Validation and comparison of the use of diuresis cystometry and retrograde filling cystometry at various infusion rates in female Beagle dogs

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Objectives—To compare retrograde filling cystometry at infusion rates of 5, 10, and 20 mL/min with diuresis cystometry for determination of an appropriate infusion rate and to confirm the reproducibility of measurements obtained by urethral pressure profilometry (UPP) and cystometry in female Beagles.

Animals—6 adult female Beagles.

Procedure—Successive UPP and cystometry were performed by use of a water perfusion catheter on dogs anesthetized with propofol. Dogs randomly underwent each of the following at 1-week intervals: retrograde filling cystometry at 5, 10, and 20 mL/min, and diuresis cystometry. The maximum urethral pressure and closure pressure, functional and anatomic profile lengths, threshold pressure, threshold volume, and compliance were measured.

Results—For each UPP variable, significant differences were found among dogs, but no significant differences were found in intra- or interstudy measurements for individual dogs. For retrograde filling cystometry, threshold pressure was not significantly different between a 5 and 10 mL/min infusion rate. Threshold pressure was significantly higher during retrograde filling cystometry at 20 mL/min, compared with 5 and 10 mL/min, and was associated with bladder wall damages. Threshold pressure was significantly lower during diuresis cystometry, compared with retrograde filling cystometries. Threshold volume and compliance were not significantly different among retrograde filling cystometries but were significantly higher during diuresis cystometry.

Conclusions and Clinical Relevance—Retrograde filling cystometry at 20 mL/min leads to unacceptable sudden increase in threshold bladder pressure. Retrograde filling cystometry at 10 mL/min can be recommended in a clinical setting, shortening the anesthesia time. However, diuresis cystometry approximates physiologic bladder filling most accurately. (*Am J Vet Res* 2003;64:574–579)

With the development of new medical and surgical treatments in urologic veterinary medicine, it is important to recognize the cause of urinary incontinence and to address it with the appropriate treatment. Among the various diagnostic tools available to examine the lower urinary tract, urodynamic investigation (including **urethral pressure profilometry [UPP]** and cystometry) helps to specifically identify functional causes of urinary incontinence and has been developed for use in veterinary medicine.

Functional evaluation of the lower urinary tract requires standardized methods. Reproducibility of urethral pressure profiles is highly dependent on several factors, such as animal position,[1] orientation of the transducer within the urethra,[1-3] type of catheter,[4,5] type of sedatives used,[6-8] and catheter withdrawal rate.[9] Using a microtip transducer, previous studies on the reproducibility of consecutive UPP measurements have shown conflicting results; some authors recorded a decrease in maximum urethral closure pressure throughout successive urethral pressure profiles,[10] whereas others reported the first measurement to be lower than the consecutive ones.[4,7] Arnold et al[4] recommend recording 3 urethral pressure profiles and using the mean value as representative of the basal condition. In contrast, in an early study in which a single-lumen perfusion method was used, little variability in consecutive UPP measurements were found from the same animal,[8] and Nickel et al[11] recently had good reproducibility in consecutive and repeated profiles using a saline (0.9% NaCl) solution perfusion technique and multi-lumen catheter.

Evaluation of bladder storage function by use of cystometry should be part of the investigational workup for urinary incontinence in dogs. Indeed, abnormalities of bladder storage function, such as detrusor instability, are possible causes of urinary incontinence in dogs.[12] Standardization and reproducibility of measurements obtained by use of this technique are also essential and could be affected by several variables. Poor reproducibility of successive cystometric measurements in the same patient is reported in the human literature[13] and has been sparsely analyzed in veterinary medicine.[14,15] The rate of bladder filling during cystometry is an important variable to define, as some cystometric features, such as compliance, can be altered by the rate of bladder filling.[16] In human medicine, a medium filling rate (10 to 100 mL/min, often between 60 and 100 mL/min) is commonly used.[16,17-19] In veterinary medicine, various protocols have been used, most often applying human rates to dogs or cats. Although filling rates up to 100 mL/min have been recommended for large breed dogs,[20] to our knowledge, there has been no experimental study comparing various infusion rate regimens

Received July 19, 2002.
Accepted December 19, 2002.
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in the veterinary literature from which to adequately recommend an ideal infusion rate. Therefore, a large variability is observed in clinical studies, with filling rates varying from 20 to 50 mL/min.[7,12,21]

As an alternative to retrograde filling cystometry, Nickel et al[11,22] recently described the use of simultaneous diuresis cystourethrometry in continent and incontinent female dogs to evaluate urethral and bladder functions. Because the filling rate is much slower than in the conventional retrograde filling cystometry, diuresis cystourethrometry is described[13] in humans as a more physiologic approach in bladder function investigation. Nickel et al[11,22] confirmed that this technique allows better detection of unstable detrusor contractions in dogs with and without clinical signs of bladder dysfunction. Moreover, the simultaneous measurement of urethral pressure during the bladder storage phase allows detection of sudden changes in urethral pressures that are characteristic of an unstable urethra.[17]

The purposes of the study reported here were to evaluate the reproducibility of successive simultaneous UPP and cystometric measurements at a given infusion rate and compare retrograde filling cystometry infusion rates of 5, 10, and 20 mL/min with diuresis cystometry in order to determine the most appropriate and physiologic infusion rate for cystometry in female Beagles. Beagles were used in our study to reduce possible interindividual variability previously observed in studies conducted on mixed populations of dogs, which were characterized by a wide range of size, weight, and age, possibly explaining the observed variations in UPP and cystometric measurements.

Materials and Methods

Dogs—Six middle-aged (mean ± SD, 5 ± 0.5 years old) sexually intact female Beagles were used in this study. All dogs were born and housed at the animal facilities of the Department of Clinical Sciences of the College of Veterinary Medicine, University of Liège. Animal housing, care, and experimentation were in accordance with Belgian governmental regulations and the National Institute of Health Guide for Care and Use of Laboratory Animals.[23] Complete physical examinations were performed each week. Dogs were housed in groups of 2 to 5 in indoor/outdoor runs (2.5 × 10 m), exposed to natural light, fed a commercial dry food once a day in amounts sufficient to maintain body weight, and provided with water ad libitum. Their body weight ranged from 12.5 to 20 kg (mean ± SD, 15.1 ± 2.5 kg). As determined by vaginal cytologic examination,[24] all dogs were in anestrus during the study. Prior to each experiment, a physical examination, which included measurements of heart rate, respiratory rate, and rectal temperature, was performed, and a urine sample was obtained via catheterization for urinalysis and cytologic examination. Urinalysis included determination of specific gravity and pH and detection of blood, proteins, bilirubin, and glucose when present. Dogs included in the study had no signs of lower urinary tract disease, and no abnormalities were detected on urinalysis. However, urine samples were not submitted for bacteriologic culture, preventing total exclusion of the presence of a urinary tract infection.

Study design—Each dog was anesthetized on 6 occasions, at an interval of 7 to 10 days, and on each occasion, was randomly[25] allocated to undergo 1 urodynamic test. Each urodynamic test consisted of 3 successive simultaneous UPP measurements, followed by either retrograde filling cystometry at 5, 10, or 20 mL/min or diuresis cystometry. The retrograde filling cystometry at 5 mL/min was repeated 3 times to study the consistency and repeatability of the measurements.

For each test, food was withheld for 12 hours, and dogs were allowed to urinate prior to each urodynamic measurement. Anesthesia was induced with an IV bolus of propofol[a] (6 to 8 mg/kg) and maintained with a continuous IV infusion of propofol at a dosage sufficient to maintain a stable plane of anesthesia[26] (range, 0.82 to 1.38 mg/kg/min). All dogs were intubated and monitored with a pulse oxymeter.[b] They received oxygen supplementation if oxygen saturation was < 85%. When dogs were under a stable plane of anesthesia, they were placed in right lateral recumbency.[1] A sterile 10-F polyvinylchloride triple lumen perfusion catheter[c] with 2 side-holes opposing the other (1 at 0.5 cm from the tip and the other at 7 cm from the tip) was inserted via the urethra into the bladder. The side-hole located in the urethra was oriented dorsally, as recommended by Holt.[1] Prior to insertion, the catheter was connected to water pressure transducers[d] that were positioned at the level of the vulva, the system was flushed, and the pressure channels were zeroed to atmospheric pressure.

Three successive simultaneous UPP measurements were then recorded by use of a computer-based urodynamic system.[e] Fluids were infused through the perfusion catheter, which was mounted and clamped on a mechanical puller arm that withdrew the catheter at a rate of 1 mm/s.[9]

Immediately following UPP recordings, the bladder was emptied, and the 10-F polyvinylchloride triple lumen perfusion catheter was inserted via the urethra into the bladder and positioned so that the urethral side-hole was placed at the level of maximal urethral pressure, as had been the placement for the previous UPP recordings. This allowed constant simultaneous urethral pressure and bladder pressure recordings. The cystometry was then performed.

For retrograde filling cystometry, saline (0.9% NaCl) solution[f] was infused into the bladder via the triple lumen catheter at a rate of 5, 10, or 20 mL/min. Bladder and urethral pressures were recorded until micturition was detected. At that moment, the infusion was stopped, the amount of fluid infused was recorded to measure the threshold volume, and anesthesia was discontinued.

For diuresis cystometry, the technique described by Nickel et al[11] was used. A cephalic IV catheter was placed, and furosemide[g] (5 mg/kg, IV) was administered just prior to starting the IV administration of a balanced isotonic replacement fluid (Hartmann solution[h]) at a rate of 20 mL/kg/h. Bladder and urethral pressures were recorded until micturition was detected. At that moment, the IV fluid administration was stopped, fluid was aspirated from the bladder to measure the threshold volume, and anesthesia was discontinued. The measurement of the threshold volume did not include the minimal volume of urine lost by the dog at the initiation of micturition, which was determined to be < 10 mL in a preliminary study (data not shown), or the potential residual urine left in the bladder after collection. This technique, although less precise than the radionucleotide dilution analysis of urine described by Nickel et al,[11] is more practical and does not require the use of radioactive isotopes. After each procedure, urinalysis was performed to detect the presence of blood, and the dog was monitored the following days for any signs of bladder dysfunction.

Data interpretation—The following variables were measured from the UPP measurements: **maximum urethral pressure (MUP)**, **maximum urethral closure pressure** ([**MUCP**], the difference between MUP and bladder pressure), **functional profile length** ([**FPL**], length of the urethra along which the intra-urethral pressure exceeds the bladder pressure), and **anatomic profile length** ([**APL**], the distance

between the point in the urethra where intraurethral pressure exceeds the total bladder pressure and the point where the intraurethral pressure decreases to atmospheric pressure). Definitions are in accordance with those of the International Continence Society.[27]

The following variables were measured from the cystometric measurements: threshold pressure (**bladder pressure** at the time of micturition), threshold volume (volume of saline [0.9% NaCl] solution infused when micturition reflex was detected or equal to the fluid volume retrieved from the bladder at the time of micturition reflex in the case of diuresis cystometry), and compliance. This is calculated by

(threshold volume - Vo)/(threshold pressure – Po)

where Vo and **Po** are the bladder volume and bladder pressure at the start of the cystometry. Definitions are in accordance with those of the International Continence Society.[27]

Statistical analysis—Inter- and intrastudy differences for mean UPP and cystometric measurements of a given dog, interindividual differences among dogs for UPP and cystometric measurements, and the treatment effect on the various variables described were determined by use of an ANOVA II and Fisher least-square difference posthoc analysis using a software program.[i] A value of $P < 0.05$ was considered significant.[25]

Results

No complications were observed during general anesthesia, administered using a continuous IV infusion of propofol. All dogs made an unremarkable recovery from anesthesia and regained consciousness within 10 minutes after discontinuation of the infusion.

Reproducibility of UPP measurements—No significant differences in MUP, MUCP, FPL, and APL intra- or interstudy measurements were observed for individual dogs (data not shown). Significant differences in mean MUP, MUCP, FPL, and APL values **(Table 1)** were found among dogs.

Reproducibility of cystometric measurements—During the repeated retrograde filling cystometry at an infusion rate of 5 mL/min, no significant differences in interstudy values were found for individual dogs (data not shown). Significant differences in threshold pressure ($P = 0.01$), threshold volume ($P < 0.001$), and compliance ($P < 0.001$) values were found among dogs for all cytometric regimens **(Figs 1 and 2, Table 2)**.

Comparison of the cystometric regimens—Significant differences in threshold pressures were not found between retrograde filling cystometry at infusion rates of 5 and 10 mL/min. Significant differences in threshold pressures were found between retrograde filling cystometry at infusion rates of 5 and 20 mL/min ($P = 0.02$) and between infusion rates of 10 and 20 mL/min ($P = 0.03$). Significant differences in threshold

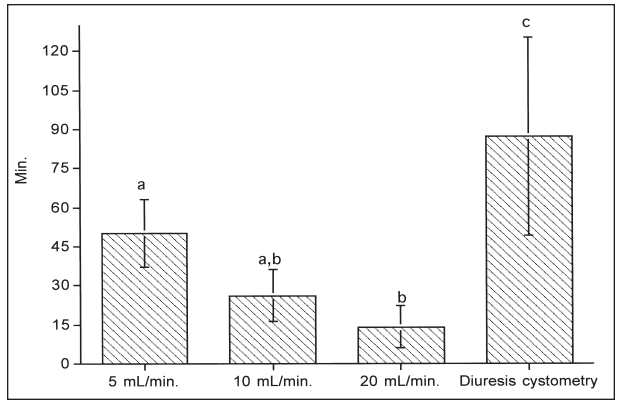

Figure 1—Mean (± SD) duration (in minutes) of the 4 cystometries in 6 female Beagles. Values for the retrograde filling cystometry at an infusion rate of 5 mL/min are based on mean values of 3 repeated measurements in a same dog. [a,b]Bar graphs with different letters represent values that are significantly ($P < 0.05$) different. Min = Minutes from the beginning of the infusion or IV fluid administration until the micturition reflex.

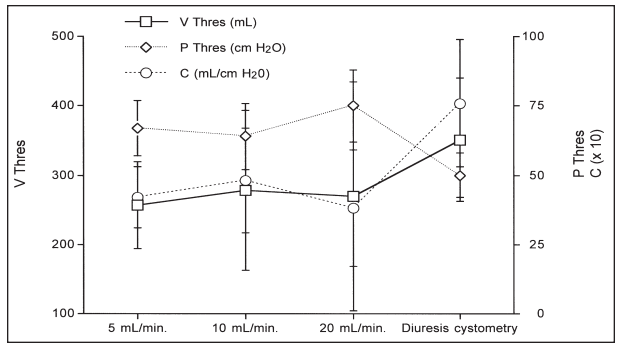

Figure 2—Mean (± SD) values of threshold pressure (P Thres), threshold volume (V Thres), and compliance (C) for the retrograde filling cystometry (at 3 infusion rates) and diuresis cystometry. P thres = bladder pressure at the time of micturition. V Thres = Volume of saline (0.9% NaCl) solution infused when micturition reflex was detected or equal to the fluid volume retrieved from the bladder at the time of micturition reflex in the case of diuresis cystometry. C = (V Thres - Vo)/(P Thres – Po), where Vo and Po are the bladder volume and bladder pressure at the start of the cystometry, respectively. The compliance values are 10-fold the originals.

Table 1—Mean (± SD) values of urethral pressure profilometric variables for 6 female Beagles*

	Dogs					
Variables	**1**	**2**	**3**	**4**	**5**	**6**
MUP (cm H_2O)	42 ± 14^{a}	63 ± 7^{b}	25 ± 7^{c}	19 ± 3^{c}	65 ± 14^{b}	42 ± 9^{a}
MUCP (cm H_2O)	$37 \pm 14^{a,b,c,d}$	$55 \pm 6^{a,e}$	$21 \pm 8^{b,f,g}$	12 ± 4^{f}	$49 \pm 2^{c,e}$	$37 \pm 9^{d,g}$
FPL (mm)	$47 \pm 5^{a,b,c}$	$57 \pm 4^{d,e,f}$	$54 \pm 4^{a,d,g,h}$	$55 \pm 4^{b,e,g,i}$	77 ± 10^{j}	$43 \pm 13^{c,f,h,i}$
APL (mm)	$67 \pm 7^{a,b}$	$73 \pm 3^{a,c,d}$	$88 \pm 6^{e,f}$	$81 \pm 6^{c,e,g}$	$96 \pm 10^{f,g}$	$63 \pm 11^{b,d}$

*Mean values based on 18 urethral pressure profiles obtained from each dog.
[a-i]Within each row, mean values with different superscripts letters are significantly ($P < 0.05$) different.
MUP = Maximum urethral pressure. MUCP = Maximum urethral closure pressure (the difference between MUP and bladder pressure). FPL = Functional profile length (length of the urethra along which the intraurethral pressure exceeds the bladder pressure). APL = Anatomic profile length (the distance between the point in the urethra where intraurethral pressure exceeds the total bladder pressure and the point where the intraurethral pressure decreases to atmospheric pressure).

Table 2—Mean (± SD) and median values of cystometric measurements obtained from 6 female Beagles

	Retrograde filling cystometry			Diuresis cystometry
	5 mL/min*	10 mL/min	20 mL/min	
Variables	**Mean (median)**	**Mean (median)**	**Mean (median)**	**Mean (median)**
Threshold pressure (cm H_2O)	67 ± 10 (67)	64 ± 12 (66)	75 ± 13 (74)	50 ± 8 (52)
Threshold volume (mL)	256 ± 63 (266)	278 ± 116 (239)	269 ± 166 (255)	351 ± 89 (336)
Compliance (mL/cm H_2O)	4.2 ± 1.1 (3.9)	4.8 ± 1.9 (4.3)	3.8 ± 2.1 (3.2)	7.6 ± 2.3 (7.1)

*Values based on the means of 3 repeated retrograde filling cystometries (5 mL/min) in the same dog.

pressures were found between retrograde filling cystometry at an infusion rate of 5 mL/min and diuresis cystometry ($P = 0.002$) and between an infusion rate of 10 mL/min and diuresis cystometry ($P = 0.004$). Threshold pressures were significantly higher during retrograde filling cystometry at an infusion rate of 20 mL/min and significantly lower during diuresis cystometry, compared with threshold pressures during retrograde filling cystometry at an infusion rate of 5 or 10 mL/min (Fig 2).

Significant differences in threshold volumes were not found between retrograde filling cystometry at an infusion rate of 5, 10, and 20 mL/min. Threshold volumes were significantly higher during diuresis cystometry, compared with threshold volumes during retrograde filling cystometry at infusion rates of 5, 10, and 20 mL/min ($P < 0.001$, 0.001, and 0.001, respectively; Fig 2).

Significant differences in compliance values were not found between retrograde filling cystometry at infusion rates of 5, 10, and 20 mL/min. Compliance values were significantly higher during diuresis cystometry, compared with threshold volumes during retrograde filling cystometry at infusion rates of 5, 10, and 20 mL/min ($P = 0.001$, $P < 0.001$, and $P < 0.001$, respectively; Fig 2). After retrograde filling cystometry at an infusion rate of 20 mL/min, blood was macroscopically observed in urine samples of 3 of 6 dogs at the time of micturition.

Discussion

One purpose of our study was to define a reliable protocol to perform reproducible urodynamic measurements (by use of UPP and cystometry) in female Beagles. The choice of a simple 10-F water perfusion catheter with 2 side-holes that are a distant of 7 cm from each other was judged to be of adequate size for the dogs in this study. The catheter did not stretch the urethra and thus did not induce false higher urethral pressures, and the distance between the 2 side-holes allowed constant bladder pressure recording while measurements of MUCP, FPL, and APL were performed (data not shown).

The UPP measurements were highly reproducible with our experimental protocol. This is opposed to previous statements advocating the need of a multichannel catheter when using water perfusion catheter to record reproducible urodynamic data.[11] However, we found no significant differences in inter- or intrastudy UPP measurements in individual dogs. Possible explanations for these findings include slow catheter withdrawal rate (1 mm/s), which allowed pressure variation recordings; the relative softness of the catheter, which avoided false high pressure recordings as a result of a possible bending of the catheter during withdrawal from the urethra; and the fact that the side-hole located in the urethra was always oriented dorsally, as recommended by Holt.[1]

Reports on the reproducibility of cystometric measurements are sparse in the veterinary literature.[14,15] Nickel et al[11] reported good reproducibility of diuresis cystourethrometry measurements, but the reproducibility of retrograde filling cystometric measurements has not been investigated yet. In veterinary medicine, previous data regarding reproducibility of cystometric measurements in the same animal have concentrated on the absence or presence of the micturition reflex during cystometry performed under sedation with various anesthetic agents.[14,15] Therefore, we were interested in studying the reproducibility of cystometric measurements (threshold volume, threshold pressure, and bladder compliance) during retrograde filling cystometry. The infusion rate of 5 mL/min was empirically chosen, because this retrograde bladder-filling rate appeared to be the closest to that obtained during diuresis cystometry. For ethical reasons, we judged it unacceptable to study each infusion rate as well as the diuresis cystometry multiple times on the same dog, because this would have required repeated anesthesias. In our study, good reproducibility of measurements obtained by use of retrograde filling cystometry was observed. This finding is in agreement with the observations of Nickel et al[11] with the use of diuresis cystometry, but is opposed to the poor reproducibility reported for cystometric measurements found in the human literature.[13]

Several anesthetic agents and their effects on UPP values have been investigated. Results of previous studies indicate that after administration of xylazine hydrochloride or halothane, lower MUCP values are obtained,[4,6-8] compared with values in non-sedated dogs.[21] This is expected with the use of an α-adrenergic blocking agent, as the urethral tone is under the influence of α-adrenergic receptors. However, xylazine is believed to be the drug of choice for use during cystometry, because it does not inhibit the micturition reflex.[14]

We chose to use propofol anesthesia to obtain UPP and cystometric recordings, because Combrisson et al[6] obtained high MUCP values and good reproducibility in successive urethral pressure profiles when using propofol anesthesia. To our knowledge, propofol had

not been investigated for use in cystometry in dogs. Administered as a continuous IV infusion, it provided a safe and stable light plane of anesthesia that was followed by a rapid recovery phase in our study. The high dosage necessary to maintain dogs under a stable plane of anesthesia (0.82 to 1.38 mg/kg/min) is explained by the absence of any premedication that could have affected the urodynamic measurements. For individual dogs, no significant difference was found in the dosage of propofol used during our experiments. One drawback to the use of a continuous infusion of propofol for cystometric measurements is its cost, especially in longer procedures.

Although investigators in previous studies decided to stop the procedure once the bladder pressure reached a certain value (ie, 30 or 40 cm H_20),[7,11] we elected to continue the bladder infusion until micturition, even when the bladder pressure increased to > 40 cm H_2O. For each cystometry, we observed a micturition reflex, characterized by a rapid increase in bladder pressure with subsequent leakage of urine. Except for the retrograde filling cystometry at 20 mL/min, no apparent or clinical functional bladder dysfunction (eg, dysuria, hematuria, or urine retention) was observed following the procedures, even at pressures reaching 80 cm H_2O. The presence of a micturition reflex after each cystometry, even at high threshold pressures, does not correlate with previous findings of other investigators that indicate that the micturition reflex is, on some occasions, inhibited by the use of anesthetic agents.[14]

The good reproducibility of UPP measurements and high UPP values recorded with the use of propofol may be explained by the fact that propofol, under continuous infusion, does not induce changes in blood pressure[28] (as opposed to a rapid fall in diastolic pressure after rapid bolus injection[29]). Indeed, there is an appreciable vascular component in the production of intraurethral pressure at rest.[30] The urethral vascular bed probably plays an important auxiliary role in the urethral closure mechanism.

Good reproducibility of urodynamic data reinforces our opinion that repeated measurements are not necessary with the retrograde filling cystometry at 5 mL/min, as opposed to previous recommendations.[4] This is of particular value when performing cystometry, which can be a lengthy procedure requiring prolonged general anesthesia.

Although we did not find inter- or intrastudy differences in any urodynamic measurements for individual dogs, we found significant differences in measurements among dogs. Because these differences have frequently been reported in other studies[9-11] using various breeds of dogs with a wide variation of size and weight, we were expecting to minimize the sources of variability by using a homogenous group of Beagles. Despite the homogeneity in breed, age, weight, and sexual status of dogs used in our study, important variations were still recorded among dogs. This variability results in difficulty in the establishment of baseline values for urodynamic measurements as well as in the comparison of data between clinically normal and pathologically affected dogs. Indeed, objective evaluation of a potential pathologic status by urodynamic testing is not yet possible.

Another purpose of our study was to define an appropriate infusion rate for cystometry in dogs. Although a small number of dogs was used, we were able to demonstrate significant differences among cystometric measurements for the various infusion rates studied. Although infusion rates up to 50 mL/min have been described in previous studies,[21] we do not recommend the use of retrograde filling cystometry at an infusion rate of > 10 mL/min in small and middle-size dogs. In our study, the retrograde filling cystometry at an infusion rate of 20 mL/min resulted in a nonphysiologic sudden increase in bladder pressure capable of causing bladder wall damage. At high infusion rates, the bladder cannot withstand the sudden high bladder pressure, despite the small amount of fluid infused, and rupture may occur. We did not find significant differences in threshold pressure, threshold volume, and compliance values between the retrograde filling cystometry at infusion rates of 5 and 10 mL/min, and we did not detect any signs of bladder wall damage or bladder dysfunction after these procedures in any dogs. In our study, diuresis cystometry best approximated the physiologic bladder filling state, with a high threshold volume and compliance and low threshold pressure. One limitation of this study could be the method of determining the threshold volume; indeed, the measurement did not include the minimal volume of urine lost at the initiation of micturition or the potential residual urine left in the bladder after collection. However, we believe that this method, although less precise than Nickel's technique using radionucleotide products, is more practical and leads to minimal measurement errors. Using calculations defined by Nickel et al,[11] the enforced diuresis cystourethrometry, with an IV fluid administration at rate 20 mL/kg/min, results in a mean bladder-filling rate of 0.45 mL/kg/min. By extrapolating these results to our study, we calculated that the mean filling rate approximately equals a retrograde infusion rate of 6 mL/min for a dog with a body weight of 15 kg. However, we observed significant differences in all measurements between diuresis cystometry and retrograde infusions at 5 or 10 mL/min, which reinforce the idea that even though the rate of bladder filling is identical, diuresis cystometry allows the bladder storage function to be investigated under more physiologic conditions and is to be advised for any physiologic functional study of the lower urinary tract.

Diuresis cystometry has also been described in the human literature[13] as a better way to detect detrusor instability. In our study, we did not detect any unstable detrusor contractions, nor did we record any urethral instability; these problems were not expected, as we used healthy dogs with no signs of lower urinary tract dysfunction.

In previous clinical studies,[14,31-33] values of cystometric measurements have been reported, but these studies were limited by a small number of dogs with a wide range of body sizes and weights. Regarding diuresis cystometry, Nickel et al[11] reported higher threshold volumes and lower threshold pressures than we found, but they were using dogs weighing between 18 and 40 kg, whereas we used Beagles weighing between 12 to 20 kg in our study. This wide variability among dogs makes any comparison between studies difficult.

[a]Diprivan, AstraZeneca SA, Brussels, Belgium.
[b]Nellcor, Nellcor Puritan Bennett Inc, Pleasanton, Calif.
[c]3-way catheter, Porgès Laboratories, Le Plessis Robinson, France.
[d]Gould P10 EZ, Recording Systems Division, Cleveland, Ohio.
[e]Libra +, Medical Measurement Systems, AN Enschede, The Netherlands.
[f]NaCl 0.9%, Baxter SA, Lessines, Belgium.
[g]Dimazon, Intervet, Mechelen, Belgium.
[h]Hartmann, Baxter SA, Lessines, Belgium.
[i]SuperAnova software, Abacus Software Inc, Berkeley, Calif.

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