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QUANTIFICATION OF COMPLIANCE IN CLINICAL PRACTICE

Aims of Study

To show practical graphical and mathematical methods for quantifying detrusor compliance from cystometrography (cmg) plots of detrusor pressure versus volume infused.

Methods

The graphical method is based on cmg curve, where detrusor pressure is plotted against infused bladder volume. The technique consists of laying a parallel ruler from the origin of the plot parallel to the averaged detrusor e.g. relaxed pressure line (excluding the uninhibited contractions) and reading the pressure intercept at the $V_{Cap,Norm}$, which is obtained from estimating graphs or equations (1) as a function of age, sex, height and weight. This reading is divided by 6cmw and the resulting value is called quantifying dimensionless number Nwahl (2). Mathematically the same result is achieved by taking the volumes and pressures at any two points from the averaged pressure plot line and calculating Nwahl by [(P2 - P1)/6] / [(V2-V1)/($V_{Cap,Norm}$)]. Rather than trying to make an estimate of artifacts and the averaged " relaxed" detrusor pressure line, a better method for calculating Nwahl is to use the automated system developed for this purpose (3,4) . But the method described here is useful for checking and understanding the automated results. This was applied to 20 cmgs of various diagnoses [frequency (1), day-time or mixed wetting (6), Hinman bladder (1), bladder extrophy (1), urethral valve (1), menincomyelocele (mmc, 10 of which 2 augmented)]. The tested patients were of different ages and sizes.

Results

Three patients, one with frequency and two with wetting problems, had completely normal cmg with Nwahl ranging 0.4 - 1.4. The bladder compliance was varying considerably between the wetting patients, Nwahl value being in average 2.5 (range 0.4-7.5). Three patients with abnormal, non-neurogenic bladders presented cmgs with minimal detrusor instability but poor compliance (Nwahl ranging 4.3-9.6). All neurogenic bladders were hyperreflexive, but their compliance was varying from normal for younger patients to highly abnormal for the older children.

Conclusions

Given a cmg plot of pressure versus volume, this methodology yields a result which is standardized to a patient's age and size. By these methods the results are not much affected by such factors as short test time due to strong urge or overactivity of the detrusor, both distorting the test results when using the usual equation of $[(V2-V1)/(p2-p1)]$ between two points on cmg. Thus, this calculation is convenient for comparing compliance between patients and between serial tests for the same patient. Consequently, this method is a valuable tool when choosing a right treatment or assessing a treatment efficacy and timing for a patient.

References:

1. Estimation of bladder capacity and glomerular filtration rate from birth on. Submitted to Neurourology and Urodynamics, March 2000.
2. Quantification of bladder compliance by a dimensionless number. Submitted to Neurourology and Urodynamics, February 2000.
3. Quantification of detrusor compliance and contractility, Society for Urological Engineering, AUA annual meeting, 1998.
4. Quantification of detrusor compliance and contractility submitted to Neurourology and Urodynamics, March 2000.
5. A prototype pediatric cystometric apparatus of improved accuracy. Submitted J Endourology, February, 2000.

Table1. CONTRACTILITY AND COMPLIANCE SUMMARIZED FOR 20 PATIENTS.

Cases are listed by increasing pulsation activity as determined by the normalized power factor $\Lambda_{N,T}$. Different values of N_{Wahl}, $\Lambda_{N,T}$, number of pulses and average amplitude characterize different patient conditions. VUR= vesicouretreal reflux, Hinman= non-neurogenic neurogenic (Hinman) bladder, mmc= meningomyelocele, augm= bladder augmented, extrophy= bladder extrophy (operated), valve= urethral valve, sacr = sacral agenesis

Case	Diagnosis category	Age Yrs	Sex	$V_{cap,Norm}$	Test Time min.	N_{Wahl}	$\Lambda_{N,T}$	Λ_N	Λ	area min-cm_W	Low Amplitude %	No. of Pulses >3	>15	>30	Avg Amp Cm_W
1	frequency	29	F	418	57	0.7	0	0	0	0	0	0	0	0	0
2	wetting,VUR	4	F	175	43	0 4	0.1	2	74	3	100	16	0	0	4.7
3	wetting,VUR	4	F	190	44	0 4	0.1	6	211	6	87	20	1	0	6
4	wetting	7	F	236	25	2 4	0.2	6	236	9	14	24	12	7	21 1
5	Hinman	10	M	249	37	4.3	0 2	6 4	255	12	100	24	0	0	5.1
6	mmc	2	F	112	42	4 4	0.4	18	423	17	95	86	3	0	8.2
7	extrophy	7	M	234	20	9.6	0 4	9.2	351	16	73 61	29	2	0	8.3
8	mmc	1	M	120	25	-0 4	0.5	13	321	20	44	45	11	3	14.2
9	wetting,VUR	14	F	419	40	1 4	0.7	28.3	1586	32	100	29	0	0	5.2
10	valve	10	M	311	31	4 4	0 8	26.8	1228	58	100	36	0	0	6 9
11	mmc-augm	13	F	373	34	1.9	0 9	29.9	1548	33	100	58	0	0	5.7
12	mmc	7	F	226	22	2 7	1	22.7	841	31	67	24	3	0	10 5
13	sacr -augm	42	M	422	36	4 5	1.2	42 5	2392	73	86	95	2	0	7 9
14	mmc	10	M	268	11	10.1	1.3	14	602	41	28	53	25	8	15 8
15	wetting	8	M	344	30	7.5	1.7	51	2524	55	34	70	28	4	13.8
16	wetting	7	F	219	29	2.9	2.7	78	2844	98	19	78	37	11	20.1
17	mmc	12	M	383	23	14.8	3.2	72	3794	137	57	60	5	0	10.1
18	mmc	0.5	F	81	7	6.4	3.4	25.3	473	80	2.84	29	26	22	54.2
19	mmc	3	M	159	40	3.3	4.2	169	4972	164	27	65	30	4	14.9
20	mmc	0.3	M	59	42.	0.6	5.3	223	3385	214	19	145	105	35	24.5