

# The Place of the Ice Water Test (IWT) in the Evaluation of the Patients with Traumatic Spinal Cord Injury

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## ABSTRACT

*In the last decades, functional Urology developed itself as a subspecialty, and, although is strongly linked to Urology, it has its own language, devices and dedicated people. The ice water test (IWT) was first described in 1957 and gained its place in the armamentarium of functional urologists for the coming years. Now, when urodynamic devices are more and more complex and sensitive, when neuromodulation and neurostimulation are gaining popularity and with the terminology changes of the last decade, one can wonder if a 50 years old test may still be of some use. We performed a prospective study using the ice water test in 150 consecutive patients referred to us for urodynamics in order to identify if there is any improvement in the diagnostic process. The patients were referred for varied indications, but a large number of them were neurogenic, given the special profile of our unit. We classified the patients in four different groups and analyzed the data for each group. The results showed that, while there is no use of the IWT as a routine procedure, the test might prove extremely useful in selected cases.*

**Keywords:** ice water test, urodynamics, neurogenic bladder, voiding dysfunction

## INTRODUCTION

**F**unctional Urology is becoming more and more individual and distinct as a subspecialty of Urology, having its own terminology, dedicated devices that become more complex and sensitive

each day and, maybe the most important aspect, with its own dedicated specialists, that chose to sacrifice many of the clinical aspects of their life as urologists while turning themselves towards exploring the physiology of the urinary tract and treating its functional problems. While the early days of interest in the

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storage and voiding phases of the urinary tract function are contemporaneous with urology itself, the real development and most of the important accomplishments in this field are no older than fifty years old. This period brought changes in the understanding of the physiology of the urinary tract, new techniques for investigating it, a new terminology for reporting findings and many technological advances that allowed dedicated specialists to go more in-depth for a better evaluation or treatment (1).

Urodynamics itself changed in these years top to bottom. While the term itself is nothing new, the meaning behind it is completely different nowadays compared to what it was fifty years ago. From the basic timing of voiding to advanced pressure-flow tests with video-urodynamics for real time monitoring of the voiding phase, nothing seems to be the same any longer. Many of the old urodynamics concepts are no longer accepted and are being replaced by other theories which try to explain things starting from the neural or receptor level (2).

A good urodynamic exploration, regardless of its complexity level, should reproduce and understand the patient's symptoms; otherwise the invasivity of this test is not balanced by proper information obtained. Sometimes, bring-

ing the urinary tract in the exact status that is bothering the patient may prove challenging, and this is where provocative maneuvers come in. If one is looking for detrusor overactivity and, under normal filling conditions, there is no raise in detrusor pressure, and then it may be a good idea to try and trigger the contraction using a maneuver that relies on some reflex motor activity. The IWT is just one of the many provocative maneuvers used to identify and evaluate reflex bladder contractions during the storage phase.

In this era of scientific and technical advances, it may be useful to revisit some older concepts or techniques, and to find out there is any place for them in our time. Our study focuses on the use of the ice water test (IWT), which has been known for almost 55 years, as a provocative maneuver during modern urodynamic explorations. We performed the IWT as part of the cystometric examination, on consecutive patients, regardless of their main indication for urodynamics. □

#### HISTORY OF THE ICE WATER TEST

The ice water test was first described in 1957, by a team of scientists under the lead of E Bors and KA Blinn, in a paper called **"Spinal reflex activity from the vesical mucosa in paraplegic patients"**. This paper was considered as the birth certificate of the IWT, but the technique, indications and explanations of the initial discovery changed several times in the coming decades.

Bors and Blinn started by investigating if there are any temperature receptors in the bladder, how do they work and how their finding could help as a diagnostic or even therapeutic measure. They instilled 2 ounces (60 ml) of ice-cold water into the bladder, in 30 seconds time, and asked the patient to try and keep the fluid inside their bladder. In some cases they noted a rapid evacuation of the fluid, due to a reflex contraction of the detrusor that occurred shortly after the instillation. They considered the test positive if the water was expelled in less than one minute. Their finding was that the test is positive in patients with upper motor neuron lesion, making it useful in differentiating this type of lesion from the lower motor neuron lesion. Many studies in the following years tried to demonstrate that the test may also be positive in patients with lower mo-



FIGURE 1. Computerized device for urodynamic explorations

tor neuron lesions, but the results proved questionable. Bors and Blinn were unable to fully understand what was happening in the bladder wall and that it was the neurological substrate on which the whole process relied (3).

Other researchers demonstrated in the coming years that this is a lower motor neuron reflex, starting at the level of cold receptors in the bladder wall. The C-fiber afferents associated with these receptors are involved in the transmission of impulses towards the spinal cord. This reflex seems to be present in all children aged less than four years of age, (4) but there are authors suggesting that the real cut-off point is around two years of age, and that after that age, the reflex is inhibited centrally (5).

The initial indication for this new test was in neurogenic dysfunction of the bladder, and it was mainly used in spinal cord injury (SCI) patients. Some authors published promising data after using a somewhat warmer water (up to 10 degrees Celsius), proposing the term of **bladder cooling test (or reflex)**, which is basically the same maneuver (6).

After 16 years from the initial description of the test, and based on already more developed technology, another author has the initiative of performing this test as a part of the filling cystometry, opening the era of the IWT as we know it today. His development made possible the correlation between the expulsion of cold water from the bladder and the contraction of the detrusor itself. The author soon found out that, in many cases, although the water is not expelled, there is a strong contraction of the detrusor, and only a good sphincter prevented water from leaking out. These findings allowed him to postulate that many negative results obtained using the original technique are, in fact, false negative results (7). The technique described by Raz in 1973 is the most used technique until today.

All the data acquired throughout these years sustain the theory that the IWT relies on the activation of the C fibers, which are now being looked at as a key factor in understanding detrusor overactivity, be it neurogenic or idiopathic, so it makes sense to consider the IWT as an important element in identifying those patients with symptoms that can be explained by a C fiber functional abnormality. □

## MATERIALS AND METHODS

In our department, urodynamics is performed routinely, as most of our patients are referred to us for such evaluation. Given the particular specificity of our practice, about one half of our patients have a neurological condition, with SCI prevailing over any other.

Our urodynamic unit features a Medtronic Duet Logic G/2 device, fitted with the electromyography (EMG) module, flow-meter and puller for urethral pressure profile evaluation. The examination table is custom-made, so it can also accommodate impaired mobility patients. Also, the table can be easily adapted for both supine and lithotomy positions.

The examination procedure includes a brief abdominal and pelvic ultrasonography, a urinary dipstick and a three day bladder diary. For the urodynamic evaluation, we use room temperature saline, instilled at 50 ml/min for non-neurogenic patients and 20 ml/sec for neurogenic bladders. The filling rate is adjusted during the exam according to the particular aspects of each case.

Bladder pressure is measured via 2 or 3 lumina, 8Fr catheter, continuously irrigated. Abdominal pressure is measured using a balloon tip catheter, filled with saline. The patient is usually in a lithotomy position, unless this position is uncomfortable or impossible to reach.

In all our urodynamic examination, the doctor is always running the exam itself and making appropriate annotations on the graphic recording. Also, any provocative maneuvers are being recorded, although they are not routinely performed, but only if the examining doctor thinks some maneuver might be useful.

For our prospective study, we decided to do the IWT routinely, in 50 consecutive patients, regardless of their particular condition or indication for urodynamics. The test itself was performed at the end of cystometry or the pressure flow study, after emptying the bladder. We used 100 ml of saline at room temperature, which was instilled into the bladder. After emptying once again the bladder, we instilled 100ml of ice-cold water. We considered the test to be positive if a detrusor contraction could be observed after the instillation of ice-cold water but not after the instillation of saline at room temperature.

Generally, our patients were referred after being investigated by their referring physician

to a level that was considered enough to evaluate not only their main complaint but also their general status. All neurological patients had at least one investigation carried out by a neurologist, in which their history, evolution and actual status were detailed. All women referred for stress incontinence had at least one pelvic exam before our investigation.

Our series consisted of 50 patients, 28 females aged between 21 and 68 years old and 22 men, between 18 and 74 years old. The patients were divided into four groups, based on their main indication for urodynamics:

- A. Neurogenic bladder – 22 patients
- B. Idiopathic overactive bladder – 13 patients
- C. Stress urinary incontinence – 9 patients
- D. Bladder outlet obstruction – 6 patients

The patients with mixed urinary incontinence were assigned to either group A or C, according to the predominant component of their pathology.

The neurogenic bladder (A group) consisted of 9 women, aged 21 to 68 and of 13 men, with ages between 21 and 64 years old. In this group, filling cystometry was performed routinely at a filling rate of 25 ml/min. In this group, 16 patients had a SCI, and other 6 had a diagnosis of medullar compression by discal herniation or multiple sclerosis (MS).

In the idiopathic overactive bladder group (B), we included 8 females (21 to 46 years old) and 5 men (18 to 33 years old). Cystometry was performed using a filling rate of 50 ml/sec, but the value was lowered in some cases.

The C group consisted of patients with stress urinary incontinence, and included 5 women aged 22 to 66 and 4 men, with ages between 45 and 68 years old. Cystometry was performed using a 50 ml/sec filling rate.

The D group included two females and four men with signs of bladder outlet obstruction that required further investigation in order to rule out an acontractile detrusor.

Provocative maneuvers were used in those cases in which the medical history was suggestive for an overactive bladder syndrome and where detrusor overactivity could not be found. The IWT was performed at the end of the examination. If another provocative maneuver was used before, the results were correlated with the result after the IWT.

Data was analyzed separately for each group and reported as percentage of the total number of patients in that group. □

## RESULTS

As an overview of the procedure, the IWT can be considered a maneuver which is easy to perform, reasonably fast and rewarding in many cases. Data in the literature tends to suggest that a positive result of this test is a confirmation of a neurogenic disorder, involving most frequently the upper motor neuron, although lower motor neuron lesions might also lead to a positive response to the IWT (8).

In the group of neurogenic bladder patients, a contraction of the detrusor was obtained after the IWT in 21 out of 22 patients, meaning a 95.5% response rate. But, in most of these cases, the urodynamic examination was conclusive enough before the IWT, so, despite a very good sensitivity, the usefulness of this particular test was disputable, as it only diagnosed an overactive detrusor in two more cases than cystometry alone (10%).

Our small series of patients did not allow for a comprehensive comparison between upper and lower motor neuron lesions, where data in the literature is a bit unclear or even misleading. But, in a patient with traumatic SCI, the IWT is rarely needed according to our findings, as it usually triggers a contraction with a morphology and parameters which are similar to the one obtained during filling cystometry alone.

Many authors argue that the filling rate during cystometry, as low as it can be, is still too

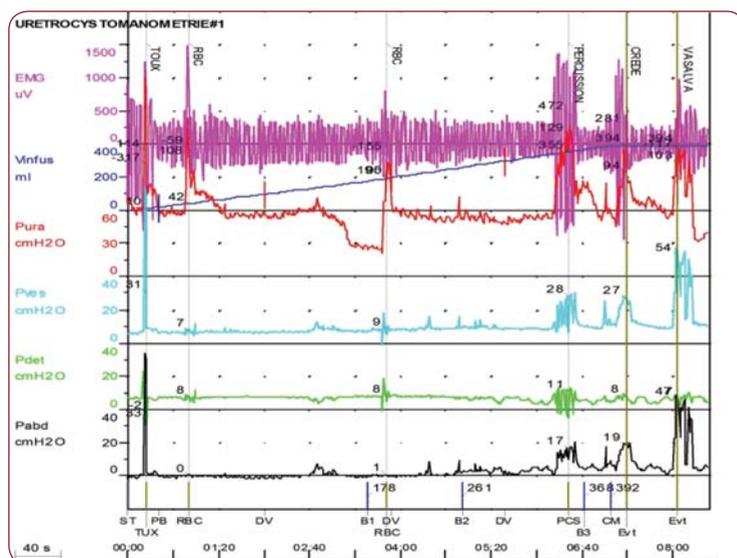


FIGURE 2. Filling cystometry with provocative maneuvers at the end

high and is considered not physiological. This argument is equally true for the IWT, keeping the urodynamic exam far from being the ideal functional test for the lower urinary tract.

In the group of idiopathic overactive bladder, the IWT was positive in 10 out of 13 patients (77%). In seven cases, the increase in bladder pressure was minimal during the contraction. Considering that detrusor overactivity was seen in 3 patients (23%) after standard cystometry, we conclude that the IWT improved the diagnosis in a significant 54% of the cases.

In the stress urinary incontinence group, the IWT was positive in one case (11%). The increase in bladder pressure was limited to 4 cm water, and the test was not relevant because the proposed treatment for the patient was not changed. We speculate that the IWT might still have a role in this type of patients as it could identify detrusor contractions that may compromise the results of surgery for stress incontinence.

In the bladder outlet obstruction group, the IWT had an overall response rate of 50%, divided as no response in the two females and 75% positive test (3 out of 4) in the males. This result might be of particular interest for future basic science or other research projects, as it underlines the limited knowledge that we have in understanding the mechanisms of bladder overactivity in BPH. The increase in bladder pressure was significant in all cases, up to a value of 40 cm water at the peak of the contraction.

In women, no conclusion can be drawn, probably because of the very small series that we had. Data in the literature shows a significant response rate in women with outlet obstruction and speculates that the results of the ice water test might be able to foresee the results of the treatment (9).

Based solely on our results, we observed that the IWT is able to trigger a contraction of the detrusor in many cases, but this outcome is quite often misleading, as the most appropriate treatment for that particular patient is one that doesn't take into account a minor contraction during storage. □

## DISCUSSION

To the best of our knowledge, the IWT is not used routinely in our country, and in a literature search we performed we found no reports or data regarding the use of this test. The

international literature is abundant in data concerning this provocative maneuver, although the conclusions are very diverse (10). Some argue that this test is not indicated at all; others consider it as the fastest, easiest and least expensive way of demonstrating a contraction of the detrusor during storage (11).

The method itself has many versions, with different agents, volumes or temperatures being used. The definition of the uninhibited contraction changed over time, and no clear mechanism of action was described (12).

The IWT was initially described as a mucosal spinal reflex in patients with spinal cord injuries. It was already clear that spinal or topical anesthesia makes this reflex disappear, and that the contraction is not triggered by tension or pressure receptors. With the further understanding of the C-fiber reflex, and with the advances made mainly in the field of basic science, the bladder cooling reflex got a better understanding.

Thinking about the indication of the urodynamic examination, one idea became classical – is this invasive test going to change the management of the patient in some way? Based on our experience on consecutive patients, the same idea came into our minds: is the IWT going to change the treatment proposed to the patient? The test failed to convince us, as it failed to convince others before, that it can be sensitive and specific enough to reveal a hidden neurological condition in a patient with an idiopathic OAB syndrome, on the other hand being easy enough for both the patient and the doctor as to try to perform it if you have even a weak hope this can be helpful.

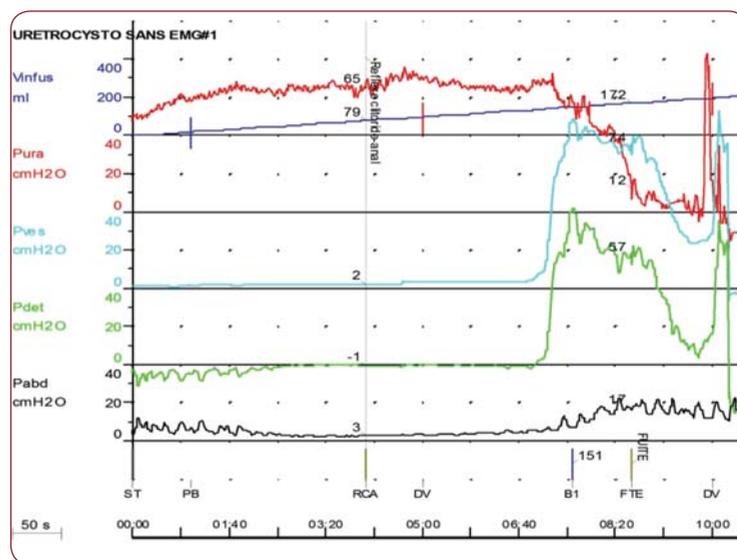


FIGURE 3. High pressure detrusor overactivity triggered by the IWT

We were not able to identify a particular group of patients where this test could be indicated routinely. But, assuming that the purpose of an urodynamic examination is to reproduce the patient's symptoms, the IWT could be tried if we suspect detrusor overactivity but we are unable to see it during our exploration.

Data in the literature supports the IWT as being positive in upper motor neuron lesions (up to 95%), and was long time considered to be a tool for the differential diagnosis between upper and lower motor neuron lesions. But, with the evolution of the definition of detrusor overactivity, the IWT became positive even in lower motor neuron lesions (up to 40%), and this shadowed this indication (13).

Stress urinary incontinence is definitely not an indication for the IWT, but the test can be used as a screening test for an underlying neurological condition (14). Some authors argue that this is not always sensitive and specific, so might get misleading results.

Some experiments were conducted on healthy subjects, showing a positive test in up to 44% of the cases, with low pressure contractions. Putting together data from the healthy subjects, the stress incontinence cases and the lower motor neuron patients, we might speculate that future research in the field should look at the pressure change during the contraction. There is a high possibility that a standardized test, which is considered positive only if the

bladder pressure rises with more than 15 cm water (or any other cut-off value), could be more valuable than the IWT as we know it today. □

## CONCLUSION

The IWT is fast and easy to perform, although its indication in real life is rather limited. It is certainly not a routine test during urodynamics, regardless of the condition or symptoms of the patient. More than that, if used routinely, it might lead to confusing results.

We should not forget that the IWT is a simple way to prove that the reflex arc involved in micturition is intact. Going beyond this test, researchers got a better understanding of the bladder cold perception and the activity of the C fibers. This might emerge as a new indication for the IWT, more prone to the experimental part of functional urology, and maybe a new life for a maneuver now considered obsolete.

A simple answer to our initial question would be Yes, the ice water test still has a place in modern urodynamics. But, that place is not a central one; it's rather a test with very limited indications, which can be substituted if necessary. It remains simple, inexpensive and accurate if used properly, and future specialists in the field should be aware of the IWT and should not forget how to properly perform it.

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