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FLOW TIME AND VOIDING TIME – DEFINITIONS AND USE IN IDENTIFYING DETRUSOR UNDERACTIVITY

<u>Hypothesis / aims of study</u>

Flow time and voiding time are currently defined by the ICS respectively as "the time over which measurable flow actually occurs" and the "total duration of micturition" [1]. The threshold, above which flow is considered "measurable" and the definition of the end of micturition, presumably at the end of measurable flow, are not clear. The ICS definition of detrusor underactivity (DU) includes a reference to "normal timespan" [1] and this is acknowledged to be imprecise [2]. This paper aims to clarify these descriptions and to identify differences in these time variables between patient groups.

<u>Study design, materials and methods</u>

We have been analysing our database of 28,282 urodynamic tests in order to determine what signs and symptoms indicate DU [3]. In the process, we have analysed flow and voiding time in a smaller group, in order to test for differences between diagnostic groups (290 males: 80 with DU, 115 with bladder outlet obstruction (BOO), 45 with both DU and BOO, and 50 with normal pressure flow studies (PFS); and 192 females: 75 with DU, 63 with BOO, and 53 with normal PFS). As there was only one female with both DU and BOO, this was not analysed.

For males, DU was defined as bladder contractility index (BCI) < 100, bladder voiding efficiency (BVE) < 90%, and bladder outlet obstruction index (BOOI) < 20. DU+BOO was defined as BCI < 100, BVE < 90%, and BOOI >= 40. BOO was defined as BCI >= 100, BVE >= 90%, and BOOI >= 40. Normal PFS was defined as BCI >= 100, BOOI < 20, BVE = 100%, and no present medication use related to bladder or urethra.

For females, DU was defined as pdetQmax < 20, Qmax < 15, and BVE < 90%, excluding those with clinically observed obstruction. DU+BOO was defined as pdetQmax < 20, Qmax < 15, BVE < 90%, and with clinically observed obstruction. BOO was defined as pdetQmax >= 40, Qmax < 12, and BVE >= 90%. Normal PFS was defined as pdetQmax >= 20, Qmax >=20, BVE = 100%, and no present medication use related to bladder or urethra, excluding those with clinically observed obstruction.

Data were analysed using a rank ANCOVA model with age as covariate, considering significance as a p-value <0.05 compared to the DU group. The results are thus corrected for age, and patients with or without detrusor overactivity were not differentiated.

<u>Results</u>

For males (see Table 1 for quartile ranges), median flow time, voiding time, average flow measured over flow time, average flow measured over voiding time and the ratio of flow to voiding time for those with normal PFS was 42.0 sec, 46.5 sec, 10.5 ml/sec, 9.2 ml/sec and 0.9 respectively. The results indicate that, adjusting for age, flow time and voiding time were significantly increased and average flow was significantly decreased for males with DU compared to those with normal PFS; (DU males: flow time: 52.2 sec; voiding time: 70.8 sec; average flow measured over flow time: 4.4 ml/sec; average flow measured over voiding time: 3.4 ml/sec). Notably, the average flow, whether over flow time or voiding time, in males with DU was significantly decreased compared to those with BOO (BOO males: average flow measured over flow time: 4.9 sec; average flow measured over voiding time: 4.3 sec).

For females (see Table 1 for quartile ranges), median flow time, voiding time, average flow measured over flow time, average flow measured over voiding time and the ratio of flow to voiding time for those with normal PFS was 39.0 sec, 44.8 sec, 11.8 ml/sec, 10.5 ml/sec and 0.9 respectively. The results indicate that, adjusting for age, flow time and voiding time were significantly increased and average flow was significantly decreased for females with DU compared to those with normal PFS (DU females: flow time: 49.8 sec; voiding time: 69.2 sec, average flow measured over flow time: 4.0 ml/sec; average flow over voiding time: 2.9 ml/sec). The average flow measured over voiding time in females with DU was significantly increased compared to those with BOO (BOO females: average flow measured over voiding time: 4.0 ml/sec).

	Male median (Q1 - Q3)				Female median (Q1 - Q3)		
Variable	DU (N=80)	DU+BOO (N=45)	BOO (N=115)	Normal PFS (N=50)	DU (N=75)	BOO (N=63)	Normal PFS (N=53)
Flow time (sec)	52.2 (36.6 - 74.0)	49.0 (34.0 - 78.2)	59.1 (38.3 - 74.5)	42.0 * (31.0 - 58.0)	49.8 (33.0 - 69.0)	51.0 (37.0 - 75.0)	39.0 * (29.6 - 46.0)
Voiding time (sec)	70.8 (47.8 - 105.0)	63.0 (39.0 - 121.0)	68.7 (42.1 - 84.1)	46.5 ** (34.0 - 67.0)	† 69.2 (42.7 - 124.5)	63.0 (42.0 - 93.0)	44.8 ** (33.6 - 53.8)
Average flow measured over flow time (mL/sec)	4.4 (3.0 - 6.2)	3.1 ** (2.5 - 3.8)	4.9 (3.9 - 6.1)	10.5 *** (8.4 - 13.6)	4.0 (2.8 - 5.2)	4.8 * (3.9 - 5.7)	11.8 *** (10.1 - 14.9)
Average flow measured over voiding time (mL/sec)	3.4 (2.1 - 5.6)	2.5 * (1.5 - 3.3)	4.3 * (3.1 - 5.4)	9.2 *** (6.9 - 11.9)	† 2.9 (1.8 - 4.3)	4.0 * (3.0 - 5.4)	10.5 *** (8.1 - 12.3)
Ratio of flow time to voiding time	0.8 (0.6 - 1.0)	0.8 (0.6 - 0.9)	0.9 (0.8 - 0.9)	0.9 * (0.8 - 1.0)	0.8 (0.6 - 0.9)	0.9 (0.8 - 1.0)	0.9 ** (0.8 - 0.9)

Table 1. Summary of flow and voiding time data. Stars indicate statistically significant differences from the DU group at: *: $p<0.05$; **: $p<0.01$, ***: $p<0.0001$. † N=78 for these data.

Interpretation of results

For both males and females, the average flow rate measured over voiding time is significantly decreased in DU patients with respect to patients with BOO, and those with normal PFS, and is increased with respect to males having both DU and BOO. Averaging the flow rate essentially compensates for the volume voided, since a patient with a large voided volume will probably take a long time to void, but their average flow rate will be greater than a slow, long void in a DU patient, even if voiding times are the same for both patients. In addition, averaging over the voiding time allows inclusion of intermittency in the comparison, since periods of no flow are measured within voiding time. It should be noted that the ratio of flow time to voiding time is also a measure of intermittency, implying that analysis of flow curve shape will be of value.

It is suggested from these results that a normal voiding time can be considered to be less than 60 sec.

While gathering the data, it became apparent that the definitions of flow time and voiding time will need refinement, since machine measurement of voiding time often needed manual adjustment. Most urodynamic machines use 0.5 ml/s as the threshold for marking flow, in order to eliminate urine drops and signal noise, while the current definition implies 0 ml/s as the threshold. Consensus is required on whether voiding time should include all micturition including leaks from post-void coughs, as these were a source of many of the extended voiding time measurements, and the coughs were part of the urodynamic test protocol, rather than normal practice for the patient.

Concluding message

The definitions of flow time and voiding time will need clarification, in terms of the threshold used for minimum flow and whether post-void coughs should be ignored, and proposals for definitions have been made. Our data suggest that flow time and voiding time may be used to distinguish between patients with DU and those with normal PFS. Further, average flow measured over voiding time may be used to distinguish between patients with DU and patients with BOO.

There appears to be some diagnostic power in measuring flow and voiding times. These variables should be incorporated into multivariate analysis to increase the sensitivity and specificity of non-invasive urodynamic tests, and the different characteristics of flow pattern investigated further, in order to develop adequate non-invasive testing for DU.

References

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