W2: Underactivity and obstruction in Women - A new syndrome? - How to be measured.

Workshop Chair: Luis Abranches-Monteiro, Portugal

20 October 2014 09:00 - 12:00

Start	End	Topic	Speakers
09:00	09:15	A new clinical problem	• Luis Abranches-Monteiro
09:15	09:30	clinical syndromes	• Miguel Silva-Ramos
09:30	09:50	Existing male and female nomograms	• Luis Abranches-Monteiro
09:50	10:05	Existing evidence - post operative obstruction	• Paulo Rodrigues
10:05	10:20	Data presentation	• Luis Abranches-Monteiro
10:20	10:30	Discussion	All
10:30	11:00	Break	None
11:00	11:20	Physics and mechanics	• Luis Abranches-Monteiro
11:20	11:40	Proposed adjustments for clinical practice	• Luis Abranches-Monteiro
11:40	11:50	Take home messages	• Luis Abranches-Monteiro • Miguel Silva-Ramos
11:50	12:00	Questions	All

Aims of course/workshop

Bladder outlet obstruction in women and abnormal detrusor function are a cause for LUTS and can result in voiding dysfunction. This is particularly true when facing surgical correction of urinary incontinence.

Yet, both are difficult to define and even more difficult to measure. No clinical syndromes are clearly related but the long term consequences may be important resulting in high residual volumes, infection and voiding difficulties.

It is urgent to have tools that can assess urethral resistance and detrusor function in women. The methodology used in males is not suitable to the female lower urinary tract. We depict the main urodynamic and clinical differences and propose adjustments to be used in clinical practice.

FEMALE BLADDER OUTLET OBSTRUCTION THE GROWING PROBLEM

LUIS ABRANCHES MONTEIRO

RIO 2014

PROBLEM

- MALE BLADDER OUTLET OBSTRUCTION (BOO) IS FAR BETTER DOCUMENTED AND STUDIED NOT ONLY BECAUSE OF ITS FREQUENCY BUT ALSO BECAUSE MORE OBVIOUS CLINICAL CORRELATIONS
- BECAUSE THEY LACK A PROSTATE, WOMEN (AND WOMEN DOCTORS) TEND TO FORGET THE VOIDING PHASE OF MICTURITION AND EXPLAIN SYMPTOMS BY STORAGE, INFLAMMATORY, INFECTIOUS OR PSYCHIC MECHANISMS

PROBLEM

- WOMEN FAIL TO DESCRIBE THEIR STREAM AND COMPARE IT WITH THE PAST.
- THEY ARE MOST CONCERNED WITH LEAKAGE THAN WITH RETENTION
- URINARY INFECTION IS TO BLAME FOR ALL SYMPTOMS (AND IT MAY BE ALSO PRESENT)

NEW FACTS

- INCONTINENCE HAS BEEN OBJECTIVELY STUDIED IN THESE LAST DECADES AND SOME MANOMETRIC PROBLEMS WERE IDENTIFIED
- THE OCCURRENCE OF IMPAIRED CONTRACTILITY ALONG WITH INCREASED RESISTANCE HAD BEEN RECOGNIZED – THE UNDERACTIVE BLADDER

NEW FACTS

- THE NEW ANTI-INCONTINENCE SURGERIES CAN BE OF MECHANICAL INFLUENCE TO THE OUTLET
- UNSUCCESSFUL SURGICAL OUTCOMES HAVE TO BE THOROUGHLY EXPLAINED (GIVEN THE OVERALL ACHIEVEMENT OF SURGERIES)
- DETRUSOR FUNCTION AND URETHRAL RESISTANCE **BECAME WORTH TO MEASURE OBJECTIVELY**

NEW FACTS

- PURE OBSTRUCTION IS RARE IN WOMEN
- THE FLUID DYNAMICS OF FEMALE VOIDING IS MORE DIVERSE AND WIDE-RANGING THAN IN MEN.
- THE BOUNDARIES OF "NORMALITY" LESS DEFINED
- THE NEED FOR A STANDARD OF MEASUREMENT IS URGENT

TOPICS

- WE WILL TRY TO:
  - DEPICT THE CAUSES
  - EXPLORE THE CLINICAL FEATURES
  - MAKE AN HISTORICAL SURVEY OF DIAGNOSTIC APPROACHES TO OBSTRUCTION
  - PRESENT SOME DATA AVAILABLE
  - WALK AROUND THE PHYSICS OF PHENOMENA IN ORDER TO
    - REALIZE THE DIFFICULTIES OF MEASUREMENTS IN WOMEN
    - UNDERSTAND ITS LIMITATIONS
    - PROPOSE SOLUTIONS
    - SUGGEST FURTHER DEVELOPMENTS

New and old causes

- ETIOLOGIC FACTORS:
  - ANATOMICAL
  - FUNCTIONAL
- ASSOCIATION TO HYPERACTIVE DETRUSOR
  - CAUSE?
  - EFFECT?

New and old causes

- ANATOMICAL
  - EXTRAURETHRAL
    - GYNECOLOGIC MASSES
    - INCONTINENCE SURGERIES
  - URETHRAL
    - STENOSIS
    - NEOPLASIA
    - INFECTION
      - GLANDULAR
      - DIVERTICULA
    - CERVICAL OBSTRUCTION

Carr e Webster, Urol Clin N Amer, 1996

New and old causes

- FUNCTIONAL
  - DISSYNERGIAS (NEUROGENIC)
    - ACTIVE CONTRACTION DURING VOIDING
    - INFRAPONTICAL, SUPRASACRAL LESIONS
  - DYSFUNCTIONAL VOIDING (NON NEUROGENIC)
    - SPHINCTERIC SPASMS [1,2,3]
    - CERVICAL OBSTRUCTION [4]
    - PSEUDODYSSINERGIA
    - NEUROGENIC/NON-NEUROGENIC
    - FOWLER'S SYNDROME
    - PELVIC SPASTICITY (VESICO-PELVIC DYSSINERGIA)
    - HINMAN SYNDROME[5]
    - IDIOPATIC DYSSINERGIA[6]
    - LEARNED VOIDING DYSFUNCTION[7]
    - ACQUIRED VOIDING DYSFUNCTION[8]

1-Raz e Smith J Urol, 1976
2-Kaplan et al. JUrol, 1980
3-Axelrod e Blatvas J Urol, 1987
4-Dokmo et al. J Urol, 1984
5 Hinman, J Urol, 1986
6 Jorgensen et al Eur Urol, 1982
7 Groutz et al Neurourol Urodyn, 2001
8 Groutz e Blaivas Curr Opin Urol, 2002

VOIDING DYSFUNCTION - CAUSES

- UNLIKE MEN IN WHOM OBSTRUCTION HAS A CERVICO-PROSTATIC OR URETHRAL ORIGIN, FEMALE DIAGNOSTIC ALGORITHMS ARE MORE COMPLEX:
  - THE LACK OF OBVIOUS ANATOMICAL CAUSE OF OBSTRUCTION LEAD SOME TO STUDY ITS PSYCHOGENIC GROUNDS (FEINSTER AND PATTERSON, 1995; SAKAKIBARA ET AL., 2007)
  - ITS RELATION TO VAGINAL PROLAPSES IS UNEQUIVOCAL (SALVATORE ET AL. 2010; BOER ET AL., 2011) BUT THEIR INTERFERENCE ON CONTRACTILITY AND POSTURAL VARIABILITY HAMPERS A CLEAR UNDERSTANDING OF ITS MICTURITION CONSEQUENCES

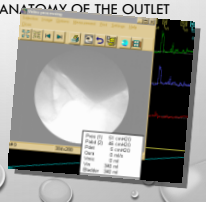
VOIDING DYSFUNCTION - CAUSES

- THE CASE OF YOUNG WOMEN UNABLE TO RELAX URETHRA DURING VOIDING ATTEMPTS – ASSOCIATION TO OVARIAN CYSTIC DISEASE – FOWLER'S SYNDROME (FOWLER ET AL, 1988)
- PSEUDO DYSSINERGIAS
- POST-ANAESTHETIC URINARY RETENTION (WOHLRAB ET AL., 2009)
  - UNCLEAR AND OF DETRUSOR OR URETHRAL ORIGIN
- SLING SURGERY RELATED – THE NEWEST CAUSE?
  - RARE ACUTE URINARY RETENTION

  BUT…
  - **FREQUENT CHRONIC VOIDING DYSFUNCTION**
- MULTIFACTORIAL BUT DIRECT OBSTRUCTIVE EFFECT OF TAPE LIKELY (DANESHGARI ET AL, 2008; ORDORICA ET AL., 2008; PASSOS ET AL,2010; TSE AND CHAN, 2011)

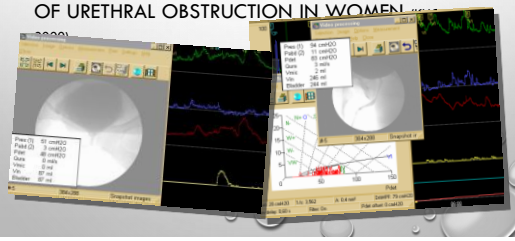
CONCEPTS

- MANOMETRIC CONCEPT OF A RESERVOIR: PRESSURE AND FLOW GENERATED THROUGH ITS OUTLET
- IMAGING CONCEPT OF FUNCTIONAL ANATOMY OF THE OUTLET
  - INTERPRETATION OF IMAGES REQUIRES THE PRESENCE OF A DOCUMENTED CONTRACTION



CONCEPTS

- USING VIDEO-URODYNAMICS, KUO FOUND 9,6% OF URETHRAL OBSTRUCTION IN WOMEN

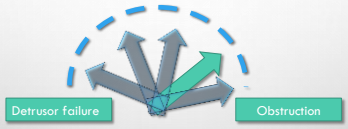


OBSTRUCTION AND UNDERACTIVITY

- BOTH COEXIST AS A BROADER CONCEPT OF VOIDING DYSFUNCTION.
- 2002 ICS DEFINITION : "*CONTRACTION OF REDUCED STRENGTH AND/OR DURATION, RESULTING IN PROLONGED BLADDER EMPTYING AND/OR FAILURE TO ACHIEVE COMPLETE BLADDER EMPTYING WITHIN A USUAL TIME SPAN*"
- TWO NOTIONS:
  - HIPOCONTRACTILITY
  - SHORTNESS OF CONTRACTION

VOIDING DYSFUNCTION

Obstruction and detrusor failure are often both involved in Voiding Dysfunction and their relative contribution must be assessed



- UNDERACTIVITY INTERACTS WITH OBSTRUCTION IN SUCH A WAY THAT THEY SHOULD NOT BE CONSIDERED INDEPENDENTLY

SUMMARY

- FEMALE CLINICAL AND DYNAMIC DIVERSITY
- GROWING IATROGENIC CAUSES
- BROAD CONCEPT OF VOIDING DYSFUNCTION
- LACK OF DIAGNOSTIC CONSENSUS

Female voiding dysfunction clinical presentation

Miguel Silva Ramos

Centro Hospitalar do Porto

Voiding dysfunction

- Definition:
  "abnormally slow and/or incomplete micturition based on symptoms and urodynamic investigations"

  Haylen BT et al, 2010 (ICS/IUGA joint report)

- Possible causes:
  - Detrusor underactivity or acontractility
  - Bladder outflow obstruction

Prevalence: 2,7 to 39% referred for evaluation

Rees et al, 1976
Nitti et al, 1999
Haylen et al, 2007

19,5% women have voiding symptoms

Irwin DE et al, 2006

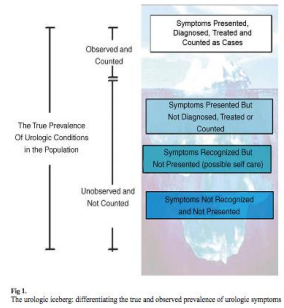
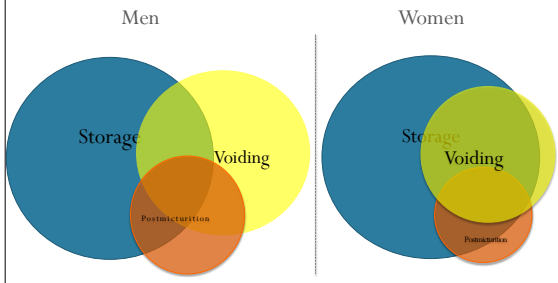


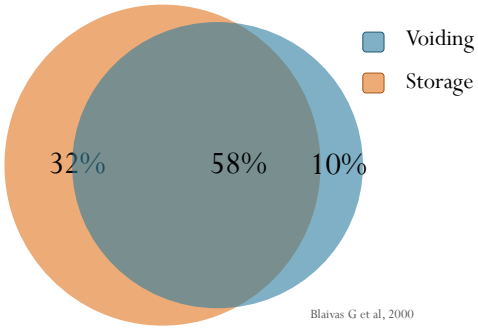
Fig 1.
The urologic iceberg: differentiating the true and observed prevalence of urologic symptoms

EPIC study symptom distribution



Irwin DE et al, 2006

Female with BOO according to Blaivas-Groutz



Blaivas G et al, 2000

OAB and Bladder outlet obstruction

- Patients with de novo urgency after anti-incontinence surgery have mid-urethral kinking and proximal urethral dilatation

Murray et al, 2011

	Controls	BOO	p
Detrusor overactivity	58(39,2%)	38 (55,1%)	0,02

OAB and Bladder outlet obstruction

	Age mean	Qmax(ml/s) mean	Pdet@Qmax (cmH2O) mean
Idiopathic detrusor overactivity (25)	47,2±15	14,47±10,22	58,97±35,13
Controls (40)	47,62 ±8	23,24±12,43	25,56±17

Kaygil O et al, 2007

- Repair of genital prolapse, may provide relief of OAB symptoms in 49 to 82% of patients — Fletcher SG et al, 2010; Foster RT et al, 2007
- Urethrolysis can also relief OAB symptoms in about 50% of patients — Starkman JS et al, 2008

Voiding dysfunction

Voiding symptoms are more specific of obstruction

- Straining, poor stream, hesitancy ++
- Incomplete emptying sensation, double voiding –

But still low (specificity): Jeffery S et al, 2008; Dietz HP et al 2005

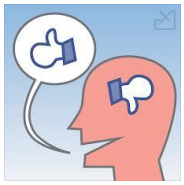
- > 50% of women with voiding symptoms are not obstructed

Lemack GE, 1999

Voiding dysfunction

- There were no associations between "Urethral resistance" (Schafer grades) and the following clinical variables:
  - "urge incontinence" (p=0,892)
  - " incomplete emptying sensation" (p=0,745)
  - "terminal dribbling" (p=0,834)
  - "Pain" (p=0,975)
  - "Frequency" (p=0,444)
  - "Nocturia" (p=0,082)
  - "Stream strenght" (p=0,824)
  - "Strain to void" (p=0,841) or
  - "Hesitancy" (p=0,987)

Monteiro L, unpublished



Regarding voiding dysfunction:

"The female bladder is an ~~un~~reliable witness…" (even less)

Female voiding dysfunction Diagnostic evaluation

History

- High index of suspicion
- Other symptoms associated with voiding dysfunction
  - Feeling a bulge in the vagina
  - Pelvic pressure
  - Spraying
  - Need to immediately re-void
  - Post-micturition leakage
  - Position-dependent micturition
  - Dysuria
- History of UTIs
- Neurologic history and co-morbidities
- Record information related with the probable causes of voiding dysfunction

History

Causes of Female voiding dysfunction

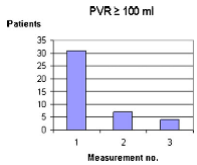
Detrusor underactivity/ Acontractile detrusor	Bladder outflow obstruction
Pharmacological	Urogenital prolapse
Ageing	Continence surgery
Overdistension injury	Urethral stricture, caruncle, diverticulum
Chronic urinary retention	Pelvic mass
Neurogenic	Prolapse surgery
	Dysfunctional voiding
	Primary bladder neck obstruction
	Detrusor sphincter dyssynergia

Physical examination

Abdominal exam, pelvic exam and a neurological exam

Post-void residual volume

- Key test for the evaluation of the emptying phase
- Issue of variability



Saaby ML et al, 2012

Post-void residual volume

- 19% of women with LUTS have high PVR
  - Positively related to
    - Age
    - Prior incontinence surgery
    - AUASS
    - Vaginal parity
    - Prolapse

Milleman et al, 2004

Post-void residual volume

Symptoms alone have a weak correlation with PVR

Symptom/sign	OR	CI
Absence stress incontinence	0.55	0,33-0,92
Vaginal bulge	2,19	1,38-3,38
Pelvic pressure	1,79	1,14-2,86
Urinary splitting	2,89	1,24-6,74
Presence prolapse > stage II	2,6	1,62-4,18

Lukacz ES et al, 2007

Post-void residual volume

High PVR was found in 10% of patients with urge incontinence

In patients with UUI:
POP > Stage II
Voiding symptoms
Absence of stress incontinence

→ Predict 82% patients with PVR> 100cc

Fitzgerald MP et al, 2001

Post-void residual volume

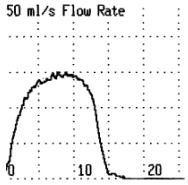
4th ICI recommended the measurement of PVR in the initial assessment of women with suspected voiding dysfunction

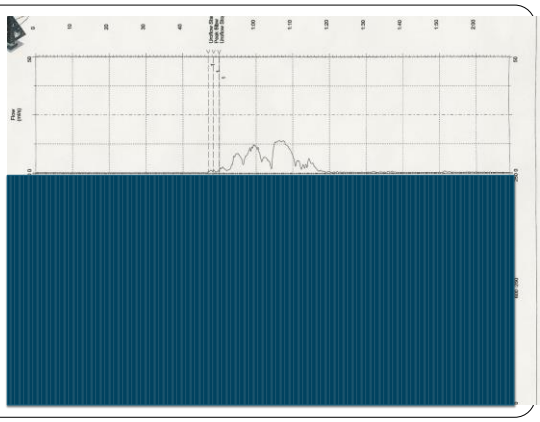
Recommendations	GR
Post-voiding residual should be measured by ultrasound.	A
Measure post-voiding residual in patients with urinary incontinence who have voiding dysfunction.	B
Measure post-voiding residual when assessing patients with complicated urinary incontinence.	C
Post-voiding residual should be monitored in patients receiving treatments that may cause or worsen voiding dysfunction.	B

Thuroff JW et al, 2011

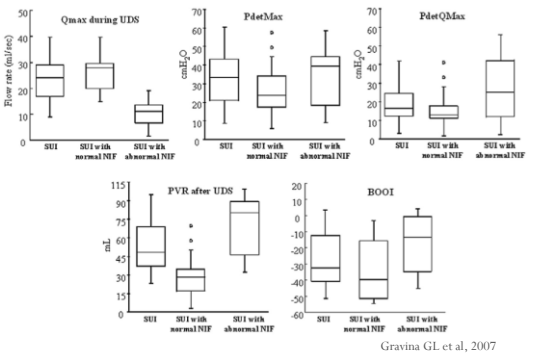
Uroflowmetry

- Qmax < 12ml/s or 15 ml/s
- < 10th centile in Liverpool nomogram





Uroflowmetry



Gravina GL et al, 2007

Ultrasound

- Upper urinary tract evaluation
- Bladder stones, diverticulae
- Urethral kinking
- Detrusor wall thickness (although related to DO is not related with VD)

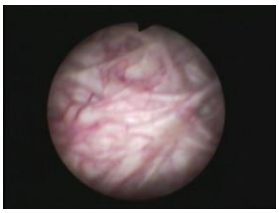
Lekskulchai O et al, 2009

Cystoscopy

- Determine the site of obstruction
- LUTS with pain
- After incontinence or POP procedures

Cystoscopy

Trabeculations



- Are associated with detrusor overactivity and stage IV cystocele.
- No clear association with obstruction

Gowda M et al, 2012

conclusions

- Women with impaired emptying present with wide array of LUTS
- PVR measurement is the mainstay of evaluation
- Free uroflowmetry enhances PVR accuracy
- When LUTS coexists with high PVR, pressure-flow studies are needed to identify BOO

FEMALE BLADDER OUTLET OBSTRUCTION

DIAGNOSTIC NOMOGRAMS

Luis Abranches-Monteiro

Rio, 2014

- Most nomograms of female obstruction do not consider detrusor function, showing only one face of the problem.
- Detrusor pressure is more difficult to evaluate but is a prominent factor of voiding efficiency
- PRESSURE-FLOW (P/Q) CURVES ARE SUPPORTED BY EQUATIONS LIKE:

$$Q=KPR^{X}$$

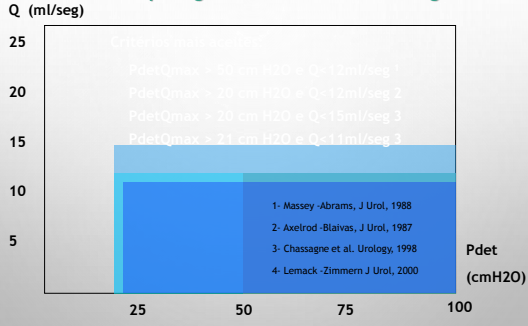
- MEANING THAT FLOW IS A FUNCTION OF BOTH, PRESSURE AND RESISTANCE (OR OUTLET SECTION RAISED TO A GIVEN POWER)

- 1 ST MESSAGE:
  - VOIDING EFFICIENCY IS A FUNCTION OF CONTRACTILITY AND RESISTANCE AND NOMOGRAMS HAVE TO CONSIDER FLOW AND PRESSURE
- 2 ND MESSAGE:
  - DURING THE VOIDING PHASE, DETRUSOR PRESSURE (PDET) IS NOT A MEASURE OF DETRUSOR CONTRACTILITY, (UNLESS THERE IS NO FLOW)

- EXISTING OBSTRUCTION NOMOGRAMS APPLIED TO WOMEN:
  - AXELROD -BLAIVAS,1987
    - PDET>20 CMH_2O AND Q< 12 ML/SEC
  - MASSEY - ABRAMS, 1988
    - PDET>50 CMH_2O AND Q< 12 ML/SEC
  - CHASSAGNE ET AL. 1998
    - PDET>20 CMH_2O AND Q< 15 ML/SEC
  - LEMACK - ZIMMERN 2000
    - PDET>21 CMH_2O AND Q< 12 ML/SEC

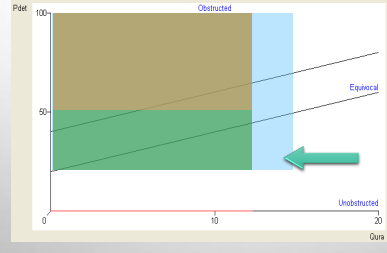
diagnosis

Comparing female obstruction nomograms



diagnosis

Massey, Axelrod and Chassaigne criteria superimposed graphically upon the classic MALE ICS nomogram for obstruction



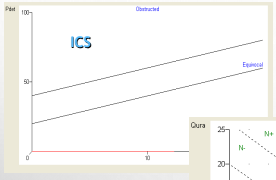
Not so different from man, but some women "invade" a unobstructed area indicating a globally lower urethral resistance.

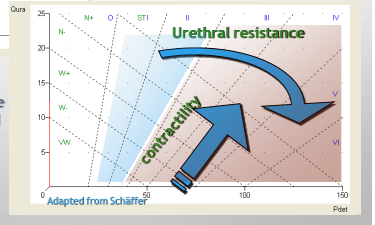
diagnosis

The classic Male nomograms:

ICS for obstruction

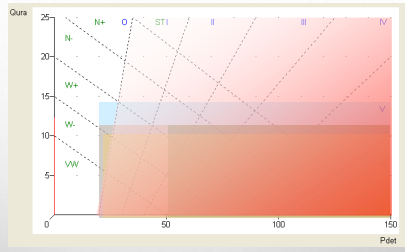
Schäfer for obstruction and detrusor contractility





Approximate correspondance of equivocal and obstructed areas of ICS's onto Schäfer's

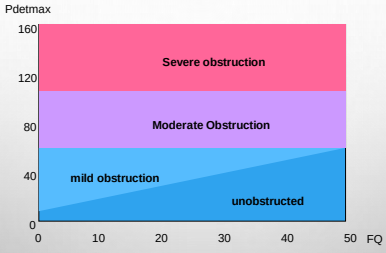
diagnosis



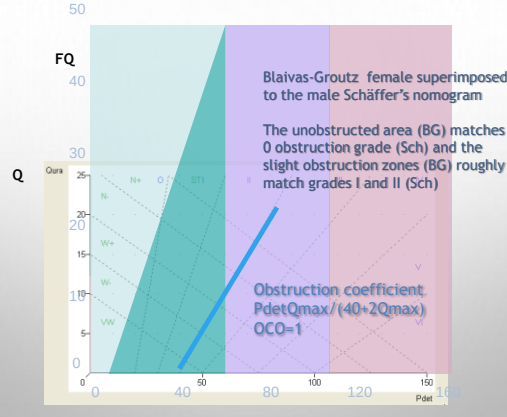
Massey, Axelrod, Chassagne and Lemack's female criteria superimposed graphically upon the male Schäffer's nomogram of obstruction and detrusor contractility.

Showing that female obstructive areas match to Schäfer's grade I to VI

Blaivas-Groutz female nomogram for obstruction



Adapted from Groutz e Blaivas Neurourol & Urodyn, 2000

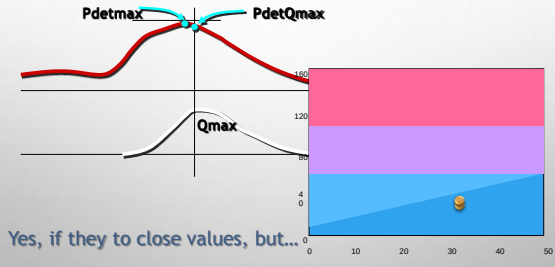


- YET,
  - BG NOMOGRAM USE FREE FLOW (FQ) AND DETRUSOR PRESSURE FROM DIFFERENT VOIDINGS
  - DETRUSOR PRESSURE USED IS MAXIMUM DETRUSOR PRESSURE (PDETMAX) INSTEAD OF DETRUSOR PRESSURE AT MAXIMUM FLOW (PDETQMAX)
    - THE TWO DETRUSOR PRESSURE PARAMETERS MAY PROVE STATISTICALLY SIMILAR, BUT IN THE INDIVIDUAL PATIENT…

- Q OR FQ – ENTUBATED OR FREE FLOW
  - DOES IT MATTER?

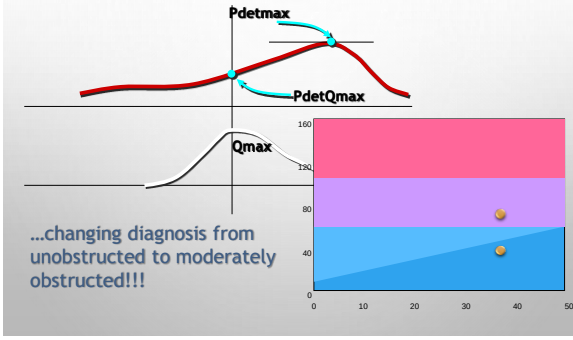
Mostly depends on catheter size.
It certainly does matter with > 7 Fr

- PDETMAX OR PDETQMAX?
  - ARE THEY THE SAME?



Yes, if they to close values, but...

...quite different if they are distant enough!



...changing diagnosis from unobstructed to moderately obstructed!!!

Ideal features for a female PQ nomogram:

- Built after a female series including normal controls
- Assess Pressure and flow in the same voiding using small enough catheters with negligible urethral effect
- Have a scale for detrusor contractility evaluation
- Be independent of abdominal influence (Pves instead of Pdet?

- BUT, SUCH NOMOGRAM IS STILL NOT AVAILABLE OR VALIDATED FOR WOMEN
- IN THE MEANWHILE...

  DIAGNOSIS OF OBSTRUCTION MUST BE SUPPORTED BY OTHER METHODS
  - VIDEO-URODYNAMICS
  - ULTRASOUND
  - EMG

- THE USAGE OF APPROVED MALE NOMOGRAMS WITH ADEQUATE ADJUSTMENTS MAY PROVE CLINICALLY USEFUL

FEMALE OBSTRUCTION AFTER INCONTINENCE SURGERY

PAULO RODRIGUES
LUIS ABRANCHES MONTEIRO
MIGUEL SILVA RAMOS

RIO 2014

- OBSTRUCTION:
  - HIGH DETRUSOR PRESSURE
    - WITH
  - SLOW STREAM

- INDIRECT EVIDENCE OF POST OPERATIVE FEMALE VOIDING DYSFUNCTION
  - SLOW STREAM
  - BINDING OR STANDING TO VOID
  - STRAINING
  - FREQUENCY
  - NOCTURIA
  - URGENCY
  - TEMPORALLY ASSOCIATED TO A SURGERY
  - OVERLOOKED BY SURGEONS IF THERE IS NO MORE INCONTINENCE

- THE NON-CONSENSUAL URODYNAMIC PARAMETERS OF OBSTRUCTION LEAD TO:
  - UNDERDIAGNOSIS
  - FEW URETHROLYSIS INDICATIONS
  - PERMANENT VOIDING DYSFUNCTION
  - DETRUSOR DAMAGE

- LUTD IN FEMALES AFTER ANTI-INCONTINENCE PROCEDURES

Characteristic	Value
Mean age (years) ± SD (range)	48.2±5 (28–67)
Mean parity (number) ± SD (range)	1.8±0.2 (0–6)
Time to start of symptoms (days) ± SD (range)	931±56 (1–5,760)
Time to presentation (months) ± SD (range)	43±8 (7–240)
Kelly-Kennedy	174 cases (57.6 %)
Burch	51 cases (16.8 %)
Kelly-Kennedy + Burch	36 cases (11.9 %)
Sling	33 cases (10.9 %)
Marshall-Marchetti	8 cases (2.6 %)

- LUTD PRESENTATIONS

Presentation	No. of cases
Urinary retention	6 (2.0 %)
Poor stream	64 (21.2 %)
Straining to void	35 (11.5 %)
Sensation of incomplete emptiness	23 (7.6 %)
Binding to void	42 (13.9 %)
Interrupted flow	15 (4.9 %)
Dysuria	30 (9.9 %)
Frequency	233 (77.1 %)
Urgency (voiding interval 1 h or less)	288 (95.7 %)
Recurrent UTI	302 (69.5 %)
Nocturia (>2×/night)	189 (62.5 %)
Urge incontinence	122 (40.4 %)

- PATTERNS

1. ELEVATED PRESSURE AND POOR FLOW
2. NON-ELEVATED PRESSURE AND POOR FLOW
3. NON-ELEVATED PRESSURE AND POOR FLOW BUT PROLONGED FLOW TIME
4. POOR DETRUSOR CONTRACTION
5. ELEVATED PRESSURE AND HIGH FLOW

- PRESSURE-FLOW STUDIES ARE THE MAINSTAY FOR OBSTRUCTION DIAGNOSIS
  - THE ASSOCIATION BETWEEN PRESSURE AND FLOW IN WOMEN IS IMPRECISE
  - MALE DESIGNED NOMOGRAMS ARE NOT SUITABLE FOR USE IN WOMEN
- THE INCREASE IN IATROGENIC OBSTRUCTION CAST LIGHT ON FEMALE OBSTRUCTION
- SLING OPERATIONS CAN PRODUCE BOO IN 6,9%
- AS RELIEF OF OBSTRUCTION IS NEEDED, A DIAGNOSIS IS MANDATORY

	$P_{det}Q_{max}$ (cmH_2O)	Q_{max} (ml/s)	Res (ml)	Time to start flow since the contraction (s)	Total flow time (s)
Pattern 1	High	Low	Irrelevant	Irrelevant	Irrelevant
Pattern 2	Normal	Low	Low	Irrelevant	Irrelevant
Pattern 3	Normal	Normal	Absent	Irrelevant	Extended
Pattern 4	Straining	Low	High	Irrelevant	Extended
Pattern 5	High	High	Absent	Irrelevant	Irrelevant

	n (%)	$P_{det}Q_{max}$ (cmH_2O)	Q_{max} (ml/s)	Res (ml)	Time to start flow since the contraction (s)	Total flow time (s)
Pattern 1	22 (7.2 %)	68±7	5.9±1.1	14±10	14±7	34±14
Pattern 2	124 (41 %)	35±6	6.2±2	<100	9±8	33±28
Pattern 3	73 (24.1 %)	28±7	11.9±4	Absent	6±6	59±32
Pattern 4	39 (12.9 %)	9±12 or straining	5.9±6	130±110	Irrelevant	79±43
Pattern 5	44 (15.5 %)	56±15	14±5	Absent	4±4	38±13

FEMALE VOIDING NOMOGRAMS PRINCIPLES & ADJUSTMENTS

Luis Abranches-Monteiro

Rio 2014

- A LITTLE OF PHYSICS…

System with:
a reservoir with volume
a pumping engine with power
an outlet with resistance

No matter if its is a man, a woman, a syringe, a fireman's hose, etc

- SPECIAL FEATURES OF LOWER URINARY TRACT:
  - THE ENGINE HAS VARIABLE POWER DEPENDING ON
    - THE LENGTH OF MUSCULAR FIBERS OR BLADDER VOLUME
      - STARLING'S LAW
    - THE SHORTENING VELOCITY
      - HILL'S EQUATION
    - FUELED BY MICTURITION REFLEXES
      - CNS-BLADDER
      - URETHRO-VESICAL

- SPECIAL FEATURES OF LOWER URINARY TRACT:
  - THE OUTLET IS A DISTENSIBLE/COLLAPSIBLE/CONTRACTILE TUBE
    - WHEN RIGID, IS GOVERNED BY
      - POISEUILLE'S OR BERNOULLI'S LAW DEPENDING ON FLOW CONTROLLING ZONE LEVEL, WHERE
        - $Q=P.R^4/8$ (POISEUILLE EQUATION)
    - WHEN COLLAPSIBLE/DISTENSIBLE
      - RADIUS IS DEPENDENT ON RESERVOIR'S PRESSURE AND THERE IS AN EQUATION FOR EACH MOMENT OF THE EMPTYING PHASE

- OUTLET RESISTANCE EQUATION VARIES WITH PATHOLOGY.
  - RANGING…
    - FROM URETHRAL RIGID STENOSIS…
    - TO A ELASTIC COMPRESSION OF PROXIMAL URETHRA OF BPH…
    - ENDING IN NORMAL DISTENSIBLE, LOW RESISTANCE FEMALE URETHRA

- IN EACH CASE…
  - FLOW WILL INCREASE
    - WITH BLADDER PRESSURE IN A LINEAR WAY, BUT…
    - IN A QUADRATIC OR EVEN AT THE 4TH POWER WITH URETHRAL SECTION (RADIUS)
  - AND…
    - IF DISTENSIBLE, RADIUS CAN INCREASE WITH BLADDER PRESSURE

- FLOW IS MORE INFLUENCED BY RADIUS THAN PRESSURE ESPECIALLY IN LESS DISTENSIBLE OUTLETS (URETHRAL STENOSIS)
- IN ELASTIC URETHRAS, PRESSURE ACTS IN TWO WAYS INCREASING FLOW:
  - BY THE POISEUILLE/BERNOULLI EQUATION
  - BY INCREASING THE URETHRAL RADIUS

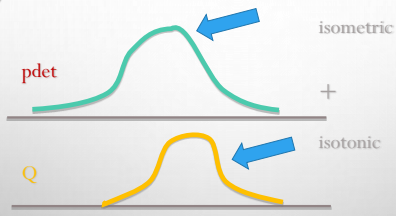
- IN SUMMARY, OUR VARIABLES ARE:
  - DETRUSOR FIBERS SHORTENING STRENGHT
  - URETHRAL RADIUS AND ITS ELASTICITY

- A LITTLE OF MATHS…
  - IF
    - Q=K.P.R,
    - THEN SHORTENING OF DETRUSOR FIBERS RESULTS IN
      - PRESSURE IN BLADDER

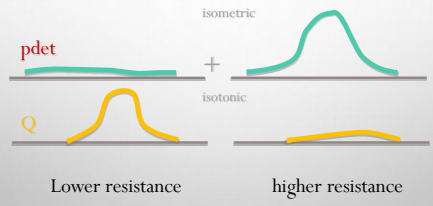
      AND/OR
      - FLOW

- IN OTHER WORDS,
  - DETRUSOR CONTRACTION RESULTS IN BLADDER PRESSURE DEPENDING ON URETHRAL RESISTANCE.
  - WHEN FLOW EXISTS, IT RESULTS IN LESS PRESSURE
- OUR SYSTEM STATE VARIES THEN, FROM
  - TOTAL OUTLET RESISTANCE (CLOSED URETHRA) AND MAXIMAL PRESSURE
  - AND LOW OUTLET RESISTANCE, FLOW AND LESS PRESSURE

Voiding contraction

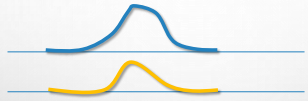


Voiding contraction



- THEN, BLADDER PRESSURE (PDET) IS A FUNCTION OF:
  - DETRUSOR CONTRACTION
  - RESULTING FLOW
- IT ONLY REFLECTS DETRUSOR PERFORMANCE WHEN FLOW IS 0! (PURE ISOMETRIC CONTRACTION)

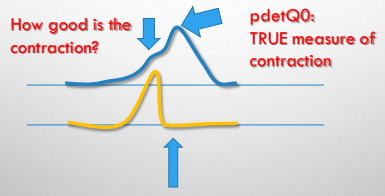
- WE KNOW THIS IS A GOOD CONTRACTION BECAUSE THERE IS A HIGH PDET



- WE KNOW THIS IS A GOOD CONTRACTION BECAUSE THERE IS A GOOD FLOW

- BUT, HOW GOOD ARE THEY?

- SINCE CONTRACTION GIVES RISE TO PDET AND FLOW WE MUST ZERO THE FLOW TO HAVE A PDET AS TRUE MEASURE OF CONTRACTION.

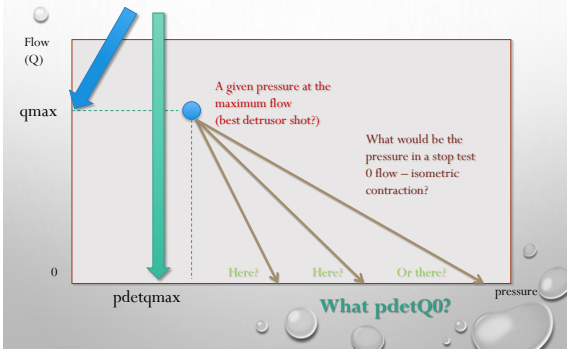


- SINCE BLADDER PRESSURE VARIES WIDELY WITH FLOW, DETRUSOR CONTRACTILITY CAN ONLY BE MEASURED IN A CLOSED URETHRA (MAXIMAL RESISTANCE)
- BUT…
  - SINCE DETRUSOR POWER VARIES WITHIN THE EMPTYING PHASE,
  - WE NEED TO MEASURE THE BLADDER PRESSURE AT THE MAXIMUM FLOW, BUT WITH NO FLOW!!!

- THE STOP TEST
  - URETHRA IS CLOSED SUDDENLY WHEN MAXIMUM FLOW IS REACHED
    - VOLUNTARY CONTRACTION OF URETHRA
    - BALLOON OCCLUSION OF BLADDER NECK
      - IN THE PRECISE MOMENT OF MAXIMUM FLOW
  - IT IS UNRELIABLE, UNCOMFORTABLE
  - DEPENDS ON SEVERAL AND UNCONTROLLABLE LOCAL AND PERSONAL VARIABLES

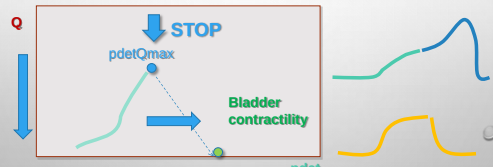
- THEORETICAL EXTRAPOLATION OF STOP TEST:
  - THE PROJECTED ISOMETRIC PRESSURE (PIP)
- IN A GIVEN SYSTEM DESCRIBED BY A TWO VARIABLE PLOT OF PRESSURE AND FLOW, MAXIMUM FLOW PRESSURE CAN BE PROJECTED ONTO THE 0 FLOW IF WE FIND THE PROBABLE DIRECTION OF THE PROJECTION. THESE PROJECTIONS DEPEND ON THE MECHANICAL/ELASTIC PROPERTIES OF THE SYSTEM
- ONCE FOUND THE PROBABLE PROJECTION, STOP TEST DOES NOT NEED TO BE DONE IN EVERY PATIENT AND A CONTRACTILITY SCALE CAN BE DRAWN.

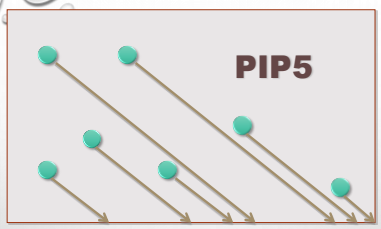
Detrusor contraction



What pdetQ0?

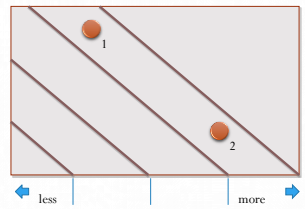
- WHAT DETRUSOR PRESSURE WHEN Q IS FORCED TO ZERO(STOP TEST)?





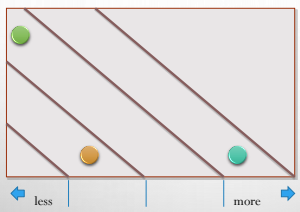
In a number of stop tests in men the pressures at 0 flow run in a fairly linear and parallel fashion, although a more parabolic (Hill's equation) theoretical curve would be expected.
Some simplicity is added for the sake of practical use.

In men, lines of y=-5x slope were most often found (Q in ml/sec to 5Q in cm H2O of pdet) – PIP5 (projected isometric pressure), recently named as Bladder Contractility Index (BCI)

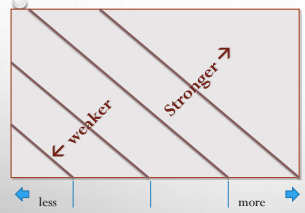


Cases 1 and 2 have quite different values of Q and pdetQmax, but belong to the same class of contractility; they share the same pdetQ0

A scale of probable pressure at 0 flow can be drawn with no more need of stop test



- High flow, very low pressure = good contraction
- Low flow, higher pressure = worse contraction
- Low flow, higher pressure = very good contraction (but obstructed)



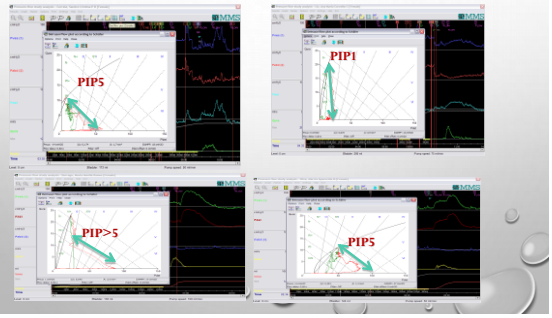
Schäfer considered 7 degrees of contractility :
- Very Weak, Weak minus, Weak, plus, Normal minus, Normal plus and Strong after plotting hundreds of men, from non-obstructed (young and operated) to obstructed

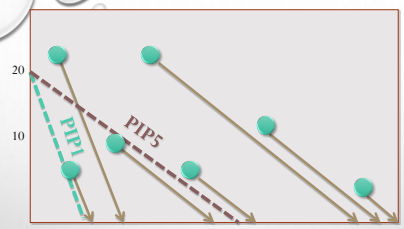
WOMEN

- WHAT ABOUT WOMEN?
  - PROBLEMS:
    - SOME HAVE ABDOMINAL CONTRACTIONS MAKING IMPOSSIBLE TO DETERMINE WHAT IS THE MAIN DRIVING FORCE TO GENERATE THE FLOW (DETRUSOR OR ABDOMEN?)
    - STOP TEST ARE EVEN LESS RELIABLE BECAUSE LESS ABILITY TO SUDDENLY CLOSE THE URETHRA
    - URETHRA IS OFTEN A DISTENSIBLE TUBE WITH MORE RADIUS VARIABILITY
  - BUT… THE SAME PRINCIPLES SHOULD APPLY

Some women show a clear PIP5 but some have more vertical patterns, say PIP1 (the same value of Q in ml/sec as pdet in cm H2O) and some in between.

STOPTESTS in Women

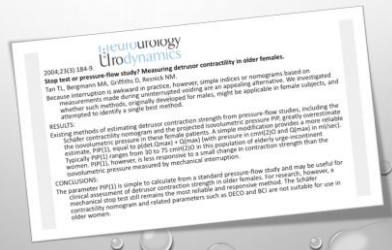


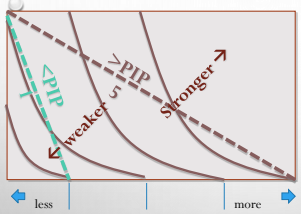


But, can we draw some pattern out of this variability?

1) Older women and those with higher flowrates and less urethral resistance tend to have lower PIP
2) Higher flows and less obstruction have PIP closer to 1 probably reflecting a more parabolic distribution of Hill's equation
3) lower Q rates and higher pressures seem like men (PIP5)

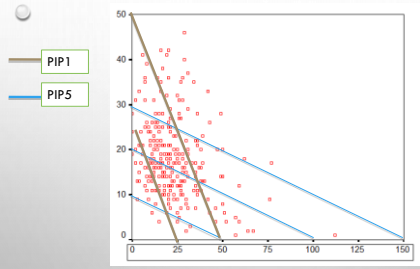
- PIP1 MAY BE USEFUL FOR THE CLINICAL ASSESSMENT OF DETRUSOR CONTRACTION IN OLDER FEMALES
- BCI (PIP5) IS NOT SUITABLE IN THIS GROUP





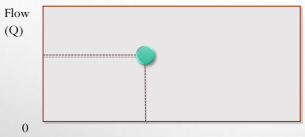
A more parabolic design could be more closely adapted to female variations from PIP1 or less to PIP5 or more?

A closer attention to the pattern of Female stop-tests should be warranted



- WHICH PIP REFLECTS FEMALE PROJECTED CONTRACTILITIES?

The abdominal contamination



When a flow is generated by intravesical pressure, it can be influenced by the abdominal contraction and detrusor contraction.
But, only detrusor pressure is considered in existing pressure-flow plots.
No pressure-flow plot using vesical pressure (Pves) have been tested

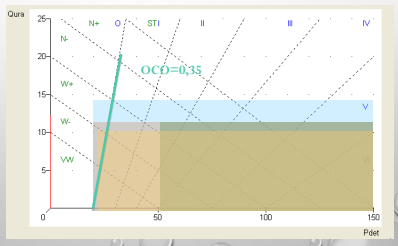
Detrusor pressure plots are only valid with no abdominal activity!

OPTIONS:

- KEEP PIP5 OPTION (SCHÄFER'S)
  - BUT NOT CONSIDERING THE EXCEPTIONALLY LOW PRESSURE-HIGH FLOWS.
  - EVENTUALLY EXCLUDE WOMEN OLDER THAN 65?
  - DEFINITELY EXCLUDE THE "ABDOMINAL" VOIDINGS
- AND PROFIT FROM IT'S SIMPLICITY, EASE OF USE AND CLINICAL VALUE LONG USED IN MEN.

- AND, WHAT ABOUT THE MEASURE OF URETHRAL RESISTANCE IN WOMEN?
- A FEW MORE AGREEMENT IN THE LITERATURE…
- SEVERAL NOMOGRAMS ALREADY DESCRIBED:
  - MASSEY-ABRAMS
  - LEMACK-ZIMMERN
  - CHASSAGNE
  - BLAIVAS-GROUTZ

- SUPERIMPOSITION OF SEVERAL FEMALE NOMOGRAMS FOR OBSTRUCTION



- PUTTING ALLTOGETHER:

1) DETRUSOR PERFORMANCE AND URETHRAL RESISTANCE HAVE TO BE MEASURED TO ASSESS THE INCREASINGLY FREQUENT FEMALE VOIDING DYSFUNCTION

2) WOMEN HAVE MORE VARIABILITY OF URETHRAL RESISTANCE AND DETRUSOR PERFORMANCE

3) OLDER WOMEN AND THOSE WITH VERY HIGH FLOWS HAVE DIFFERENT "ISOVOLUMETRIC PRESSURE PROJECTIONS" THAN THE REST AND THAN MEN

4) VALIDATED FEMALE OBSTRUCTION NOMOGRAMS ARE NOT SO DIFFERENT FROM THOSE OF MEN.

- PUTTING ALLTOGETHER:

5) DETRUSOR PRESSURE/FLOW PLOTS ARE NOT VALID UNDER ABDOMINAL "CONTAMINATION"!

6) THE BOUNDARIES OF NORMALITY ARE LESS WELL DEFINED THAN IN MEN

7) CONTINUOUS SCALES SHOULD BE USED NOT TO STICK TO "NORMAL/ABNORMAL" TERMS

- PUTTING ALLTOGETHER: QUESTIONS TO BE ANSWERED

8) THE USE OF PROGRESSIVELY THINNER CATHETERS IMPROVE INTUBATED FLOW PLOTS?

9) VESICAL PRESSURE (PVES INSTEAD OF PDET) PLOTS CAN PREVENT THE MISLEADING EFFECT OF ABDOMINAL STRAIN?

10) MATHEMATICAL SIMPLIFICATION OF NOMOGRAMS SPEED UP THEIR (URGENT) CLINICAL USE?

- Thank you
  - And
  - Explore the