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Lidocaine Cystometry in the Diagnosis of Bladder Overactivity

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The effect of intravesical lidocaine was studied in a group of patients with symptoms of urinary urgency with or without incontinence. Provocative water cystometry failed to demonstrate signs of unstable detrusor but all patients presented a continuous, steep rise of detrusor pressure at the end phase of filling. Repeat cystometry was performed after the bladder had been treated with 3 g lidocaine intravesically for 20 minutes. In the majority of patients, no change in configuration of the cystometrogram was noted. In a group of patients, a decrease of detrusor pressure occurred and there was also an influence on phasic bladder contractions. In three patients, phasic detrusor contractions developed after lidocaine. Thus, intravesical lidocaine seems to be a useful tool to increase the precision of the urodynamic diagnosis in bladder overactivity. *Neurourol. Urodynam. 20:147–155, 2001.*

Key words: overactive bladder; urodynamics; intravesical; lidocaine

INTRODUCTION

Symptoms of an overactive bladder are well known to all urologists. The diagnosis requires pathologic cystometric findings and a positive history. Sometimes the urodynamic findings do not agree with the history, the former displaying a normal pattern in spite of severe subjective symptoms. The current classification by the Standardisation Committee of the International Continence Society (ICS) was designed to provide a simple and clinically relevant nomenclature. According to the ICS, an overactive bladder should be denominated *detrusor hyperreflexia* if associated with a relevant neurological disorder and *unstable bladder* in all other cases [Abrams et al., 1988]. However, this classification is based only on the presence or absence of neuropathy and does not take function into account. Hence, from a clinical point of view, the present classification is a rather blunt tool. Moreover, the minimum criteria for establishing a neurological diagnosis have not been defined.

Thus, there appears to be a need for a more elaborate classification, also recognizing the functional and clinical presentation, including more detailed urody-

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namic features. A functional classification based on cystometric criteria has recently been proposed [Fall et al., 1989, 1995; Geirsson et al., 1993a] in which three distinct subtypes were identified, covering 90% of patients. Considering the complexity of the neural control of micturition, it cannot be expected that all variations can be covered by a simple scheme, though. One category that remains a diagnostic problem is patients with symptoms of urgency and/or urge incontinence combined with an apparently stable detrusor but with a steep pressure slope at the end of the filling phase. Our hypothesis is that this cystometric presentation might sometimes be an expression of an overactive bladder characterized by a sustained tonic bladder contraction at the terminal phase of filling rather than merely resulting from reduced bladder compliance. If so, intravesically administered high-dose lidocaine would reduce pressure in the overactive bladder by blocking the afferent nerve activity, whereas this change would not take place in a poorly compliant bladder.

PATIENTS AND METHODS

Inclusion criteria for the study were symptoms of urinary urgency and urge incontinence with or without possible outlet obstruction. All patients had previously been subjected to cystometric evaluation, which did not reveal detrusor instability but displayed a pressure rise at the end of the filling phase of 20 cm H_2O or more. End phase filling pressures varied between 20 and 88 cm H_2O (mean, 48.3 cm H_2O). Twenty-one patients, 16 males and five females, age 44–82 (mean age, 65), were studied.

If cystometry had been performed more than 3 months before, a new urodynamic investigation was performed immediately before lidocaine was infused (19 patients). Cystometry was performed as follows: two 8-F plastic catheters were introduced through the urethra, one used for fluid infusion and the other for pressure recording. The latter was connected via an MMS UD 2000 pressure transducer (Medical Measurement Systems, Holland) to an analog printer (Hewlett Packard). To obtain the detrusor pressure, the rectal pressure was recorded simultaneously by means of a balloon catheter and electronically subtracted from the intravesical pressure. With the patient in the standing (males) or sitting (females) position, isotonic saline at room temperature was infused at a rate of 100 mL/min through one of the catheters and through the other a continuous pressure recording was obtained during filling and voiding. The bladder cooling test was performed after cystometry in the supine position with rapid infusion of 100 mL sterile 0°C saline, as previously described [Geirsson et al., 1994].

The Ethics Committee of Sahlgrenska University Hospital, which also serves as the internal review board for clinical studies, approved the study protocol.

Oral and written informed consent was obtained. The patients were asked for possible lidocaine allergy. Before investigation, a urine culture was analyzed and at the time of cystometry a urine dip-slide test was performed. Negative findings in these respects were prerequisites for continuing the urodynamic investigation. After cystometry, the bladder was filled with 150 mL 2% lidocaine (3 g) (Astra) via the infusion catheter. The lack of significant absorption and adverse events had previously been explored and confirmed in a study with similar dosages [Edlund et al., unpublished data].

Statistical analyses were performed on a PC with a statistical software package (StatView 5.0, Abacus Concept, CA). For paired and unpaired comparisons we used Wilcoxon's signed rank test and the Mann-Whitney *U*-test, respectively.

RESULTS

In three patients, maximal detrusor pressure was decreased at lidocaine cystometry as compared to baseline urodynamics (Fig. 1). Five patients exhibited instability on repeat cystometry before lidocaine treatment. The instability was completely abolished after lidocaine administration in three of them and it was very markedly reduced in one more (Fig. 2). In one patient, the instability was more pronounced. On the other hand, an additional three patients presented phasic bladder contractions during the filling phase at cystometry after but not before lidocaine (Table I). In other words, a second cystometry gave the diagnosis overactive bladder in five patients and another three patients received this diagnosis after lidocaine. The finding of reduced maximal detrusor pressure indicates blockade of an active tonic detrusor contraction since this change should not have taken place had the pressure rise been due to physical changes of the bladder wall.

In 15 patients, the bladder cooling test was performed before and after lidocaine. One patient had a positive test at baseline cystometry with a detrusor contraction reaching 65 cm H_2O and leakage. After the administration of lidocaine the test was negative, the detrusor pressure reaching 33 cm H_2O without contraction and leakage (Fig. 3).

Looking at the whole series, bladder volumes at first sensation as well as at strong desire were markedly increased after the administration of lidocaine ($P < 0.001$). This

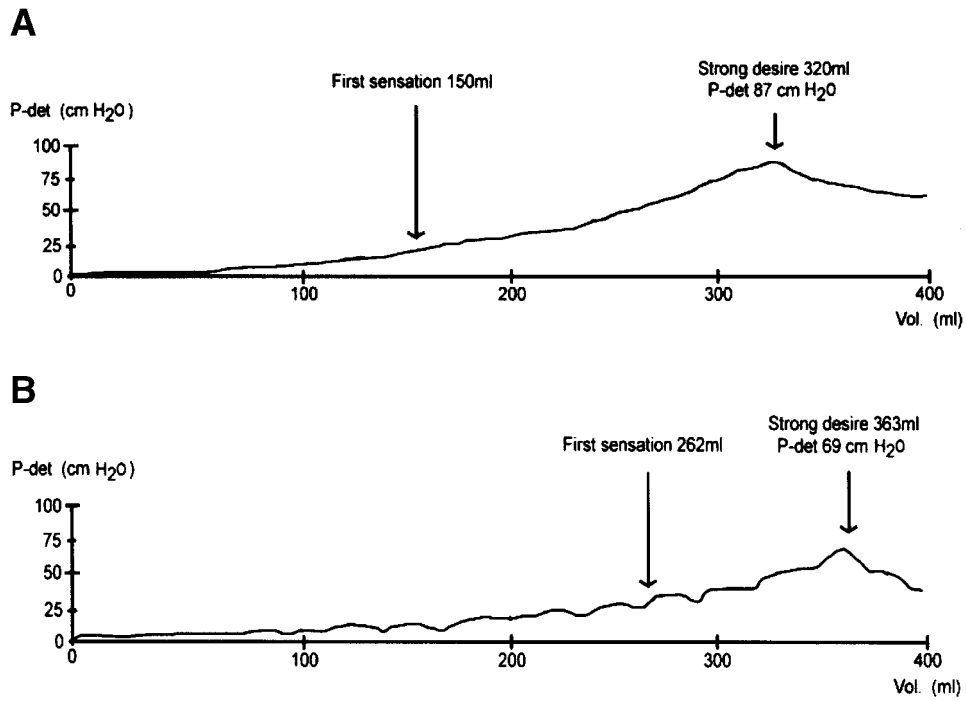

Fig. 1. **A:** Cystometry with filling (100 mL/min) of saline shows a stable detrusor and a continuously elevated detrusor pressure which reaches 87 cm H_2O at strong desire to void (320 mL). **B:** Same patient as 1A after lidocaine. First sensation of bladder filling at 262 mL and a strong desire to void at 363 mL with a detrusor pressure of 69 cm H_2O.

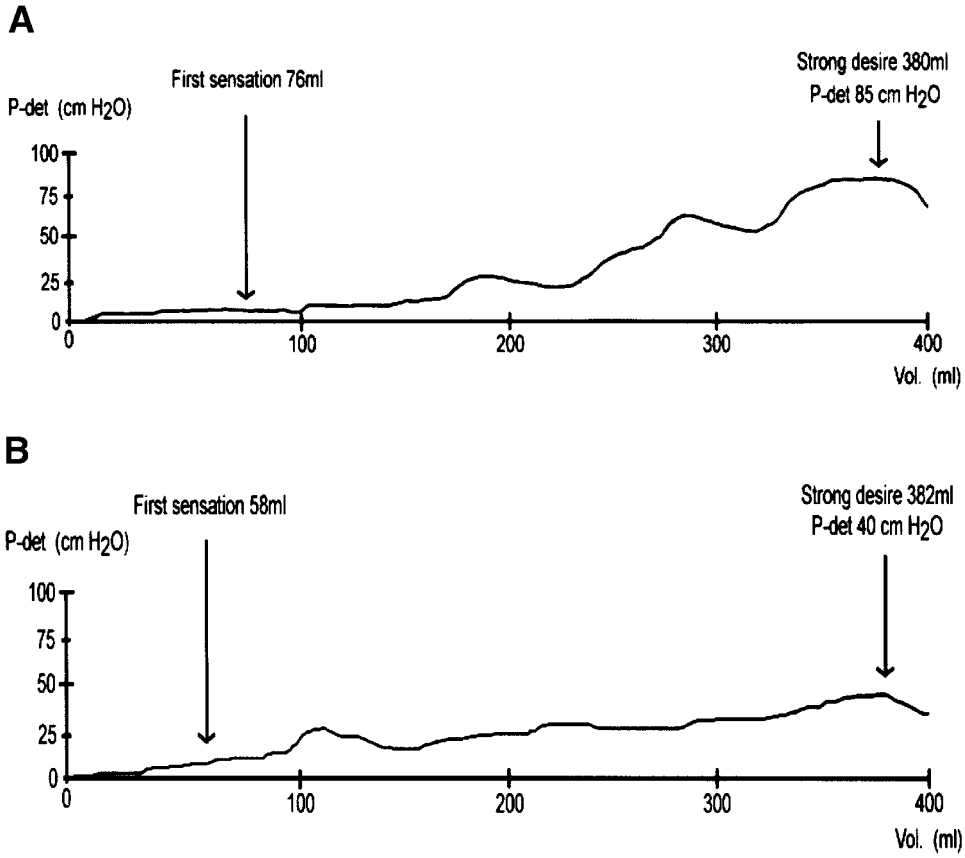

Fig. 2. **A:** Cystometrogram with filling (100 mL/min) of saline. Before lidocaine an unstable detrusor with phasic contractions is noted. First sensation of bladder filling at 76 mL, Strong desire to void at 380 mL with a detrusor pressure 85 cm H_2O. **B:** After the bladder has been treated with 3 g lidocaine, the instability is markedly reduced. The volume at strong desire to void is not changed but the detrusor pressure is reduced to 40 cm H_2O.

was also true for bladder volume at maximal detrusor pressure ($P < 0.01$) (Table I). The differences remained statistically significant when the unstable cystometrograms were excluded from the evaluation.

When comparing stable and unstable cystometrograms, before as well as after lidocaine, we found no differences in any of the recorded parameters, except for bladder volume at first sensation at baseline cystometry ($P < 0.01$).

Four of five patients who exhibited instability at cystometry after lidocaine had an increase of their maximal detrusor pressure after lidocaine administration as compared to the baseline evaluation. This was also true for three of four patients who displayed instability during baseline urodynamic evaluation (Table I).

DISCUSSION

The urinary bladder is susceptible to intraluminal exposure of drugs in spite of the relative impermeability of the urothelium. Intravesical administration of a variety of

TABLE I. Cystometric Parameters Showing the Data Before and After Lidocaine

Age	Gender	Symptom	Cystometry	FS	SD	Max P-det
77	Female	Urge incont	Stable/stable	144/268	280/320	32/32
44	Male	Urgency	Stable/stable	56/224	310/389	39/60
66	Female	Urge incont	PDI/PDI	72/195	[a] / [a]	88/93
72	Male	Urge incont	PDI/stable	314/454	514/601	32/18
55	Male	Urgency	Stable/stable	527/730	709/820	39/64
74	Male	Urgency	Stable/stable	230/450	497/645	40/59
48	Female	Urgency	Stable/stable	235/319	390/452	25/42
48	Male	Urgency	Stable/stable	236/206	335/407	28/34
63	Female	Urge incont	Stable/PDI	129/268	264/340	62/112
62	Male	Urge incont	Stable/PDI	240/332	325/454	35/45
61	Male	Urgency	Stable/stable	479/541	765/684	43/38
69	Female	Urgency	Stable/PDI	501/592	583/625	48/89
79	Male	Urge incont	PDI/stable	132/264	548/692	32/40
82	Male	Urgency	Stable/stable	232/386	439/595	36/47
62	Male	Urgency	Stable/stable	150/262	320/363	87/69
64	Male	Urgency	Stable/stable	378/376	494/536	29/35
52	Male	Urgency	Stable/stable	181/325	363/575	20/50
78	Male	Urgency	Stable/stable	191/281	370/432	70/119
78	Male	Urgency	PDI/stable	122/492	419/587	29/58
47	Male	Urge incont	PDI/PDI	76/58	380/382	85/40
78	Male	Urge incont	Stable/stable	172/337	294/423	50/100

[a]One patient experienced leakage instead of SD.

FS, volume in milliliters at first sensation of filling; SD, volume in milliliters at strong desire to void; Max P-det, maximal detursor pressure in cm H_2O; PDI, phasic detrusor instability; incont, incontinence.

agents has in fact been frequently used in overactive bladder disease [Mattiasson et al., 1989; Madersbacher and Jilg, 1991; Fowler et al., 1994; Messelink, 1999] and the effect of lidocaine as well as other local anesthetics on detrusor behavior has been reported by several authors [Reuther et al., 1983; Sethia and Smith, 1987; Yokoyama et al., 1997]. The use of lidocaine has previously been in trials to reduce instability, with unimpressive effects on symptoms, although there was an increase of cystometric capacity [Higson et al., 1979]. Our aim was purely diagnostic, namely to reveal an unstable bladder by at least partly paralyzing the bladder during filling by affecting the peripheral neural pathways. Additional information may be obtained by a variety of other pharmacological manipulations, e.g., anticholinergic blockade [Blaivas et al., 1980; Ekstrom et al., 1993], temperature stimulation [Geirsson et al., 1993b; Chai et al., 1998], rapid filling [Abrams et al., 1988], or by using acidic medium [Åslund et al., 1988]. The use of ambulatory urodynamics [van Waalwijk van Doorn et al., 1991] is another option, although not available to all urologists.

Bladder compliance is defined as the change of bladder pressure for a given change in volume. The equation $C = V/P$ is calculated by dividing the volume change (V) by the detrusor pressure (P), and is expressed in mL/cm H_2O. The detrusor pressure rises and reaches its peak at the point of maximum bladder capacity if compliance is poor due to physical changes of the bladder wall, but a similar cystometric pattern could also occur if the detrusor contracts tonically as a result of filling. There is so far no consensus as to the precise limits for abnormal compliance. Normally, the urinary bladder is a very compliant organ and end phase filling pressures above 20 cm H_2O are unusual. Also the definition of urgency is arbitrary, since it is difficult to define simple

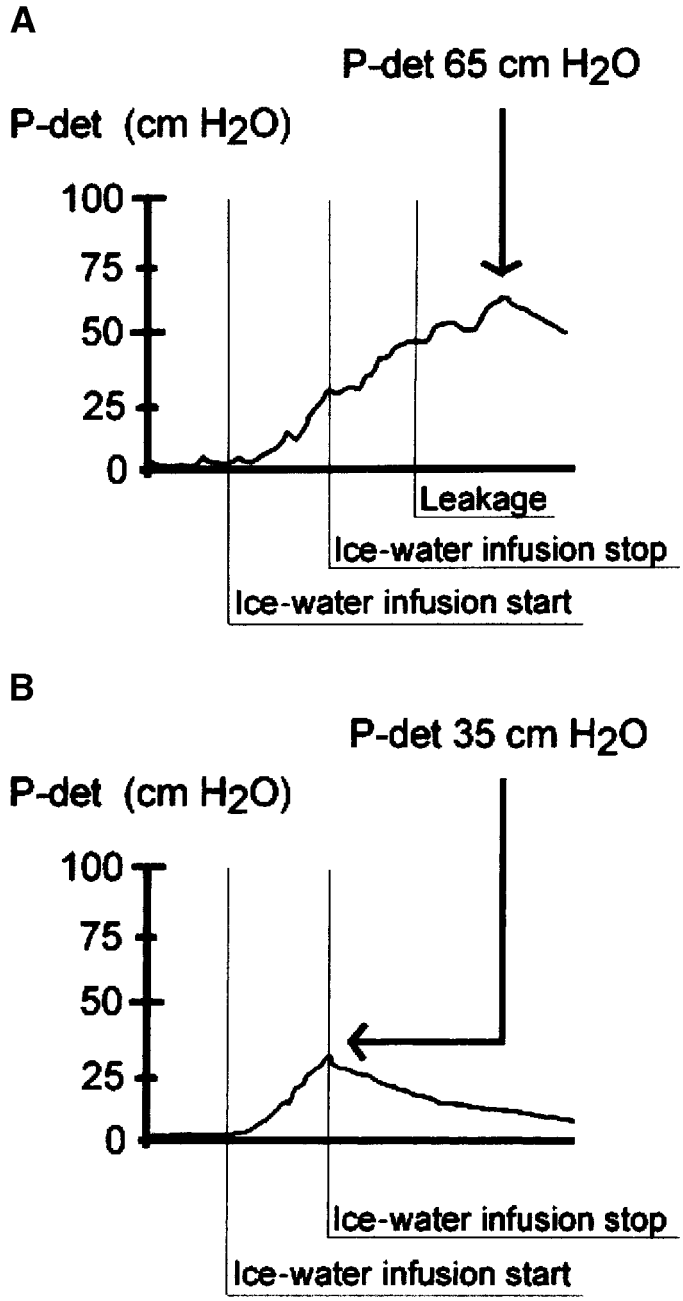

Fig. 3. **A:** Bladder cooling test before installation of lidocaine. The test is positive with a detrusor contraction reaching 65 cm H_2O and leakage. **B:** Bladder cooling test negative after the installation of lidocaine. The pressure rises to 35 cm H_2O during infusion, but falls immediately after completion of infusion. No leakage occurs.

limits for abnormality. The findings in our present pilot investigation are in keeping with our hypothesis that intravesical high-dose lidocaine may be useful in discriminating tonic bladder overactivity from poor compliance of the bladder wall. It may also provide a means to reveal phasic instability that remains undetected in a standard cystometrogram. The striking effects of lidocaine on bladder filling sensations and cystometric capacity shown here have also been demonstrated previously [Sethia and Smith, 1987; Yokoyama et al., 1997], and were thus anticipated.

We previously suggested a new classification system for overactive bladders based on urodynamic findings [Fall et al., 1995]. The following subtyping was suggested: 1) *The uninhibited overactive bladder* (UOB), characterized by a specific form of impaired perception of bladder fullness, loss of voluntary inhibition, coordinated micturition, and typically a positive bladder cooling test. 2) *Phasic detrusor instability* (PDI) is characterized by normal or increased bladder sensation, phasic bladder contractions occurring spontaneously or on provocation, coordinated voiding, and typically a negative bladder cooling test. 3) In *spinal detrusor hyperreflexia* (SDH), there is an impairment of voluntary command of micturition, detrusor contraction on external mechanical stimulation, and unsustained or uncoordinated emptying reflexes. The present investigation suggests the recognition of a fourth category of overactive bladder, namely *the tonic overactive bladder.* A similar pattern has also been discussed by Hampel et al. [1997] and Papa Petros [1999]. Although not systematically counted, a rough estimate of the prevalence in our urodynamics laboratory is that about 10% of patients evaluated with cystometry also exhibit this kind of steep pressure slope combined with urgency/urge-incontinence symptoms.

It is clear that the definition and description of bladder overactivity used today are rather crude and there is no doubt that more detailed exploration would reveal a variety of distinct functional patterns representing different combinations of dysfunction within the pathways controlling storage and micturition. The micturition and the reflexes involved are very complex and only partly known. Central nervous lesions may involve more than one functional structure of importance for the control of the lower urinary tract. Therefore, the detailed combined symptomatology and urodynamic presentation caused by disturbances of the neuronal pathways varies but at present little distinction is made between patients. Papa Petros [1999] further emphasized the complexity of bladder instability. From a different perspective, he postulated that, in the female, a mechanical factor may contribute to defective control of the bladder during filling. With loss of adequate vaginal and urethral support in combination with an open urethra, the result may be phasic instability. With a normal urethral closure mechanism, the result would be a low compliance pattern.

Another issue concerns the variety of patterns of pathological reflex activation in different bladder dysfunctions. One example is the bladder cooling reflex, which is mediated by afferent C-fibers activated by specialized cold receptors in the bladder and urethral walls [Geirsson et al., 1993]. In the normal adult, this reflex is silent but it is unmasked in dysfunctions like the uninhibited overactive detrusor and spinal detrusor hyperreflexia [Geirsson et al., 1993]. We found that this spinal reflex mechanism can be blocked by lidocaine, as previously reported experimentally [Fall et al., 1990] and clinically [Bors and Blinn, 1957; McInerney et al., 1992], as can the normal micturition reflex, which is activated by tension receptors utilizing Aδ fibers. It is quite obvious that lidocaine affects bladder afferents since it has a local anesthetic effect. The effect of lidocaine is not mediated by direct depression of the detrusor muscle since

depolarization of sodium currents in smooth muscle does not occur and moreover the tissue penetration is poor, making an effect on the efferents quite unlikely [Yokoyama et al., 1997, 2000]. Lidocaine affects the Aδ fibers responsible for the normal micturition reflex but also the much smaller unmyelinized C-fibers, engaged in bladder contraction after spinal cord injury and other pathologic states [de Groat et al., 1990; Geirsson et al., 1999]. The thinner fibers are more effectively blocked; still it is not possible to determine the relative role of each component in this type of a clinical study.

An unsophisticated subdivision of overactive bladders may explain the unpredictable effect of various therapeutic measures. To tailor treatment more efficiently, it is necessary to define different types of dysfunctions better and describe combinations of findings more relevantly since, with a more detailed analysis and improved diagnostic precision, urodynamics will be more helpful for prognosis as well as a guide to treatment. It is reasonable to assume that with a more elaborate description more could be learned about the etiology and pathogenesis of lower urinary tract dysfunction, too. Lidocaine seems to be a useful tool for improving diagnostic precision in specific groups of patients.

CONCLUSION

Lidocaine cystometry is a safe and easy addition to conventional urodynamics to increase the precision of urodynamics in patients with suspected overactive bladder.

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