: 図説



• **膀胱内圧** と **尿流** (上図) を 内圧尿流曲線 として同時に図示 (右図参照)

時系列:

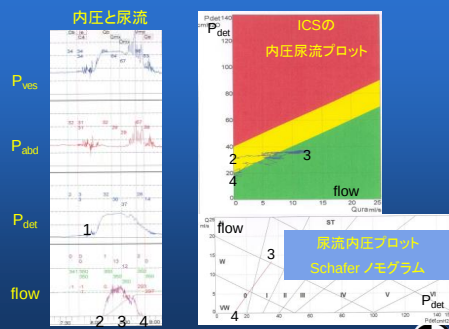
• 排尿の開始	1
• 尿流の開始	2
• 安定状態	3
• 尿流の終了	4



内圧尿流曲線

- 排尿筋圧に対する尿流の評価
- 下部尿路閉塞と排尿筋収縮力を解析可能
  - ICS 内圧尿流曲線:
    - ICS 閉塞指数
      - (Abrams/Griffiths 値)
  - Schafer ノモグラム (線形化動的尿道抵抗 (PURR))
  - 尿道抵抗係数 (URA)
- 全ての排尿に適用可能

内圧尿流解析

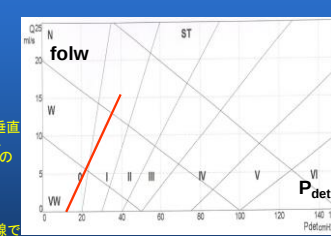


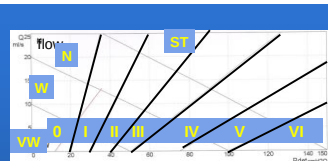
Schafer(シェファー) ノモグラム

(線形化動的尿道抵抗 PURR)

前立腺腫大を有する男性に特異的

- P_{det} at Q_{max} と $P_{det.min.void}$ を **直線** で結ぶ
- **直線** の大部分が、(おおよそ)垂直方向の線で区分にされたクラス (0 – VI)のどこにあるかでBOOのグレードを判定
  右図では grade I
- **直線** の先端が、右下がりの斜線で区切られた区域のどこにあるかで排尿筋収縮力を判定
  右図ではN (ormal)





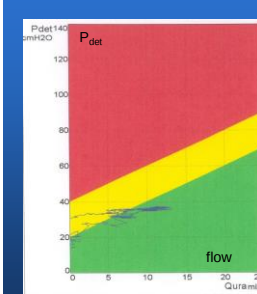
直線 の大部分が、(おおよそ)垂直方向の区分のどこにあるか:
閉塞グレードは:

0-I	閉塞なし
II	中間
➢III	閉塞あり

直線 の先端が(おおよそ)水平方向の区分のどこにあるか:
排尿筋収縮力グレードは:

VW	Very weak 非常に弱い
W	Weak 弱い
N	Normal 正常
St	Strong 強い

ICSの内圧尿流曲線



- 内圧と尿流を同時に曲線で図示:
- **3 つの領域:**
- 赤: 閉塞あり
- 黄: 境界域
  (または: '中間')
- 緑: 閉塞なし

ICS 閉塞指数 (A/G* 値)

- 内圧尿流検査結果の簡便な評価:
- 計算式： $P_{det}Q_{max} - 2 \times Q_{max}$ (*)
  - 最大尿流時圧から最大尿流量の2倍を引く
  - 内圧の単位はcmH_2O, 尿流量の単位はml/s

*** Abrams –Griffiths 値 = ICS-閉塞指数**

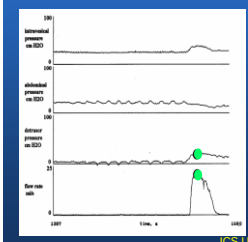
ICS 閉塞指数

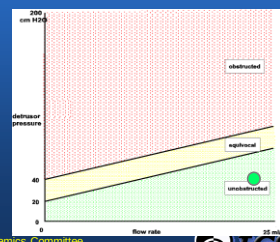
- ICS-閉塞指数 は前立腺腫大を伴う高齢男性患者に対して「臨床的に算出された」指数である
  - ICS-閉塞指数 < 20: 閉塞なし
  - ICS-閉塞指数 >40: 閉塞あり
  - ICS-閉塞指数 20～ 40 境界域 / 中間
  - 前立腺腫大を伴う男性患者に対して*:
    - 閉塞なし: 閉塞解除は排尿をあまり変えない
    - 閉塞あり: 閉塞解除は排尿の改善が期待できる
    - 境界域I: 閉塞解除の結果は予測が困難 (症状改善の見込みは50%)

** ただし、蓄尿相の異常所見の有無を考慮していない*

膀胱出口部閉塞なし

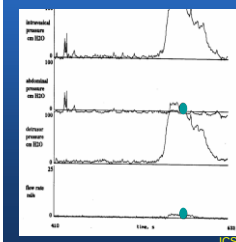
- ICS ノモグラム 例1
  - 高尿流
  - 低排尿筋圧
    - 閉塞なし

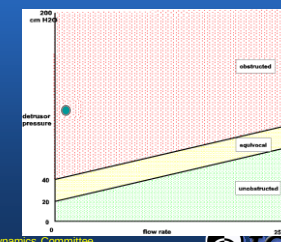




膀胱出口部閉塞あり

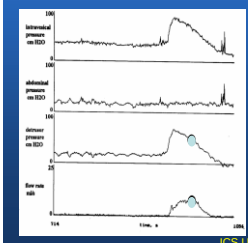
- ICS ノモグラム 例2
  - 低尿流
  - 高排尿筋圧
    - 閉塞あり

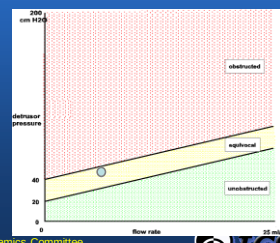




境界域 (2直線の中間)

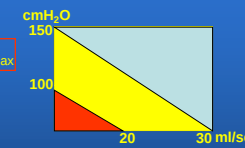
- ICS ノモグラム 例3
  - 中尿流
  - 中排尿筋圧
    - 境界域



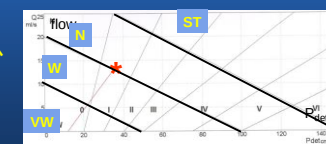


内圧尿流解析: 排尿筋収縮力

- ICS-収縮指数:
  - 計算式: $P_{det}Q_{max} + 5 \times Q_{max}$
    - Normal: 100-150
    - Weak: <100
    - Strong: >150



- Schafer ノモグラム
  - STrong
  - Normal
  - Weak
  - Very Weak



内圧尿流解析

- 前立腺腫大を伴う高齢男性では比較的明快で‘型通り’:
  - 排出路の特性が前立腺に依存して比較的安定 (筒状)
- 尿流調整帯(FCZ)が安定
  - ‘単純に’伸展し
  - そして、閉鎖する
- 評価やグレード分類が標準化され臨床的にも検証済み

ICS Urodynamics Committee

質の管理

- 検査の開始前に:
- 患者は十分な説明と指導を受けたか?
- 尿流動態検査の予定後から何か変化がないか?
- 不必要な人は検査の場から離れたか?
- 患者は可能な限り見られない状態にあるか?
- 患者は快適な姿勢がとれているか?
  - (特に男性では) 排尿時の好みの姿勢か?
- 滅菌したカテーテルと注入液が使われているか?
- 感染対策が行われているか?
- 患者に検査終了後すぐに0.5～1L程度の飲水を指示したか?

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質の管理 (内圧尿流解析)

- 患者に質問せよ:
  - 今回の排尿は、普段の/自宅での排尿と大体同じでしたか?
    - もし違うとしたら、臨床的な尿流動態診断は不適切な可能性がある
      - 例: 排尿不能は腎機能のためのことは少なく(常にではないが)、尿流動態検査中の環境的な原因である
- 波形を観察せよ(膀胱内圧測定全体の波形を)
  - 内圧は生理的な範囲内か
  - 膀胱内圧と腹圧が患者の動作や咳と同期して反応しているか(内圧がつりあっているか)?排尿終了後もそうか?
  - 排尿命令が的確に記録されているか?

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質の管理(つづき)

- 内圧と尿流を観察せよ:
  - 時間差が適切に補正されているか?
    - 施設毎に標準的な時間補正があるだろう
  - 尿流にアーチファクトがみられないか?
  - 内圧にアーチファクトがみられないか?
    - (排尿前後の咳による圧テストを比較する)
  - 内圧尿流曲線が作成されているか?
    - 生理的に妥当な内圧尿流曲線が認識できるか?
    - 内圧の下限値が認識されるか?
    - 自動解析の結果は妥当で正当か?
  - 残尿量は測定されているか?
  - 下部尿路排尿機能に対する適切で完全な診断が可能か?
    - もしできないならば、検査のやり直しを

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臨床評価の質

- *検査環境のせいで*排尿できない患者
  - 「恥ずかしがり屋」なのかもしれない
    - 時間をかける、プライバシーを確実にする、部屋を暗くする
    - (冷たい) 飲み物を飲んでもらう
    - 蛇口から水を流す (音を聞かせる)
  - 膀胱収縮はみられるが、排尿がないまたは少量しか排尿しない:
    - 無収縮ではない、普段の排尿を反映していない、計算不可能な膀胱出口部閉塞*
  - 膀胱収縮がみられず、排尿もない:
    - 普段は排尿できるのであれば
    - 無収縮膀胱とは断定できない、普段の排尿を反映していない*
- *患者はいきみ排尿になりがちで、その場合は意味がなく普段の排尿も反映しない
- *Schafer ノモグラムのVW 領域では、内圧尿流解析での膀胱出口部閉塞Oの評価の信頼性は低い
- 「恥ずかしがり屋」という以外には、正式な内圧尿流解析と(膀胱出口部閉塞や排尿筋収縮力の)診断はできない。

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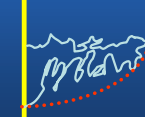
若年男性における内圧尿流解析

- 排出路の特性が不安定 (の可能性がある)
- 尿流調整帯(FCZ)が (より)動的である
  - 骨盤底の活動
    - 痛み
    - 不安
  - 膀胱頸部の動態
- 排尿筋収縮が変動しやすい (可能性がある)
  - 排尿反射のon/off
- 妥当性の確認された基準がない

‘動的’故に、内圧尿流曲線は乱雑に見える。しかし、内圧尿流曲線の推定下縁から出口部閉塞は評価できる。

推定下縁



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女性の内圧尿流解析

- 基本的に、内圧尿流解析は同じである
  - 排尿解析の際の留意点:
    - 尿流調整帯(FCZ)は「仮想的な」ものである
- 女性の排尿では:
  - 高排尿筋圧 は膀胱出口部閉塞を意味する

そして(排尿が普段通りである限り！):
- 低排尿筋圧かつ高尿流量かつ
  - 効率的な(完全な)排尿: 良い
  - 効率的でない (不完全な、残尿がある) 排尿: 悪いかもしれない
- 低排尿筋圧かつ低尿流量かつ
  - 効率的な排尿: 悪くない
  - 効率的でない (不完全な、残尿がある) 排尿: 悪い

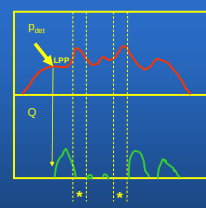
- しかし、確立された明確な女性用の内圧尿流解析の分類法はない!

小児の内圧尿流解析

- おそらくここで紹介した一般原則に準ずる、しかし:
  - 解剖学的な多様性が関与する
  - 典型的で普段通りの排尿を再現することが難しい
  - 慣習的にまたはしばしば、小児の排尿時の排出路特性の診断は（ビデオ）画像をもとに行われる!
- 小児を対象にした妥当性の確認された評価基準はない
  - 小児の内圧尿流グラフや内圧尿流指数がない
  - (恥骨上カテーテルを用いた膀胱内圧の標準化された補正方法がない)

神経学的異常を有する患者の内圧尿流解析

神経因性尿失禁
- 意図しない排尿
- 非協調的な排尿
- 意識されない排尿
- 随意的に排尿開始ができない



- 排尿筋漏出時圧 (DLPP) = 尿が漏れ始める排尿筋圧 (右図矢印)
- 非協調的排尿
  - 排尿筋と排出路の協調性の欠如
  - 排出路の弛緩が持続しない
  - 尿流が止まり同時に内圧が上昇する
    - (図参照: * 点線の間で、排出路が収縮) (排出路の抵抗が上昇)
- 変動する膀胱出口部閉塞や非協調的排尿の妥当性の確認されたグレード分類はない

神経学的異常を有する患者の内圧尿流解析

一般原則 (ただし例外は多数！)

- 上部運動ニューロン疾患：脊髄排尿中枢より上部:
  - 下部尿路知覚の変化 (または消失)
  - 排尿筋過活動 かつ/または
  - 排尿筋底部（括約筋）過活動 かつ/または
  - 骨盤底過活動
- 結果的に:
  - 非協調的排尿または尿失禁 (慢性的な残尿)
  - 高漏出時圧
  - 高膀胱内圧
  - 上部尿路障害の危険性
- 下部運動ニューロン疾患：脊髄排尿中枢～末梢神経:
  - 下部尿路知覚の変化 (または消失)
  - 排尿筋低活動 かつ/または
  - 排尿筋底部（括約筋）低活動 かつ/または
  - 骨盤底低活動
- 結果的に:
  - 持続的または間歇的な腹圧性尿 (便) 失禁
  - 慢性的な残尿
  - 上部尿路障害の危険性は低い

内圧尿流解析: 結語

- 尿流は内圧と関係し、排出路の特性で定まる(制限される)
  - 普段通りの排尿と臨床的に有意義な内圧尿流解析は、良好な尿流動態検査の実施と適切に確認された患者協力による
- 排出路閉塞はグレード分類できる

ICS-閉塞指数 と内圧尿流曲線

- 排尿筋収縮力はグレード分類できる
- *ICS-収縮指数 と 内圧尿流曲線*

内圧尿流解析: 結語

- (前立腺腫大を伴う) (高齢) 男性:
  - 内圧尿流（関係と）解析は分かりやすい
  - （排出路特性のグレード評価方法）の臨床的適応性には限界がある
- 若年男性、女性、小児: (*EO*)
  - 排尿と内圧尿流解析の基本原則は既知で適応可能である
  - 広く合意された排出路特性の臨床的グレード評価方法はない
- 動的な排出路閉塞 / 機能障害的排尿: (*EO*)
  - 標準化されたグレード評価方法はない
  - 尿流動態(内圧と尿流の関係) の評価基準がない
- 神経因性協調不全、神経因性動的排出路閉塞: (*EO*)
  - 標準化されたグレード評価方法がない
  - 尿流動態(内圧と尿流の関係) の評価基準がない
  - *しかし、排尿筋漏出時圧は関連がある*


ICS
Continence Society
International
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ICS Urodynamics Committee
ICS

ICS teaching Module: Electromyography in the assessment and therapy of lower urinary tract dysfunction in adults

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ICS International Continence Society
Teaching Module

Principle of EMG

- Recording of the electrical activity from (striated) muscle with electrodes, to unveil function and innervation.

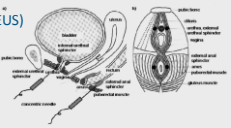
2 methods:

Needle EMG > Needle electrode(s): Inside muscle – motor unit.
- Positive: - allows assessment of single action potentials
- Negative: - invasive
  - complex expertise in EMG required

Surface EMG > Surface (patch) electrode(s): On muscle – 'whole' muscle.
- Positive: - non-invasive, less time- and money-consuming
- Negative: - less specific, less 'detail'
  - does not allow assessment of single action potentials

EMG tests in adult urology

- Needle EMG of external anal sphincter (EAS)
- Needle EMG of external urethral sphincter (EUS)
  - Monopolar
  - Bipolar (concentric)
  - Wire(s)



- Surface EMG of external anal sphincter (EAS)
- Surface EMG and sacral reflexes conductivity testing
- Surface EMG and biofeedback
- Surface EMG with cystometry and pressure/flow

- *Surface EMG = 'kinesiological EMG': with pair (or array) of electrodes over muscle*

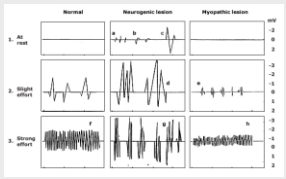
Needle EMG of external anal sphincter (EAS)

Principle:
- Recording of electrical activity of EAS
- Elements of muscle activity of the pelvic floor

Technique:
- Patient in lateral decubitus or lithotomy position
- EAS: Needle electrodes inserted bilaterally, approximately 0.5 cm lateral to the anus
- Assessment during maximal relaxation, during slight pelvic floor contraction, during maximal voluntary contraction and or during artificial bladder filling

Needle EMG of external anal sphincter (EAS)

Evidence:
- Potentially useful to detect disturbances in neuroregulation of the pelvic floor muscles in patients with
  - lower motor neuron lesion
  - demyelinating diseases
  - with Parkinson disease
  - Multiple System Atrophy



Sakakibara R, et al.: J Neurol Neurosurg Psychiatry 2000; 68:25

Needle EMG of external urethral sphincter (EUS)

Principle:
- Direct recording of electrical activity of EUS

Technique:
- Patient in lateral decubitus or lithotomy position
- Needle electrodes inserted transperineally (♂) or transvaginally (♀) or transurethrally – via catheter
- Assessment during maximal relaxation, during slight pelvic floor contraction, during maximal voluntary contraction and or during artificial bladder filling

Needle EMG of external urethral sphincter (EUS)

Evidence:

- Limited evidence for role in clinical setting for EUS –EMG
- Some role in Fowler's (♀ retention) syndrome
- Potentially useful in direct detection of electrical activity while bladder filling

Surface EMG of external anal sphincter (EAS)

Principle:

- Recording of muscle activity using surface (patch) electrodes or electrodes on cone or plug

Technique:

- Degreasing of the perianal skin
- 2 'active' electrodes adjusted bilaterally to the muco -cutaneus line + ground electrode
- Assessment of activity rest vs. contraction

Evidence:

- Tool to detect pelvic floor muscle activity or relaxation

Surface EMG and Sacral reflexes conductivity testing

Principle:

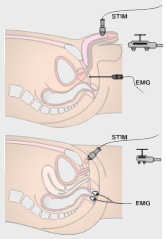
- Stimulation of the pudendal nerve to induce pelvic floor contraction to evaluate of bulbocavernosus (clitero-anal) reflex

Technique:

- Stimulation using electrode dorsal at the base on the penis (♂) or on clitoris (♀)
- The response recorded with surface or needle electrodes from the region of anal sphincter or bulbocavernous muscle

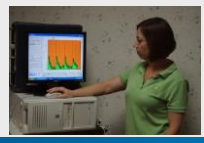
Evidence:

- Absence or delay in response, suggest lower motor neuron impairment
- No relevant recent study which could support the role of this examination in the daily clinical work-up was found



Surface EMG and biofeedback

- **Principle:**
  - Detect the pelvic floor muscle activity and transform it into a visual and/or acoustic display in order convey the information to the patient
- **Technique:**
  - Surface electrodes are placed close to the anal sphincter or on an anal or intravaginal plug
  - Recorded signal transformed into apparent sound or visual clue
  - Allows the patient to better understand the functional status of the pelvic floor



Surface EMG and biofeedback

Clinical observations:

- Baseline between contractions – inconsistent and elevating
- Resting baseline – varies widely from session to session, especially when pain exists
- Erratic tracing without artifact or noise
- Patient has symptoms of overactive PFM – obstructed urination, defecation, pain
- Return to baseline after startle or frightening – overactive PFM is slow
- 2/3 of dysfunctional muscles will have normal resting baseline

Surface EMG and biofeedback

- **Evidence:**
  - Potentially useful for conservative treatment (PFM training) of stress urinary incontinence and OAB
  - Little evidence regarding the use of EMG biofeedback as tool to help relax the pelvic floor muscles during micturition in adults

Dannecker C, et al: Arch Gynecol Obstet. 2005;273(2):93-7; Wang AC, et al: Urology. 2004 Jan;63(1):61-6

Surface EMG with cystometry

Principle:
- Recording of pelvic floor muscle activity during filling of the bladder.

Technique:
- Surface EMG (as on earlier slides)

Evidence:
- Introduced on the basis of expert opinion/ plausibility
- No (comparative) evidence
- Surface EMG may fail to reflect urethral (continence) function

Surface EMG with pressure flow studies

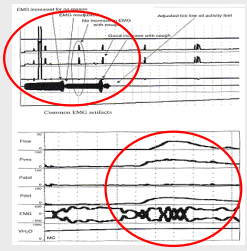
Principle and technique:
- Identical to surface EMG

Evidence:
- Introduced on the basis of expert opinion/ plausibility
- No (comparative) evidence
- Expert series demonstrating plausible results
- However: Large (n= 655) prospective cohort ♀ with EMG revised:
  - Many (51%) were not interpretable (but also)…
  - …surface EMG failed to reflect EUS relaxation.

Kirby AC et al. Neurol Urodyn 2011; 30: 1591-1596

Surface EMG (adult)

- May be not interpretable
  - (technical) artefacts
- May give not plausible results
  - Not reflect relevant (EUS) activity
  - Smooth flow-rate and bizarre EMG



sEMG with urodynamic tests (adult)

Lacking practice standards for:
- Display: envelope; linear envelope; full wave; half wave
- Time scale
- Sampling: … Hz; Filtering: moving average; root mean square
- Placing of active electrodes (♀ ; ♂)
- Impedance check(s) (cleaning of skin): <5 (or <10) kΩ
- Reference electrode - neutral! (Not on another muscle); trochanter; pelvic rim; sacrum
- Technical and clinical quality checks
- Analysis, interpretation and reporting

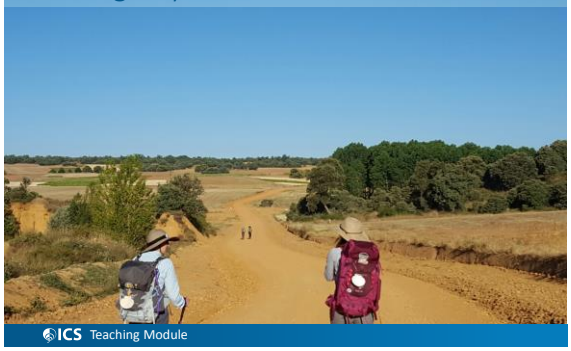
sEMG with urodynamic tests (adult)

- Not very invasive
- Not very time and cost consuming
- Without standard
- Without certainty of relevance
- May add confusion if artefacts are not acknowledged
- May be of help in (pelvic) muscle strength and control training and learning to relax

EMG tests in adult urology

- The concept of use of EMG methods in functional urology/urogynaecology and physiotherapy is supported by good theoretical basis
- Current value of EMG in diagnosis is however limited
- Currently EMG practice can only rarely play a decision making role in diagnostics of LUT partially due to lack of standards

A long way ahead…….



ICS Teaching Module

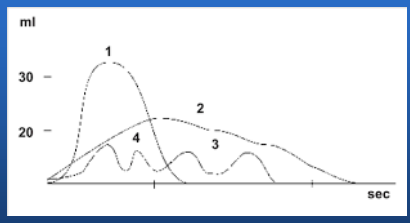
Uroflowmetry

International Continence Society
School of Urodynamics

Uroflowmetry

- Measures flowrate in mL/s..
- ….and volume.
- (should be done in combination with PVR)

Flowmetry



Normal lower urinary tract function

- Bladder filling begins
- Nervous system maintains low pressure
- Distension activates stretch receptors
- Perception of fullness develops
- Cortical determination of desire to void
- Voiding
- Bladder filling, again
- Controlled autonomic reflex

Normal voiding

  - Voiding is desired
- Pelvic floor relaxes and urethral sphincter relax and (antagonistic) detrusor contracts
- Detrusor pressure forces the opening of the (relaxed) bladder neck and the urethra
- Urine flow begins
- Detrusor contraction ends
- Urethral sphincter and pelvic floor contraction resumes

Mechanics of voiding

- Detrusor pressure generates flow
  - Flow is limited by the 'flow controlling zone (FCZ)'
- 'Bladder outlet' ≈
  - Urethra and surroundings
    - distend and collapse again
- No detrusor contraction, no voiding

Practice of flowmetry

- Private
- Position

- 'Full bladder'
- Patient decides….
  - (or not?)
  - Influenced by the situation (hurrying)
  - Following on to cystoscopy?

Practice of flowmetry

- Awareness of usual voided volume helps
  - Bladder voiding diary
  - Voiding frequency

- 'Shy voiders'
  - 'parauresis'

Flowmetry practice

- (ICS-) Good urodynamic practice

- Best possible (comfortable for patient) position
- Flowmeter as close as possible to the meatus
- No hindering of stream
  - e.g. voiding through tube
- Minimize time delay between flow at meatus and entering flowmeter

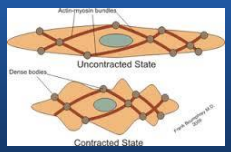
Flowmetry mL/s

- Maximum flow

Volume

- Bladder volume zero: can not contract
- Bladder volume low: can not contract very well

- Bladder volume too high: can not contract, or not very well



Test retest

- At best 2mL/s when adequate volume and good circumstances
- Usually larger in women

- Probably better (smaller) when the prostate is controlling the flowrate

- Larger differences in larger flowrates (>16mL/s) are clinically not very meaningful

- High chance of pathology when <12mL/s

Patients decide

- On the basis of your instructions!
- Comfortably full bladder
- But you should measure and ask and compare afterwards

Flowmetry practice

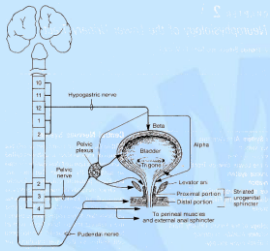
- (ICS-) Good urodynamic practice
- Comfortably full bladder
- Best possible (comfortable for patient) position
- Flowmeter as close as possible to the meatus
- No hindering of stream
  - e.g. voiding through tube
- Minimize time delay between flow at meatus and entering flowmeter

UMC Utrecht

Lower Urinary Tract Function and physiology (& urodynamics)

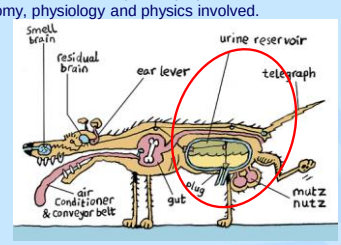
LUT Function

- Storage and voiding
- Muscles
- Sensorimotor (voluntary) system
- Autonomic system
  - Reflexes
    - Storage
    - Voiding

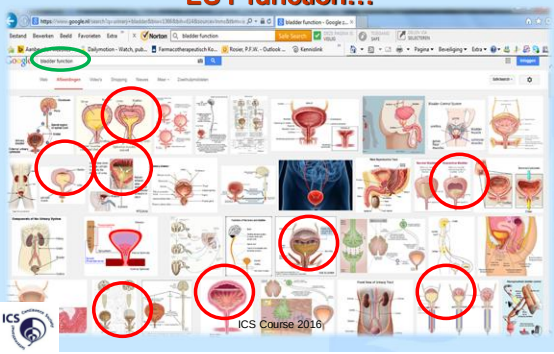


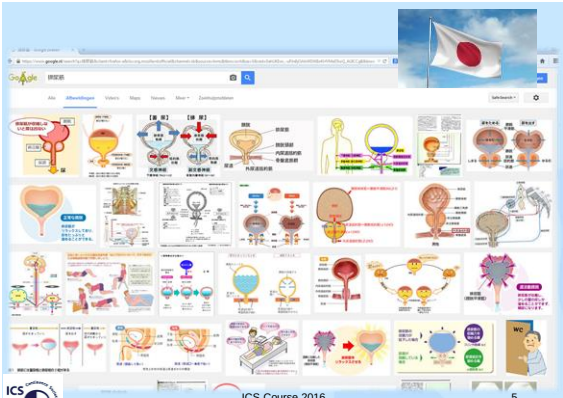
Anatomy & Physiology

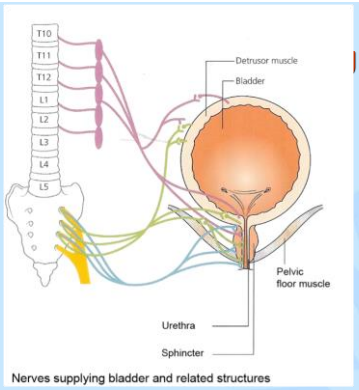
- Who treats lower urinary tract (dis)function should understand anatomy, physiology and physics involved.



What your patients Google about LUT function…







Nerves supplying bladder and related structures

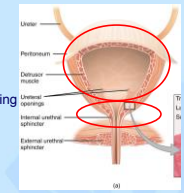
Normal lower urinary tract function

- Kidneys produce urine
  - 1,5-2L per day > 1-2 mL /minute
- Urine fills the bladder
  - Bladder is emptied ±4-6 times per day
  - ± 3-400mL per voiding

Normal lower urinary tract function

- Storage function
  - (detrusor muscle)
    - Adapts to volume increment
    - Low pressure
    - Signals stretch
      - = 'sensation of filling'
    - Contraction is suppressed
  - *Outlet closed (continent)*
- Voiding function
  - At a convenient moment
    - Controllable
      - Pelvic muscle relaxation
    - Detrusor contraction is activated
  - Outlet relaxes
    - Pelvic muscle > Internal sphincter
  - *Efficient and effective voiding*

Normal storage



- Bladder fills and voiding is inhibited
- Pelvic floor is in 'normal activity' state
  - pelvic floor is *set of muscles*
  - 'reactive' to physical activity, movements, coughing
  - sub (-sub) maximal contracted
- Detrusor dome contraction is inhibited
- Detrusor base (bladderneck) is contracted
- Volume increment distends the bladder (dome)
  - (muscle) -stretch is perceived (sensation of filling)
    - Starting from a certain volume (±30% of usual capacity)
    - Propriocepsis

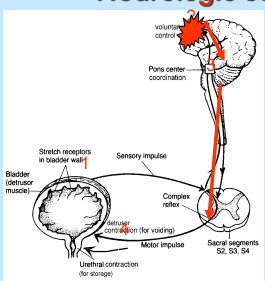
Normal act of voiding (neurologic)

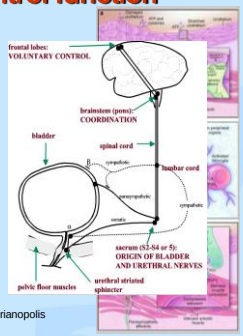
- Pelvic floor initiates voiding
  - (after permission by frontal brain lobe)
- Detrusor and bladderneck act coordinated
- Detrusor and bladderneck are antagonists
  - Alternate *synergic* contraction-relaxation of detrusor and bladderneck.
    - Holding (storage)
      - » pelvic floor is active
      - » bladderneck is contracted and detrusor remains relaxed
    - Voiding (emptying)
      - » pelvic floor relaxes
      - » **'Causing':**
      - » bladderneck to relax and detrusor to contract

LUT function = controlled autonomic reflex

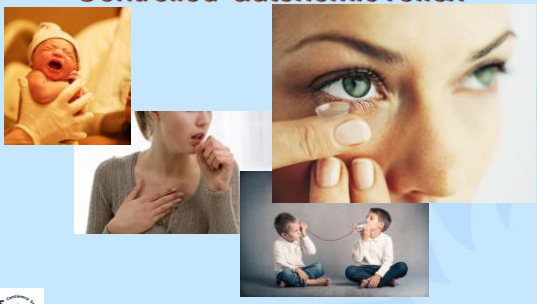
- Detrusor <> Internal sphincter
  - Antagonists
    - Autonomic (automated) at birth
      - Even before birth
- Potty training:
  - Autonomic reflex becomes…
  - …guided by will through pelvic floor muscle signal
    - (sensorimotor)

Neurologic control function





'Controlled' autonomic reflex

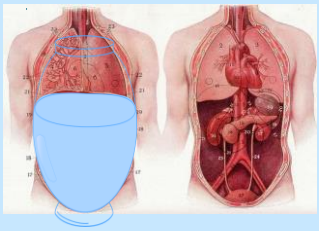


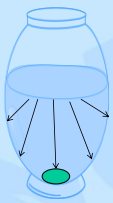
'Controlled' autonomic reflex

- Somatomotoric (pelvic) control of autonomic reflex
- To void:
  - Shift from 'sympathetic dominance' (storage) to
- >> Parasympathetic activity
- Requires 'mental relaxation':

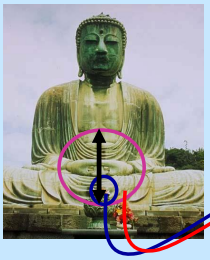
Urodynamics (physiology/physics)

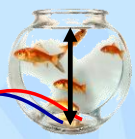
Urodynamics (physics)





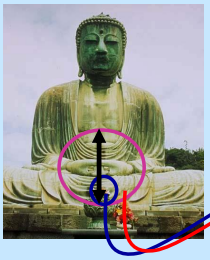
Urodynamics (physics)

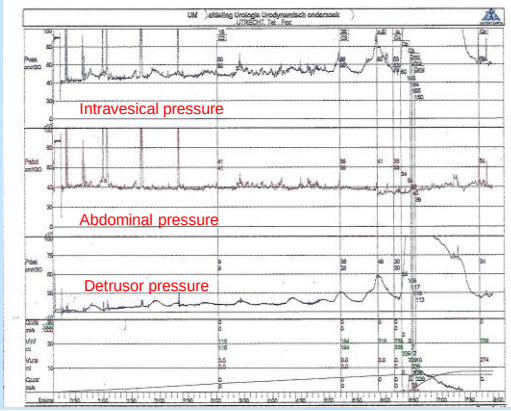


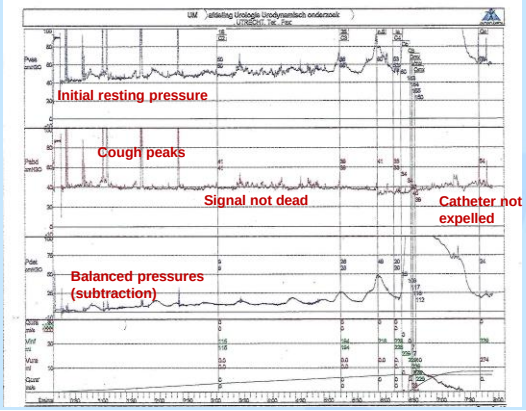


Watercollumn
(30-40) cm H_2O

Urodynamics (physics)





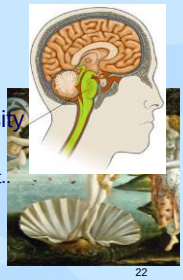


Initial resting pressure (urodynam)

- Depends on position
  - Lower in supine position
- Everything inside the abdomen has an average weight equal to water
  - High BMI (overweight persons):
  - predominance of the extra mass is outside the abdominal cavity
  - (not resting on the pelvic floor)
- Abdominal muscle contraction and diaphragm contraction elevate the pressure inside and outside the bladder

Psychology Urodynamics

- Fear, as for every test
- Shame, as for every test
- Fear; as evolutionary necessity
  - 'Built in', in brainstem
    - LUT function + e.g. Fight or flight..
- Shame; genital area



Emotions

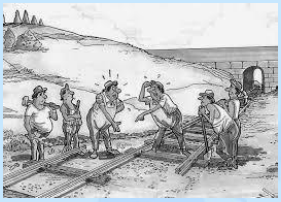
- Diagnosing functions in a physical area that is full of emotions is a challenge for every caregiver.
  - Recognize emotion
  - Acknowledge emotion
  - Be aware of own emotion
- Ensure dignity

(Especially for voiding) you need the patient to be at ease and to cooperate with you for a good urodynamic test.

Concluding

Understand:

- Anatomy
- Physiology
- Technology
- Pschology



- Of urodynamics

ICS teaching module
Tokyo, Japan

assessment of the pelvic floor for urinary incontinence

16 September 2016

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Maastricht University Medical Centre, the Netherlands
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pelvic physiotherapist
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Physiotherapeutic Diagnostic Process

acknowledgment:

Maura Seleme, Marijke Slieker,
Fetske Hogen Esch, Nol Bernards

objective

using MEDICAL DIAGNOSIS to be able to make an inventarisation of the nature and severity of the healthproblem UI, and to investigate, using the medical data, the extent of influence of a specific therapy on this health problem

i.e., if and to what extent is an intervention adequate and significant

also, to rule out other pathology and contra-indications!!
medical diagnosis based on ICD and ICPC

PDP

history-taking
tests
physical examination:
observation
digital palpation
evaluation
analysis
statement of targets intervention

information & explanation

before starting the clinical exam, explain the patient where to find the pelvic floor muscles and inform about execution of a full physical exam of the pelvic floor

at every stage of the exam, explain what you are doing, and show where the pelvic floor muscles are, also the pelvic organs, the bladder, uterus, vagina and intestines.

explanation

abdominal evaluation

Seleme,Berghmans,2016

how to …abdominal evaluation

- observe whether the respiration is apical, diaphragmatic or abdominal, simply observing not (yet) touching.
- after this, place a hand on the apical, diaphragmatic and abdominal region for better feeling of the movements.
- observe the abdomen. scars, any irregularities, and the quality of the skin.
- palpation of the scars to find any fibrosis.
- palpate also clockwise the abdomen in order to investigate pain and signs of fecal impaction.

anteversion - retroversion

Seleme,Berghmans, 2016

how to ....

- in order to evaluate the lumbar spine to observe the mobility in anteversion and retroversion ask the patient to bend both knees.
- the physiotherapist (PT) puts one hand at the lumbar spine and another on the abdomen and explains the patient to move the PT's hand upwards as if putting the umbilicus to the ceiling, then pushing the lumbar spine into the PT's hand.
- the PT observes the ease of mobility, the flexibility, the presence or absence of pain while executing these movements in anteversion and retroversion..

investigation sacro-iliacal joint, hips provocation tests

investigate the sacro-iliacal joint.

execute a pressure downwards.

rotate inside, outside, adduction, abduction, find any pain and limitations that could interfere with the gynecological exam.

SI: provocation tests

Tests	Description (Positive Findings)
Distraction	Pt supine. Examiner applies posterolateral directed pressure to bilateral ASIS. (Reproduction of pain)
Compression	Pt sidelying. Examiner compresses pelvis with pressure applied over the iliac crest directed at the opposite iliac crest. (Reproduction of symptoms)
Thigh Thrust	Pt supine. Examiner place hip in 90 deg flexion and adduction. Examiner then applies posteriorly directed force through the femur at varying angles of abduction/adduction. (Reproduction of buttock pain)
Sacral Thrust	Pt prone. Examiner delivers an anteriorly directed thrust over the sacrum. (Reproduction of pain)
Gaenslen's	Pt supine with both legs extended. The test leg is passively brought into full knee flexion, while the opposite hip remains in extension. Overpressure is then applied to the flexed extremity. (Reproduction of pain)

hips movement

sensibility

position observation

how to ....

optimal position to perform the physical exam is supine position, upper body 45 degrees, head supported, mirror at in front of table end, patient spreads the legs, one leg is supported between the body and elbow of the physiotherapist, the other leg by the PT's hand of the same arm.

in this way the PT can control whether there is any movement like more spreading or closing of the legs, any movement of the buttocks or the abdomen.

this position is also very suitable to observe the perineum.

observation external parts

how to ....

before starting the invasive exam, look for any external pain areas

open the cover of the clitoris, check for any pain in this region, whether the clitoris can leave its cover

then palpate the labia majora on both sides, labia minora

open the vaginal orifice investigating whether there is any pain at the entrance of the vaginal orifice, inspect the perineal body and at last around the anal region

clitoro-vaginal reflex

how to ....

the clitoris reflex shows integrity of the nervous system and is performed using a cotton swab stick.

move the cotton swab gently on the clitoris and observe if there is any reflex contraction.

repeat if necessary

anocutaneous reflex

how to ....

- the anal reflex shows integrity of the nerve supply.
- move the cotton swab gently on the anal sphincter and observe if there is any reflex contraction.
- repeat if necessary

Pelvic floor Muscle functional assessment
Patient(number) :
Researcher :
Date : Time:
Number of fingers r : 1 2 Position:

INSPECTION during moving

Inw.mov. visible	Yes			No	Desc.
Cocontraction	No			Yes	
	RA/TrA	Diaphragm	Adductors	Gluteal	
Relaxation visible	Good	Delayed	Incomplete	Absent	
Relaxation visible	Yes			No	

INSPECTION perineal movement during coughing and pushing

Coughing	Inw.	None	Desc.	
- in case inwards	before		during	after
Pushing	Desc		No	Inw.

PALPATION in rest

Pain	No	Yes	R	L	A	P
VAS	0-100					

PALPATION during moving

Conscious maximal contraction				
Urethral lift	Strong	Normal	Weak	Absent
Levators closing	Strong	Normal	Weak	Absent
Symmetric L/R	Yes	No	R > L	L > R
Level contraction	Strong	Normal	Weak	Absent

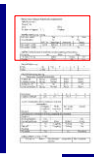
Endurance	≥10	9 - 7	6 - 4	3 - 1	0
Explosive strength	≥15	14 - 11	10 - 6	5 - 1	0

Level of relaxation after conscious maximal contraction				
	Complete <restlevel	Partly =restlevel	Incomplete >restlevel	Absent
Delayed	Yes	No		
Unconscious contraction during coughing and pushing				
Coughing				
Reflexcontraction	Yes			No
Descent perineum	Absent	Weak	Modest	Strong
Lift	No	Coughing	Pushing	Yes
Flatus/Fl	No	Coughing	Pushing	Yes
Pushing				
Relaxation	Yes		No	Paradoxal

CONCLUSION condition PFMF

Overactive	Normal	Coordination disorder	underactive	Non functional

Guidelines on Stress Urinary Incontinence - Royal Dutch Society for Physiotherapy (KNGF) – 2011



Pelvic floor Muscle functional assessment
Patient(number) :
Researcher :
Date : Time:
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Inw.mov. visible	Yes			No	Desc.
Cocontraction	No			Yes	
	RA/TrA	Diaphragm	Adductors	Gluteal	
Relaxation visible	Good	Delayed	Incomplete	Absent	
Relaxation visible	Yes			No	

INSPECTION perineal movement during coughing and pushing

Coughing	Inw.	None	Desc.	
- in case inwards	before		during	after
Pushing	Desc		No	Inw.

voluntary contraction

how to ....

ask the patient to maximally contract the pelvic floor without any co- contractions, such as adductors muscles, buttocks or abdominal muscles

ask for 3 repetitions

explain the patient how to contract the PFM maximally without co-contraction of other regions

during the 3 contractions make sure that there are no co-contractions

coughing

how to ....

during a cough, protect the perineal region with a paper, because in case the patient loses (too much) urine, we need to avoid the treatment table to become wet.

observe movements of the perineum and surrounding regions during the cough.

if not clear, open the labia majora and minora to see any opening of the vagina, and then ask to cough and check any urine loss, and whether there is a closing of the vagina or rather a downward movement of the perineum (repeat 3 times)

Valsalva

PALPATION in rest

Pain	No	Yes	R	L	A	P
VAS	0-100					

PALPATION during moving

Conscious maximal contraction				
Urethral lift	Strong	Normal	Weak	Absent
Levators closing	Strong	Normal	Weak	Absent
Symmetrc L/R	Yes	No	R > L	L > R
Level contraction	Strong	Normal	Weak	Absent

evaluation before invasive techniques-finding external pain

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finding internal pain

PALPATION in rest

Pain	No	Yes	R	L	A	P
VAS	0-100					

watch out: be aware of body work in relation to patient's intimacy and reaction

PALPATION in rest

Pain	No	Yes	R	L	A	P
VAS	0-100					

Guidelines on Stress Urinary Incontinence - Royal Dutch Society for Physiotherapy (KNGF) – 2011

PALPATION during moving

Conscious maximal contraction				
Urethral lift	Strong	Normal	Weak	Absent
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Symmetrc L/R	Yes	No	R > L	L > R
Level contraction	Strong	Normal	Weak	Absent

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conscious maximal contraction

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Levators closing	Strong	Normal	Weak	Absent
Symmetrc L/R	Yes	No	R > L	L > R
Level contraction	Strong	Normal	Weak	Absent

how to ....

voluntary pelvic floor maximal contraction – first test with one finger, if possible put two fingers in the following way: first place the middle finger gently on the posterior part of the vaginal hymen executing a light pressure downwards

next put the index finger next to the middle finger, turn the fingers, go to the levator ani and ask to contract and relax this muscle maximally

repeat this procedure 3 times, check the direction of the contraction upward and inward

how to ....

observe again the direction of the contraction upward and inward

whether the patient can close the inserted fingers that are lightly spread, whether the contraction is strong, normal, weak or absent

observe if the contraction upward and inward, symmetric left and right

observe for any synergistic activity of the abdominals, adductors or buttocks

urethral lift

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how to ....

for better observation of elevation of the bladder neck during a cough or Valsalva, put the index and middle finger on the anterior vaginal wall, put the light spreaded finger lightly against the urethra, ask for a cough, observe whether there is urine loss, if so, lift the finger upwards against the urethra and repeat the cough, observe again whether in that condition there is urine loss, repeat with more pressure in case of positive test

repeat during Valsalva

Endurance	≥10	9 - 7	6 - 4	3 - 1	0
Explosive strength	≥15	14 - 11	10 - 6	5 -1	0
Level of relaxation after conscious maximal contraction					
	Complete <restlevel	Partly =restlevel	Incomplete >restlevel	Absent	
Delayed	Yes	No			

Guidelines on Stress Urinary Incontinence -Royal Dutch Society for Physical Therapy (KNGF) – 2011

endurance

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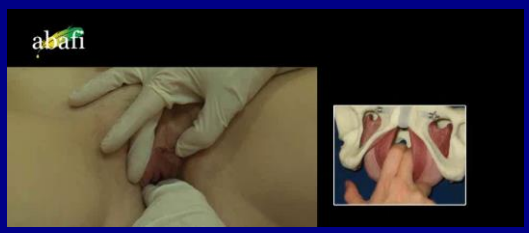
how to ....

to test endurance ask the patient to perform a maximal contraction without contracting the abdominals, buttocks or adductor muscles, count the seconds the patient can hold up to 10 second.

repeat 3 times

endurance



how to ....

explosive strength, how to ....

for quick PFM contractions (explosive strength) explain the patient to speedy contract with maximal strength and to relax as much as possible without using any other muscles

the PT should not instruct, only observe and should count the number of contractions the patient can realize in 15 seconds controlling the level of contraction and complet relaxation after each contraction

Endurance	≥10	9 - 7	6 - 4	3 - 1	0
Explosive strength	≥15	14 - 11	10 - 6	5 -1	0
Level of relaxation after conscious maximal contraction					
	Complete <restlevel	Partly =restlevel	Incomplete >restlevel	Absent	
Delayed	Yes	No			

Guidelines on Stress Urinary Incontinence -Royal Dutch Society for Physical Therapy (KNGF) – 2011

involuntary PFM contraction coughing

involuntary PFM contraction Valsalva

descent of the perineum

how to ....

for better observation of perineal descent, place you thumbs on each ischium and imagine a virtual line between both ischii. the perineum may not cross the virtual line during Valsalva.

to observe better a prolapse open the vaginal orifice and ask once again to perform a Valsalva and see whether the perineum does not cross the virtual line observing presence of prolapse

....bearing down, determine extent perineal descent....

- reduced descent may indicate inability to relax pelvic floor muscles
- excessive perineal descent (below plane ischial tuberosity's or exceeding 3.5 cm) may indicate laxity perineum (childbirth, excessive straining during defecation)
- eventually, stretching pelvic floor associated with excessive descent may injure sacral nerves
- .....and resulting in pain and incontinence

Harewood 1999

Level of relaxation after conscious maximal contraction				
	Complete <restlevel	Partly =restlevel	Incomplete >restlevel	Absent
Delayed	Yes	No		
Unconscious contraction during coughing and pushing				
Coughing				
Reflexcontraction	Yes			No
Descent perineum	Absent	Weak	Modest	Strong
UI	No	Coughing	Pushing	Yes
Flatus/FI	No	Coughing	Pushing	Yes
Pushing				
Relaxation	Yes		No	Paradoxal

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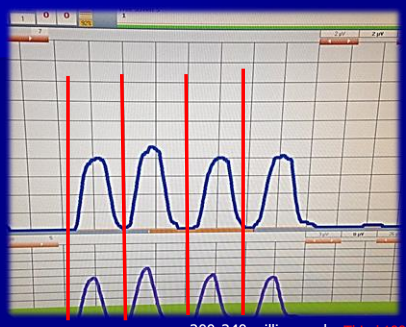
CONCLUSION condition PFMF				
Overactive	Normal	Coordination disorder	underactive	Non functional

Guidelines on Stress Urinary Incontinence -Royal Dutch Society for Physical Therapy (KNGF) – 2011

pre-contraction

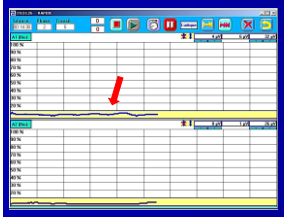
200-240 milliseconds
Thind 1990, Thompson 2003

pre-contraction

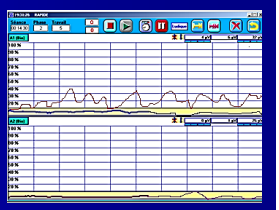


200-240 milliseconds Thind 1990, Thompson 2003

pelvic floor hyperactivity



normal activity



hyperactivity

Physical examination shown by movies produced by abafi-HOLLAND 2016