The 50-Year History of the Ice Water Test in Urology

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Abbreviations and Acronyms

BOO = bladder outlet obstruction

BPS = bladder pain syndrome

DO = detrusor overactivity

IDO = idiopathic DO

IWT = ice water test

LMN = lower motoneuron

MS = multiple sclerosis

SUI = stress urinary incontinence

TRP = transient receptor potential

UDS = urodynamics

UMN = upper motoneuron

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Purpose: The ice water test was first described in a 1957 study of cold receptors in the bladder. We examined the role of the ice water test in the diagnosis and management of different urological conditions.

Materials and Methods: MEDLINE® and PubMed® literature searches were performed, spanning 1956 to January 2009. Other studies were identified by reviewing secondary references in the original citations.

Results: The ice water test has been shown to be a lower motoneuron segmental reflex involving C-fiber afferents, which are associated with cold receptors. A number of its clinical applications have been described. The test was first thought to be specific to upper motoneuron lesions but patients with other urological conditions have had a positive test, including those with nonneurogenic disorders. The test is almost always negative (contractions less than 15 cm H_2O) in healthy volunteers and in patients with stress urinary incontinence, lower motoneuron conditions and bladder pain syndrome. In cases of upper motoneuron conditions the positive test rate is 46% to 92% depending on the underlying pathological condition.

Conclusions: The ice water test has several potential applications but it is not needed in routine clinical practice. To date the main interest has been in patients with neurogenic bladder disorders. Further studies to investigate the validity and reliability of the ice water test in patients with idiopathic detrusor overactivity could prove useful.

Key Words: urinary bladder; diagnostic tests, routine; urodynamics; nerve fibers, unmyelinated; ice

WHILE investigating cold receptors in the bladder, in 1957 Bors and Blinn described a test that they called IWT.[1] They claimed that the test could discriminate between upper and lower motoneuron lesions in patients with neurogenic urinary symptoms. Further studies were done to characterize IWT and the cooling reflex in general.[2–4] These studies showed that the reflex is a lower motoneuron segmental reflex involving C-fiber afferents, which are associated with cold receptors. The test is positive up to age 4 years,[5] after which the reflex is inhibited centrally. In neurologically mature individuals older than 5 years the reflex could be unmasked by a specific lesion of the descending inhibitory control pathways.

Most groups have used the term IWT because in their original study Bors and Blinn used ice-cold (0C to 2C) fluid.[1] Geirsson et al found that a reflex detrusor response could also be induced by somewhat warmer fluid (less than 10C), which encouraged them to use the term bladder cooling test.[5]

IWT has been done mainly in patients with spinal cord lesions. During the years many researchers have used

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the test for different urological conditions with variable outcomes. With the emerging role of C fibers in neurogenic and idiopathic detrusor overactivity IWT may have a role in identifying these patients with C-fiber pathology. We examined recent developments in identifying cold receptors in the bladder, what is known to date about the characteristics of the IWT reflex, changes in how IWT is done and clinical applications of IWT. The future role of IWT was also explored.

MATERIALS AND METHODS

MEDLINE and PubMed literature searches were done, spanning 1956 to January 2009 and using the key words ice water test or cooling reflex combined with bladder. Other studies were identified by reviewing secondary references in the original citations. Abstracts were used when publications were not in English.

RESULTS

IWT Reflex Characteristics and Pathophysiology

The exact neuronal mechanism underlying the reaction to a cold (ice) water test in humans is essentially unknown. When it was first described, Bors and Blinn suggested that it was mediated by a “mucosal spinal reflex” in patients with spinal cord lesions above the conus.[1] This reflex could be abolished peripherally by topical anesthesia or centrally by spinal anesthesia. It was always absent when the conus or cauda equina was destroyed. This reflex seemed to be separate from the tension or pressure reflex due to bladder distention or normal filling since it was evoked at bladder volume or pressure below the threshold for bladder mechanoreceptors.[6] It was also different than the nociceptive reflex since reflex threshold temperature was relatively high at 30C to 32C, making it unlikely that the bladder cooling reflex originates from nociceptors. A number of studies have been done to characterize the C-fiber reflex, mainly in cats.[3] Table 1 lists results.[2–4]

IWT Method

When Bors and Blinn first described the test, they used 2 ounces (60 ml) of cold (2C) water instilled during 30 seconds into the bladder.[1] The patient was asked to retain the fluid. The test was considered positive when water was expelled by reflex contraction and without straining within 60 seconds. In 1973 Raz modified the test to include intravesical pressure measurement and contraction monitoring.[4] This helped identify false-negative cases in which contraction was present without catheter or water expulsion.

Geirsson et al performed several studies monitoring how best to administer IWT and set general guidelines.[7] However, researchers have modified them, which makes it difficult to compare the results of different investigators.

Cold Receptors

Geirsson and Fall looked at cold receptors in the male urethra.[8] They concluded that cold receptors are present in the male urethra but cold and mechanical reflexes are more difficult to elicit in the human urethra than in the bladder. Lindström and Mazières studied the effect of menthol on the bladder cooling reflex in cats.[9] The response to cold water was enhanced by an intravesical menthol solution, which achieved the same reaction as higher temperature fluids. The menthol had no effect on the bladder mechanoreceptors. Geirsson reproduced the same effect using menthol in humans.[10]

Table 1. *A∂ and C fibers mainly in cats*[2–4]

	A∂-Fiber Micturition Reflex	C-Fiber Reflex
Fiber type	Myelinated*	Unmyelinated*
Nerve limbs	Pelvic nerve*	Pelvic nerve*
Pathway	Pontine reflex pathway*	Segmental reflex
Acute spinalization (acute transaction)	Abolishes reflex*	Survives + can be stimulated within mins
Stimulus receptors	Filling, tension, mechanoreceptor*	Cold (below 32) and pain. Not significantly facilitated by stimulating Aδ-fibers
Stimulus frequency	Higher afferent frequency needed, start at 3–5 Hz	Low 0.5–1.5 Hz, suppressed by repetitive stimulation at frequency above 2
Dorsal clitoris or dorsal penis nerve stimulation	Inhibited*	Inhibited
Threshold to electrical stimulation	Low, max at 4 × threshold	High, start at 30 × threshold, max at 100 ×
Latency	Short (90–130 millisecs)	Long (150–250 millisecs), mainly conduction time (afferent)
Active in	Normal adult*	Normal children less than 4 yrs old, most supraspinal lesions in adults*
Laterality	Reflex evoked by ipsilat or contralat bladder pelvic nerve stimulation	Ipsilat pathway
Menthol	Menthol insensitive*	Menthol sensitive*
Intravesical xylocaine infusion (2% for 10 mins)	Not studied	Decreased or abolished

* Same characteristic in humans.