DETRUSOR CONTRACTION DURATION AND STRENGTH IN THE PATIENTS WITH BENIGN PROSTATIC ENLARGEMENT

Damir Aganovic, Alden Prci}
Departement of Urology
Clinical Center of University of Sarajevo

ABSTRACT

Objective: examine detrusor contraction duration (DCD) in relation with obstruction grade and strength of detrusor contractility; analyze individual correlations of this parameter with urodynamic, physiological and symptoms variables in patients with benign prostatic enlargement (BPE).
Sample and methodology: 102 patients with proved BPE, underwent complete urodynamic measurements (UDM), namely uroflowmetry, cystometry and pressure/flow studies. Postvoid residual urine (PVR) was measured and the International Prostate Symptom Score (I-PSS) was fulfilled by each patient. Methodology of measurement and definitions of UDM are based on definitions and terminology defined by the International Continence Society.
Results: After grouping the patients (average age 64,7+-8,5) related to obstruction grades according to the Schafer nomogram, ANOVA has shown a group extension of the detrusor contraction duration related to higher levels of obstruction (LinPURR 0-VI; p<0,01), which is also followed by stronger detrusor contractility (Pdetmax; p<0,001). Dichotomizing of the patients with DCD cut off point 90 sec. has shown that 67% patients with underactive detrusor have DCD>90 sec, while extension of DCD and increase of the obstruction level are directly related to preserved detrusor contractility only in 20,5% cases. There is neither statistically significant difference of DCD in the patients that are not in obstruction allocated in two groups depending on detrusor contraction strength, (t=1.2, p>0.05); nor in the patients who are in obstruction range, divided on the same way (t=0.568, p>0.05). There is also no difference of the same patients groups regarding PVR (t=1.38 and t=1.17, p>0.05). Individual correlation of DCD with I-PSS has not been shown (r=0.16, p>0.05), although there is a statistically significant correlation with its obstructive subset (r=0.20, p<0.05), as well as, with LinPUR and URA nomograms (r=0.33, r=0.29; respectively, p<0.005) and with Pdetmax (r=0.26, p<0.01), PdetQmax (r=0.24, p<0.05), Qmax and Qaver (r=0.31, p<0.005). DCD does not have individual correlations with patients' age, prostate volume and with cystometric capacity.
Conclusion: DCD is rather independent urodynamical variable, which does not correlate with I-PSS. Generally, DCD is prolonged during obstruction, while extension of DCD only partially depends on detrusor contraction strength. Practically, individual correlations of DCD with the urodynamic factors, which characterize obstructions, are modest.
Key words: BPE, UDM, detrusor contraction duration

INTRODUCTION

Detrusor contraction duration (DCD) has become a focus of interest for urodynamic investigations of bladder output obstruction after Kaplan found correlation between DCD and I-PSS. As the parameter in a function of obstruction, which can be predicted also by I-PS Score, is based on a simple concept that a time, needed for a fluid to leave a reservoir, depends on external resistance. While this concept is correct for the reservoir with a constant volume and constant pressure, this ideal situation can not be applied to a bladder in obstruction. Resistance of a bladder outlet varies a lot during initiation and termination of micturition due to neuro-muscular mechanism, which influences the bladder output during different phases of urinating, so detrusor contraction duration can be dependent on strength, better to say on detrusor contractility, bladder capacity including additional increase of urethral resistance[2]. Due to these additional factors that can influence DCD, a role of this urodynamic factor in obstruction characterization has been examined. Inter-correlations between UDM factors and the correlation of DCD with I-PSS have been determined.

SAMPLE AND METHODOLOGY

102 patients with proved benign prostate enlargement (BPE) underwent complete urodynamic measurement (UDM). Inclusive criteria were no sign of urinary infection, no bladder stones, no haemathuria and normal values of PSA, as well as preserved kidney function. Dantec 5500 apparatus was used for uroflowmetry, cystometry and pressure/flow studies. Residual urine was determined by ultrasound and International Prostatic Symptom questionnaire was fulfilled per each patient [3]. Methodology and nomenclature of UDM, if not marked different, are founded on the basic definitions of the International Continence Society [4].

RESULTS

Out of 102 patients, 24 (23,5%) were not in obstruction at all, 28 (27,5%) were in mild (or equivocal) obstruction, while the rest of the patients (49%) were in a clear or advanced obstruction, based by the Schafer (linPURR) nomogram (5). Analysis of variance has determined that detrusor contraction duration is prolonged for increased levels of obstruction, what is proportionally followed by strength of detrusor contraction. (Table1).

Distribution of patients relating to duration and strength of detrusor contraction (according to Schafer nomogram) has show that the patients with weak or very weak (GDC 0/1) and normal or strong (GDC 2/3) detrusor are rather uniformly distributed in the zone out of obstruction (linPURR 0/I) or in the zone of equivocal obstruction (linPUR II); even predomination of patients with underactive detrusor is noted. However, number of patients with GDC 0/1 is decreasing in the levels of clear and advanced obstruction (linPUR>III), so there are only patients with normal and strong detusor in the levels linLPURR V and VI (Table 2).

Related to DCD, which cut of point value is 90 seconds (6), it has been noted that detrusor contraction duration is rather uniformly distributed in the zones out of obstruction (linPURR 0-II); while only for increased levels of obstruction, extension of detrusor contraction is appearing. Analysis of 61 patients with DCD>90s, related to detrusor contraction strength, has shown that extension of detrusor contraction is appearing in 24 patients with weak detrusor (GDC 0/1), what presents 65% of the total GDC 0/1 group. 37 patients with normal or strong detrusor (GDC 2/3) have DCD>90s, what is 57% out of the total GDC 2/3 group. Patients are relatively uniformly distributed in the levels out of obstruction (LPURR 0-II) and in the level of obstruction LinPURR III (GDC 0/1 – 53.8% comparing with GDC 2/3 – 46.2%), being independent on detrusor contraction strength. Increase of obstruction level (LinPURR ?IV) influences that 21 patients (95.5%) with GDC 2/3 have DCD>90s, while only one has this results in GDC 0/1 group. It means that the extension of DCD directly depends on preserved detrusor strength only for higher obstruction levels (LinPURR IV-VI); this relation has been noticed with 21 patients (20.5%) from the analyzed BPE group (102 patients).

When the patients are dichotomized in the regions in and out of obstruction by combination of Schafer and URA nomograms (7) , it has shown that there is no difference in the DCD between the patients out of obstruction with weak detrusor and patients from the same group, but with normal or strong muscle (p>0.05). Also, if the patients are in obstruction, there is no significant difference of DCD relating to detrusor strength (p>0.05). There is no

Table 1: Patients allocated related to obstruction grade on Schafer nomogram

LPURR	LPURR 0/1 (n=24)		LPURR 2 (n= 28)		LPURR 3-6 (n= 50)		ANOVA
Parameter	Arit.Sr.	SD	Arit. Sr.	SD	Arit.Sr.	SD	P
PdetQmax(cm H2O)	36,37	+-9,27	49,65	+-6,96	94,47	+-38,04	<0.0001
PvesQmax(cm H2O)	74,67	+-20,89	81,72	+-22,76	126,33	+-39,3	<0.0001
Pdetmax (cm H2O)	58,92	+-19,04	70,27	+-20,64	120,69	+-46,38	<0.0001
MDA (cm H2O)	46,42	+-22	50,38	+-25,11	93,65	+-39,76	<0.0001
DCD (Sec.)	87,87	+-22,76	96,65	+-24,97	109,47	+-31,12	<0.01
GDC	1,62	+-0,71	1,48	+-0,63	2,08	+-0,7	<0.001

Table 2: Patients distributed related to obstruction levels, depending on strength (GDC) and detrusor contraction duration (DCD)

		GDC		DCD			
LPURR	Number of patients	0-1(n=37)	2-3 (n=65)	<90 (n=41)	³ 90 (n=61)	DCD ³ 90 (n=61)	
						GDC (n=24) (0,1)	GDC (n=37) (2,3)
0	6	2	4	3	3	2	1
I	18	8	10	10	8	4	4
II	28	17	11	13	15	10	5
III	20	8	12	7	13	7	6
IV	17	2	15	6	11	1	10
V	3	0	3	0	3	0	3
VI	10	0	10	2	8	0	8

statistically significant difference between the patients in obstruction and out of obstruction for the group GDC 0/1 ($p>0.05$). The only statistically significant difference ($p<0.005$) is a difference of DCD for the patients out and in obstruction with normal or strong muscle (Table 3.). These results have shown that DCD extends proportionally with the obstruction level, while it is less dependent on detrusor contraction strength. Now, the question is if a weak detrusor being in obstruction can effectively empty a bladder in spite of prolonged contraction duration. To examine this, a statistical analyze was performed. Student Test has shown that there is no difference in of residual urine volume between the patients with weak muscle and those with normal one ($p>0.05$). The difference in residual urine volume was compared with the same groups in obstruction and out of obstruction regions; no significant difference has been found ($t=1.38$, $t=-1.17$, $p>0.05$). No significant individual correlation between DCD and postvoid residual urine was noted ($r=-0.009$, $p>0.05$).

Considering aspects of lower urinary tract symptoms (I-PSS), there are few and conflicting reports about obtained correlation between IPS Score and DCD. Because of this fact, correlation of lower urinary tract symptoms (LUTS) with detrusor contraction duration was examined. Analysis of variance has shown no correlation ($p>0.05$) between DCD and increase of I-PSS, so for the group with I-PS Score 0-7 (mild symptoms), the average DCD is 88.8+-26.9s; for the group of patients with I-PSS 8-19 (moderate symptoms), DCD is 101.8+-27.1s; while for the group with I-PSS of 20-35 scores, DCD is 106.6+-32.6s. Individual correlation of DCD with I-PSS has resulted with low Pearson correlation coefficient ($r=0.16$, $p>0.05$). Also no significant correlations of DCD with prostate volume, post void residual urine, patients' age and cystometric capacity have been reached (results not showed at all), nor with volume of voided urine ($r=-0.001$, $p>0.05$).

Table 4. presents individual correlations of DCD with other urodynamic parameters. Pearson and Spearman correlation coefficient factor were used. There are statistically significant correlations with urodynamic nomograms (LinPURR, A/GNo, URA) with $p<0.005$ (Scattergram 1.). There are also correlations of DCD with PdetQmax and with maximal detrusor pressure ($p<0.01$). The best correlations of this parameter with non invasive urodinamic parameters are correlations with Qmax and Qaver ($p<0.01$), what theoretically responds to the fact that increase of obstruction leads to decrease of flow; this condition is followed by extension of detrusor contraction, independently on actual detrusor strength. Nevertheless, there is no correlation between DCD and I-PSS, a statistically significant correlation with its obstructive subgroup has been shown ($r=0.02$, $p<0.05$). However, practical meaning of this correlation in its absolute sense is not significant, specifically, if correlations are considered separately.

To increase the test sensibility, better to say, prediction of DCD extension, what would give better correlations with certain levels of obstruction, a multivariate regression analysis was used to define correlations between DCD and detrusor pressure at the maximal flow (PdetQmax),

Table 3. Detrusor contraction duration related to contraction strength and obstruction

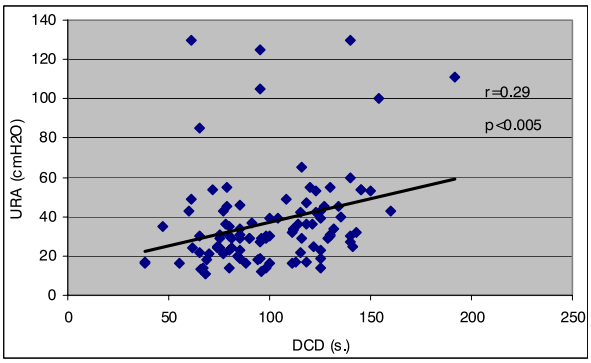
	Non obstructive group DCD (sec)	Obstructive group DCD (sec)	T-test
GDC (0/1)	95.85+-26.5	104.52+-21.14	t=-1.034, p>0.05
GDC (2/3)	85.3+-25.2	108.35+-32.8	t=-3.1596,<0.005
T-test	t=1.196, p>0.05	t=0.568, p>0.05	

Table 4: Correlation of DCD with urodinamic parameters
*p<0.05, **p<0.01, ***p<0.005

Correlation Coefficient	DCD (s)
I-PSS (Obst.).	r - 0.1993*
Tvoid.	r - 0.2684**
Qmax (ml/s)	r - 0.3092***
Qaver. (ml/s)	r - 0.3129***
Siroky nomogram	ρ-0.279**
PdetQmax (cmH2O)	r - 0.2362*
Pdetmax (cmH2O)	r - 0.2606**
LinPURR	ρ-0.3281***
AG No	r - 0.3239***
URA (cmH2O)	r - 0.2874***

detrusor contraction strength and cystometric capacity. The obtained value of correlation is R=0.341 ($p<0.001$). However, in practical sense this is considered as a modest correlation (extension of detrusor contraction is possible to estimate in 33 % cases).

Scattergram 1: Simple linear regression for DCD and URA



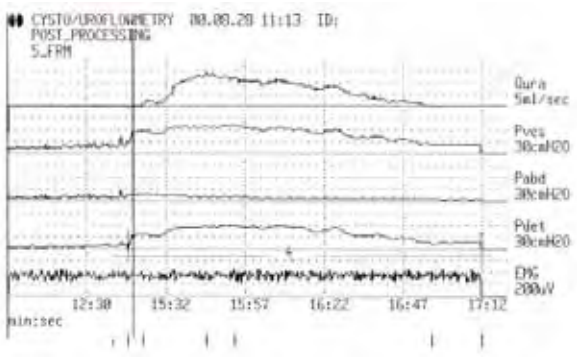
DISCUSSION

Recently, Kaplan has introduced a novel urodynamic parameter, called detrusor contraction duration, what presents the time elapsed since beginning of detrusor pressure increase during voluntarily voiding, until decrease of detrusor pressure to the value of premicturition pressure, independently on duration of the observed urinary flow (Figure 1.). The same author has found statistically significant correlation with I-PS Score considering 63 patients in obstruction [1]. However, by now, only few reports dealing with DCD have been published. Ameda [2] has not obtained a correlation between DCD and I-PS Score analyzing 58 patients. However, the same investigator has found statistically significant correlations of DCD with some urodynamic parameters (DCD with PdetQmax, r=0.2, $p<0.05$). A multiple regression was used to estimate extension of DCD with PdetQmax, cystometric capacity and contractility strenght (R=0.58). The same author has found difference of DCD between patients out of obstruction with preserved contractility and patients of the same group, but with impaired detrusor contractility; as well as with patients in obstruction with normal contractility. Turner [8] has published a good correlation between DCD and I-PSS analyzing patients, not medically treated yet, what shows that this parameter is important value for basic urodynamic examination of patients with BPE.

This study has not shown statistically significant correlation between DCD and I-PSS, although a correlation with its obstructive subgroup has been found. There is also a good correlation, in a practical sense, between DCD and nomograms, which determine urodynamic obstruction. Acceptable correlations between DCD and Pdetmax, as well as, with PdetQmax and with non invasive urodynamic parameters (Qmax, Qaver, Tvoid). Individual correlations with cystometric capacity and volume of the voided urine have not been shown.

The presented results show that increase of urodynamic obstruction is followed by extension of detrusor contraction duration. However, detrusor contraction strength is not a factor to determine this extension, as a patient with underactive detusor can be in obstruction with prolonged DCD. This study has shown that detrusor contraction strength influences obstruction grade and extension of DCD only for 20.5% of the examined sample. Even 67% patients of the total number patients with impaired detrusor contractility have DCD>90s. Extension of DCD depends on detrusor strength only in increased obstruction grades (linPUR IV-VI), what seems to be logical and in accordance with BOR [9] diagram. Opposite to Ameda's findings, there is no difference in DCD between non-obstructive subgroups with weak and strong detrusor; the same result has been achieved for obstructive subgroups.

Figure 1. Detrusor contraction duration (DCD); DCD = 109sec, flow time = 93 sec, Qura-flow, Pves –intravesical pressure, Pabd.-abdominal pressure, Pdet.- detrusor pressure, EMG – electromyography – not followed



As DCD depends on bladder strength, better to say on work necessary to prevail urethral resistance and effectively empty the bladder, very important finding is a lack of statistically significant difference of postvoid residual urine (PVR) between groups distributed relating to muscle contractility in obstructive and non obstructive groups. Generally, if the bladder outlet is obstructed, detrusor contractions can be normal at the beginning of voiding, but can also be aborted prematurely leaving larger part of total bladder capacity as residual urine. In patients with symptoms, but without obstruction, a complete empting of bladder can be achieved, even when maximal detrusor contractility is decreased, but with appropriate contraction duration [10]. Underactive detru-

sor in patients with LUTS does not seem to be a predictive condition for urinary retention [11], what is exactly resulted by this study.

These data bring us to a conclusion that patients from the selected sample extend detrusor contraction proportionally with obstruction increase and that the contraction is partially dependent on detrusor strength. The factor, which determinates extension of detrusor contraction duration, is the urethral resistance. As voiding is a mechanical balance between detrusor strength and realized flow (urethral resistance is prevailed), one function determines the other [12], so decrease of flow causes extension of time needed for complete bladder voiding (Tvoid), while the time, before the stream is initiated (time for opening of urethra- Pdetop), is a part of DCD, which will be extended depending on level and type of obstruction (mechanical or dynamical). Although good correlation of DCD with I-PSS has not been shown in this paper, further investigation of doxazosin effect to decreasing urethral resistance and symptoms reduction (data not published yet), has shown a great value of post treatment success in patients with BPE who had DCD>90s before the treatment. Drastic symptoms reduction and increase of quality of life have resulted by strong decrease of DCD with a moderate reduction of obstruction levels.

CONCLUSION

This study has not shown a correlation between DCD and I-PSS, although there is a correlation of this parameter with its obstructive subgroup. DCD is increasing during obstruction, although underactive detrusor can achieve the same extension, making possible an efficient empting of the bladder. Individual correlations of DCD with factors, which characterize obstruction, have a modest level, in an absolute sense.

REFERENCES

(1) Kaplan SA, Reis RB: Significant correlation of the American Urological Association symptom score and a novel urodynamic parameter: detrusor contraction duration. J Urol, 1996, 156:1668-72.

(2) Ameda K, Steele GS, Sullivan Maryrose, Stember D and Yalla SV: Detrusor contraction duration as a urodynamic parameter of bladder outlet obstruction for evaluating men with lower urinary tract symptoms, J Urol, 1998, 160:482-486.

(3) Barry MJ, Floyd J, Fowler JR, and the Measurement Committee of the American Urological Association: The American Urological Association symptom index for benign prostatic hyperplasia, J Urol, 1992, 148:1549-1557

(4) Abrams P, Cardozo Linda, Fall M, Griffiths D and al.:The standardization of terminology of lower urinary tract function: Report from the Standardization sub-committee of the International Continence Society, Neurourol/Urodyn., 2002, 21:167-178.

(5) Schafer W: Analysis of bladder-outlet function with the linear passive urethral resistence relation, linPURR, and a disease-specific approach for grading obstruction: from complex to simple, World J Urol 1995, 13: 47-52

(6) Kaplan SA, Stifelman M, Avillo C, Reia RB and Te AE: Detrusor contraction duration may predict response to alpha-blocker therapy for lower urinary tract symptoms, Eur Urology, 2000, 37 (3): 314-317.

(7) Aganovic D: Matching degree of urodynamic nomograms in defining of the different levels of obstruction in patients with benign prostatic enlargement (Part II-defining clear obstruction), MedArh 2003; 57(2):81-86

(8) Turner CD, Kunznetsov D, Contreras BA nad Gerber GS: Use of novel parameters, detrusor contraction duration and detrusor contraction index, in men with lower urinary tract symptoms, Tech Urol, 1998, 4(3):136-140

(9) van Mastrigt R: Estimation of maximum contraction velocity of the urinary bladder from the pressure and flow throughout micturition, Urol Res, 1990, 18:149-154

(10) Hald T, Brading AF, Elbadawi A and al: Pathophysiology of the urinary bladder in obstruction and ageing: The 4rd International Consulatation on Benign Prostatic Hyperplasia, Proceedings, Paris, July 2-5, 1997, Edited by S.C.I, (Ch 4), pp 131

(11) Mcinerney PD, Robinson LQ, Weston PMT and al: Assesment of the poorly contractile or aconctractile bladder in the older male in the absence of neuropathy, Brit J Urol, 1990, 65:161-163

(12) Schafer W: Urodynamics of micturition, Curr Opin Urol, 1992, 2:252-256