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#125 Calculation of Bladder Contractility in Women in Urodynamic Traces

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Introduction

Detrusor underactivity (DU):

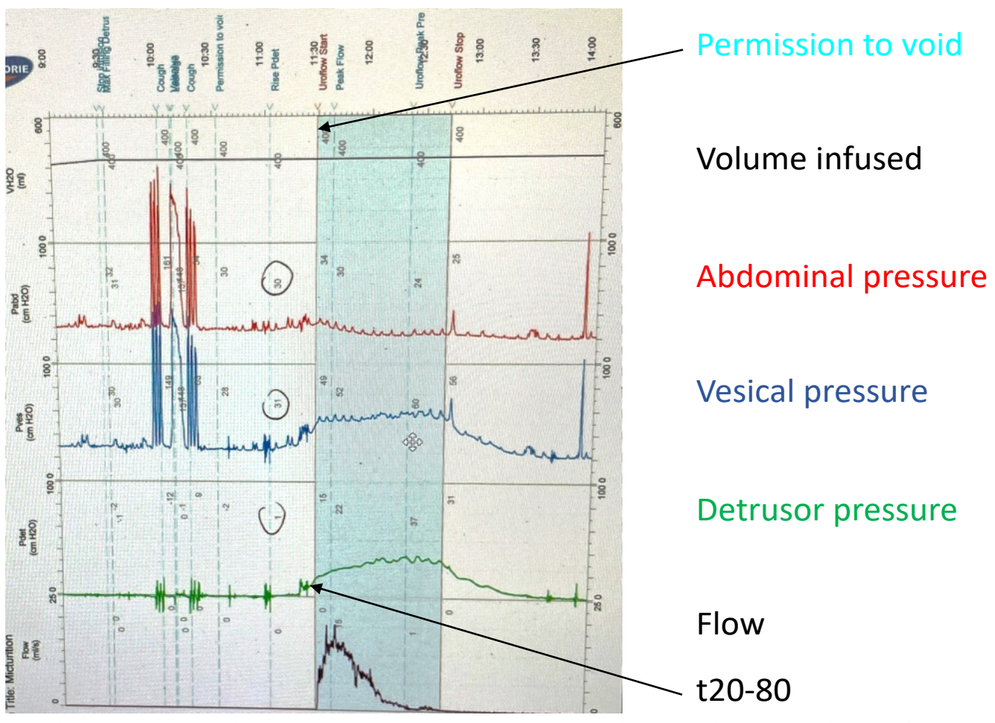
- A bladder contraction of reduced strength and/or duration, resulting in prolonged bladder emptying and/or failure to achieve complete bladder emptying within a normal time span
- Underactive bladder is characterized by slow urinary stream, hesitancy and straining to void, with or without a feeling of incomplete bladder emptying, sometimes with storage symptoms.
- Calculation of DU in women is challenging
- v_{CE}, the maximum velocity of muscle element shortening derived from the isovolumetric phase of bladder contraction, is the gold standard in the calculation of bladder contractility.
- Detrusor Contractility Parameter, or t_{20-80}, time for pressure rise from 20-80% of its max, was proposed as a true correlate of v_{CE}.

Hypothesis/ Aims of the study

1. We propose a simple method of calculation of v_{CE}
   - Using an Excel spreadsheet
   - Using information from the urodynamics trace
2. Correlation of findings to other urodynamics parameters used in the assessment of bladder contractility:

- Detrusor Contractility Parameter (DCP)
- Projected Isovolumetric Pressure (PIP1)
- Watts Factor at maximum flow (WF_{Qmax})
- Bladder Contractility Index (BCI)

Study design, materials & methods



Urodynamics trace depicting voiding phase. t20-80 is the isovolumetric phase of bladder contraction before flow is initiated.

- One hundred consecutive pressure-flow traces from 100 female patients were used to estimate t_{20-80} and for v_{CE} calculations
- Tests were conducted as per International Continence Society Good Urodynamic Practices.

Calculation of DCP:

- DCP, or t_{20-80} = time interval between p_{det} rising from 20% to 80% of the value
- Calculated directly from pressure-flow traces

Calculation of v_{CE}:

- Export data (10 Hz) from the urodynamic machine and load into Excel
- Smooth p_{det}: averaged over 0.4 s. Calculate (dp/dt)/p
- Insert X-Y scatter graph for upper 2/3 of pressure values between t_0 to t_{100} and add log trend line.
- v_{CE}, the vertical axis crossing of this trend line, is approximated by the constant in the equation (i.e. vertical axis value when p=1) of the trend curve.

Correlation with other contractility parameters

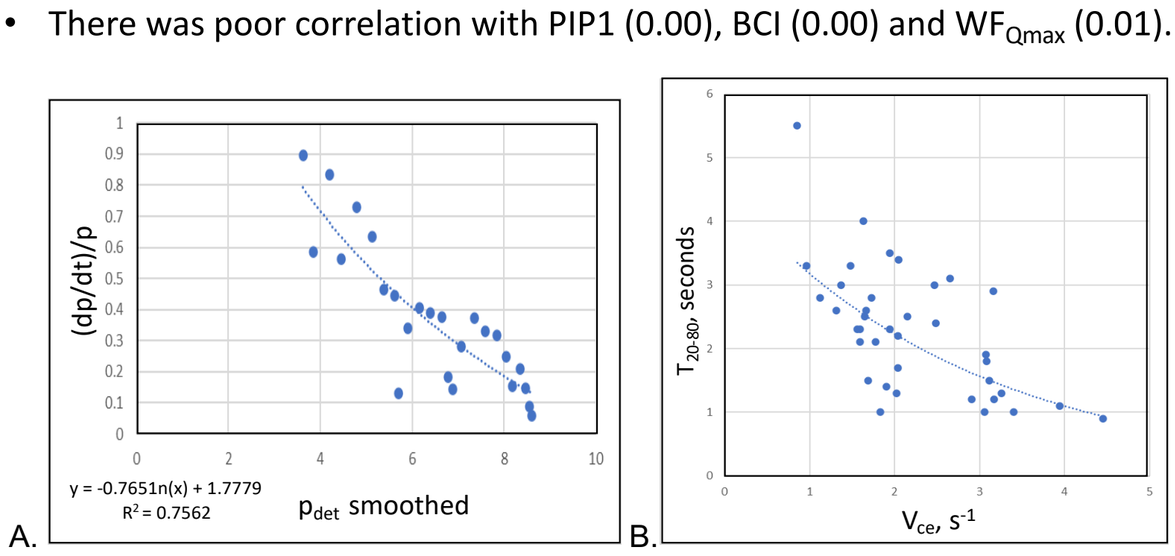
- The resultant v_{CE} calculations were correlated with DCP, PIP1, BCI & WF_{Qmax}

Results

	All patient data - Median (Interqt Range)	Patient data: good curve fitting - Median (Interqt Range)
Number of patients	100	38
Age (years)	54 (45 – 68)	50 (42 – 62)
Q_{max} (ml/sec)	21 (13 – 29)	20 (14 – 26)
$p_{detQmax}$ (cmH_2O)	16 (9 – 23)	21 (13 – 30)
Volume voided	372 (238 - 465)	357 (274 – 404)
Post-Void Residual Volume (ml)	26 (0 - 0)	13 (0 – 0)
Cystometric Capacity (ml)	393 (296 – 483)	369 (274 – 404)
Watts Factor at Q_{max}	7.6 (5.1 – 9.0)	8.2 (6.4 – 9.4)
BCI	121 (86 – 151)	123 (95 – 148)
PIP1	38 (30 – 48)	42 (33 – 50)
t_{20-80}	2.8 (1.4 – 3.3)	2.3 (1.4 – 2.9)
v_{CE}	1.4 (0.7 – 2.0)	2.2 (1.6 – 3.0)

Summary of data values for patient traces stated as median (lower, upper interquartiles). Columns: all original data, then the data from those with v_{CE} curves with fit correlation > 0.4. Interqt = Interquartile

- 80 standard and 20 video urodynamic traces were assessed.
- v_{CE} was calculated for all traces using the excel software
- Traces with artefacts, noise or poor quality pressure transmission were excluded
- 38 traces with good curve fitting were included in the correlation analysis
- Correlation analysis showed t_{20-80} had the best correlation with v_{CE} (0.41)
- There was poor correlation with PIP1 (0.00), BCI (0.00) and WF_{Qmax} (0.01).



A. An example of the curve fitting of pressure data to obtain v_{CE}. The constant in the curve fit, used as an approximation to v_{CE}, is 1.78. The fit is acceptable, as $R^2 > 0.4$
B. Correlation of t_{20-80} (DCP) with v_{CE} using data curves with R^2 values greater than 0.4, suggesting that t_{20-80} values of greater than 2 seconds are found in the majority of poorly contracting detrusors. The R^2 value for the trend curve is 0.41.

Interpretation of Results

- The maximum velocity of muscle contraction, v_{CE}, is thought to be the best way to assess true detrusor contractility.
- Our results echo that of previous studies which have shown that t_{20-80} is significantly associated with v_{CE} and may be used as a surrogate marker[3].
- We have devised an easy way to calculate v_{CE} using the Excel spreadsheet software.
- We propose that manufacturers should allow the user to mark t_0 and t_{100} and the best part of the p_{det} curve for the v_{CE} analysis.
- This would allow for automated analysis of v_{CE}.
- In patients where v_{CE} cannot be determined, due either to noisy signals, straining or poor-quality transmission, t_{20-80} may be a useful surrogate indicator for detrusor contractility.

Concluding message

We have provided a simple way of calculating the maximum contraction velocity of the detrusor, v_{CE}, using standard Excel software and information available from the urodynamic trace. Validity of DCP is confirmed by correlation analysis with v_{CE}.

By accurately diagnosing patients with poor contractility, operations on the bladder outlet may be avoided, as this may result in poorer patient outcomes

References

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3. Gammie A, Kitney D, Drake M, Abrams P, Fry C. The calculation and comparison of the Detrusor Contractility Parameter and Watts Factor. Neurourology and Urodynamics. 2018;37(8).