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Repeated, Rapid Fill CO_2-Cystometry

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Summary. 114 consecutive patients were subjected to double, rapid fill CO_2-cystometry. In 106 the two cystometries were of the same type, although several cystometric values changed statistically significantly. In eight patients the two cystometrograms were of a different type with uninhibited detrusor contraction in one but not in the other. A possible explanation for this is discussed.

Key words: CO_2-cystometry - Double investigation - Cystometric findings.

Since Rose in 1927 (9) described the clinical use of cystometry the method has gained widespread application.

However, the technique of performing cystometry varies considerably from place to place. Rapid fill CO_2-cystometry has gained increasing popularity during the last few years because of the simplicity of the method and the brief test interval. (3). Moreover, it has become common to repeat cystometry with the patient in different positions to evaluate the influence of posture and excercise on the micturition reflex (1, 2).

However, only meagre information exists on how repeated cystometry itself influences the cystometric findings (4, 5, 8, 10) and these investigations all used water as a filling medium and slow to medium filling rates or incremental filling.

We therefore undertook the present study to evaluate the influence of repeated, rapid fill CO_2-cystometry on the cystometric findings.

MATERIAL AND METHOD[1]

114 consecutive patients referred for cystometry entered the study (38 males and 76 females).

The patients were catheterised with a urethral catheter 16-18 F and the bladder was emptied. Cystometry was performed using carbon dioxide as a filling medium at a constant insufflation rate of 200 ml per minute and with the patient in the supine position. Intravesical pressure was recorded with a transducer and pressure amplifier calibrated in cm of water and connected to a strip chart recorder[2].

The patient was asked to indicate when the first sensation to void (FS) was experienced and the maximum cystometric capacity was registered as the volume at which the patient reported that the bladder filling was becoming uncomfortable. The patient was asked to inhibit the desire to void during the whole investigation. If the patient could not suppress the micturition reflex, and a detrusor contraction occurred with an intravesical pressure rise exceeding 15 cm H_2O, the cystometrogram was classified as showing detrusor hyperreflexia.

Bladder compliance was calculated as

$$\frac{\Delta \text{ volume}}{\Delta \text{ pressure}}$$

Immediately after the first cystometry the bladder was emptied and two minutes later the procedure was repeated.

STATISTICAL METHOD

As a statistical model we used that of structural relationship (7) which previously has been shown to fit well to the logarithms of the

[1] Methods, definitions and units conform to the standards proposed by the International Continence Society except where specifically noted.

[2] DISA Cystograph 21 G 45.

Table 1. Cystometric diagnoses in 114 double cystometries

	Same diagnoses at first and second cystometry	Different diagnoses at first and second cystometry First	Second
Normal	75	1	7
Detrusor hyperreflexia	25	7	1
Contracted bladder	2		
Decompensated bladder	2		
Infranuclear denervated bladder	1		
Sensory denervated bladder	1		
Total	106	8	

measurements found at cystometry (6). If repeated cystometry did not change a cystometric value, the value X found at first cystometry would be the same as the value Y found at second cystometry:

$$Y = X.$$

If repeated cystometry changed a value with a constant factor $\hat{a}$, the relation would be straight linear:

$$Y = \hat{a}X$$

and if the factor was not a constant the relation would be curvilinear

$$Y = \hat{a}X^{\hat{b}}.$$

We proposed that repeated cystometry did not change the values i.e. that $\hat{a} = 1$ and $\hat{b} = 1$.

To accept a calculated value of $\hat{a}$ or $\hat{b}$ to be significantly different from 1 we demanded a p value less than 0.05.

In this statistical model we used the logarithm of the values. The dispersion 's' consequently

Table 2. Relation $Y = \hat{a}X^{\hat{b}}$ between cystometric values at first and second cystometry in 75 patients with normal cystometries. X was the measurement at first cystometry, Y at second cystometry. All calculations were performed with the logarithms of the measurements to fit the statistical model. The relative dispersion is the antilogarithm to the dispersion on the logarithms of the measurements, and therefore the result cannot be expressed as mean $\pm$ SD but as $\frac{\text{mean}}{s}$ - mean x s

$\hat{a} = 1$ and $\hat{b} = 1$ was rejected if the estimates of $\hat{a}$ and $\hat{b}$ differed statistically significant from 1 with $p < 0.05$. For further explanation see text

	Volume at first desire to void (FS)		Cystometric capacity		Compliance	
	1. cystometry X	2. cystometry Y	1. X	2. Y	1. X	2. Y
Mean	144 ml	136 ml	264 ml	244 ml	50	40
Relative dispersion s	1,63	1,72	1,46	1,59	2,11	2,01
$\frac{\text{mean}}{s}$ - mean x s	88-234 ml	79-234 ml	180-385 ml	153-388 ml	24-105	20-80
Correlation coefficient r	0,69		0,84		0,60	
Correlation significant at level	p < 0,001		p < 0,001		p < 0,001	
$\hat{b} = 1$	Not rejected		Rejected		Not rejected	
Estimate $\hat{b}$			1,26			
$\hat{a} = 1$	Not rejected				Rejected	
Estimate $\hat{a}$			0,22		0,80	
Estimated relation Y =	X		$0,22\ X^{1,26}$		0,80 X	

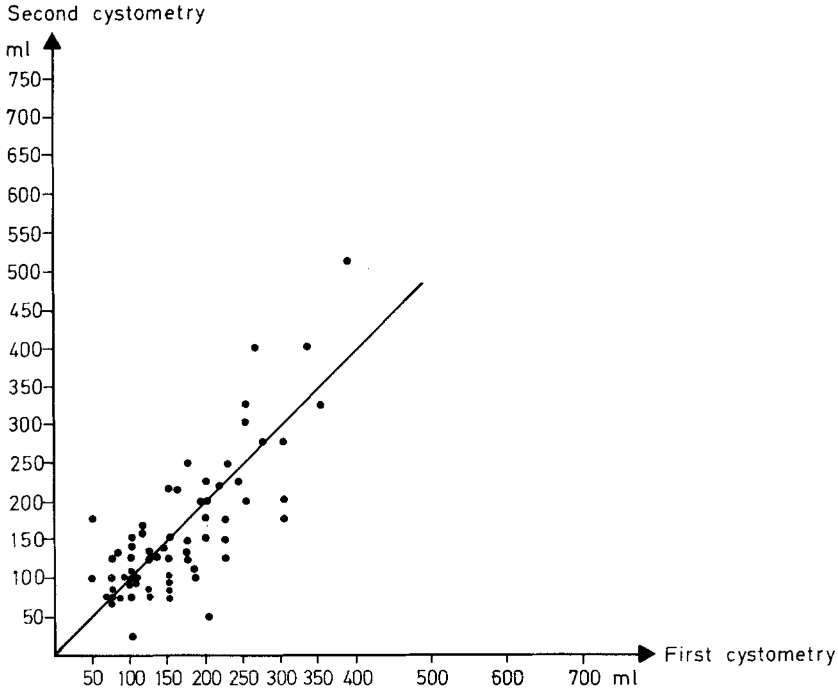

Fig. 1. Correlation between volumes at first desire to void in 75 normal double cystometries

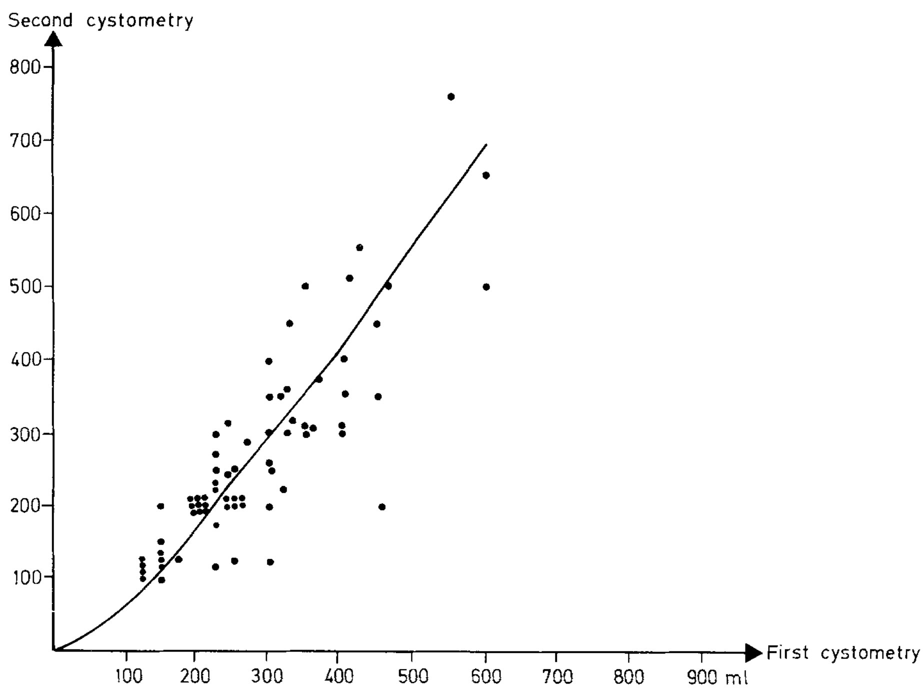

Fig. 2. Correlation between cystometric capacities in 75 normal double cystometries

described that 68 % of the observations lies between $\frac{\text{mean}}{\text{s}}$ and mean x s.

RESULTS

The diagnoses based on the cystometries are shown in Table 1.

In 75 patients both the first and the second cystometry were normal.

In Table 2 the recorded values of FS, cystometric capacity and compliance are given. No significant change in volume at first desire to void was found (Fig. 1). The cystometric capacity changed in such a way that capacities less than 350 ml at first cystometry tended to decrease while capacities higher than 350 ml tended to increase (Fig. 2). Bladder wall compliance decreased at the second cystometry to 80 % of the value found at first cystometry (Fig. 3).

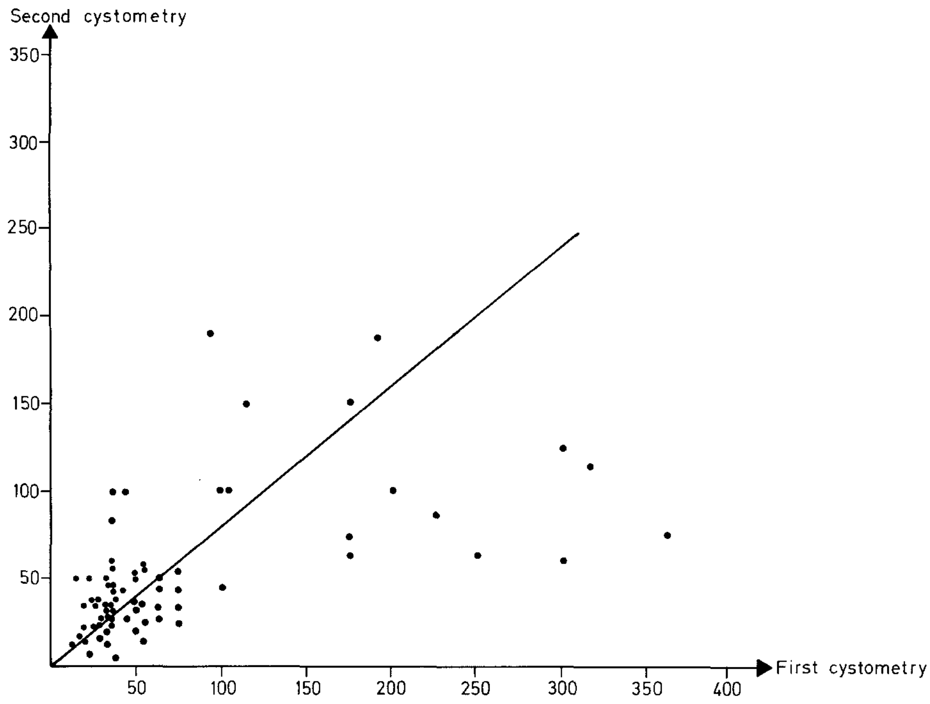

Fig. 3. Correlation between compliances in 75 normal double cystometries. Compliance = $\frac{\Delta \text{volume}}{\Delta \text{pressure}}$

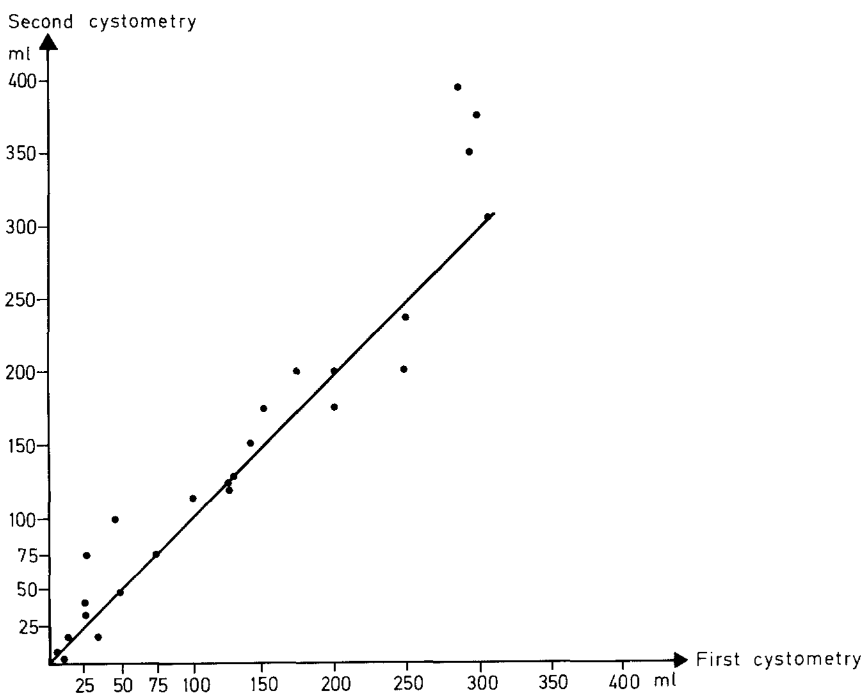

Fig. 4. Correlation between volumes at occurrence of uninhibited detrusor contractions in 25 double cystometries showing detrusor hyperreflexia

In 25 patients with detrusor hyperreflexia we did not find any significant difference in the volume at occurrence of uninhibited detrusor contractions (Table 3, Fig. 4).

Furhtermore, we found excellent accordance between highest intravesical pressure recorded during detrusor contraction at first and second cystometry (Table 3). Because the cystometer cannot register pressures exceeding 100 cm H_2O these values were not suitable for further statistical analysis.

In two patients we found a decompensated bladder and in two a contracted bladder. One had a complete infranuclear bladder paresis and one a sensory bladder paresis.

In eight patients the first and second cystometrogram gave different diagnostic information (Table 1). In one the first cystometrogram showed uninhibited detrusor contraction at a volume of 275 ml, while the second was normal with a capacity of 400 ml.

In seven patients the first cystometry was

Table 3. Relation between cystometric values at first and second cystometry in 25 patients with detrusor hyperreflexia. For further explanation see caption to table 2 and statistical method

	Uninhibited detrusor contraction at volume		Highest intravesical pressure during contraction	
	1. cystometry X	2. cystometry Y	1. cystometry	2. cystometry
Mean	61 ml	63 ml	83 cm H_2O	78 cm H_2O
Relative dispersion s	4,83	5,74		
$\frac{\text{mean}}{s}$ - mean x s	13-294 ml	11-362 ml		
Correlation coefficient r	0,94		0,94	
Correlation significant at level	$p < 0{,}001$		$p < 0{,}001$	
$\hat{b} = 1$	Not rejected			
$\hat{a} = 1$	Not rejected			
Estimated relation Y =	X			

normal, while the second cystometry showed uninhibited detrusor contraction.

DISCUSSION

Normal Cystometrograms

We did not find any significant change in FS but a considerable individual variation in the same person, which is in accordance with the findings of Poulsen (8), while Gjertsen (4) found FS to be a little higher at the second cystometry.

The capacity is changed from the first to the second measurement so that small capacities decrease and high capacities increase. Rose (10) describes a decrease in capacity in the second cystometry, while Poulsen (8) and Gjertsen (4) both found a small increase in capacity. However, no statistical analysis was undertaken in these papers. As it can be seen in Figure 2 the difference from first to second cystometry is small, which is in accordance with the previously mentioned investigations.

As seen in Figure 3 there is a considerable variation in compliance in the single individual. A significant decrease of 20% from the first to the second cystometry was the predominant finding. This is in accordance with the findings of Gjertsen (4).

Detrusor Hyperreflexia

Here we found no difference, neither in volume at beginning of first detrusor contraction, nor in highest intravesical pressure during detrusor contraction.

This is in accordance with the findings of Grynderup (5) who found no difference in 20 double cystometries, if the first cystometry was interrupted at the time of the first detrusor contraction.

The diagnosis of a contracted bladder and a decompensated bladder were based on cystometric parameters as well as clinical findings. We did not find compliance especially valuable in differentiating from normal cystometries, because of a considerable overlap.

Different Types of Cystometrograms at Repeated Investigation

Eight patients showed detrusor hyperreflexia in one cystometry, but were found to be normal in the other.

In seven of the eight patients the first cystometrogram was normal and the second showed detrusor hyperreflexia. It is possible that the main reason is that CO_2-cystometry takes only 1-2 minutes to perform and in this short time the patient is able to suppress the micturition reflex by contracting the pelvic floor. When performing the second cystometry this inhibitory mechanism is fatigued and the lesion in the central inhibitory system is disclosed.

In an attempt to verify this we continued the intravesical pressure recording after discontinuing the gas flow in five patients with severe urge. Four patients could not maintain the suppression of the micturition reflex and an uninhibited detrusor contraction occured from 14 to 45 s after discontinuing the gas flow.

In this report we nevertheless classify these cystometrograms as normal, because they would have been regarded so with conventional technique. On the other hand, these patients probably have a lesion in the central inhibitory system of the bladder and to diagnose this in the routine investigation it is therefore necessary either to repeat the cystometry or continue the pressure recording for 1-2 min after switching off the inflow in patients with severe urge at the end of an otherwise normal cystometrogram.

Another way to catch these cases of detrusor hyperreflexia is to ask the patient to void at the end of the cystometry. If he is unable to suppress the elicited detrusor contraction on command, a lesion in the inhibition of micturition reflex may be suspected.

In conclusion we find the diagnostic accuracy of repeated cystometry very good. The reproducibility of cystometric values is fairly good, and although the changes seen from the first to the second cystometry are statistically significant they are of little practical importance.

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