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RESEARCH ARTICLE

MICTURITION, URINARY CONTINENCE AND INCONTINENCE

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ABSTRACT

We put forward a novel concept to explain the physiology of micturition. Micturition consists of two stages, first stage in infancy and early childhood and the second stage starts after toilet training. In the first stage, micturition is a sacral spinal reflex. In the second stage, after toilet training, the person builds up, by learning and training, high alpha sympathetic tone at the internal urethral sphincter (IUS) keeping it contracted and the urethra closed and empty all the time. The IUS is a collagen-muscle tissue cylinder that extends from the bladder neck down to the perineal membrane. Its nerve supply is from the thoracic-lumbar alpha sympathetic nerves T10-L2. After toilet training, a gained high alpha sympathetic tone keeps the IUS contracted and the urethra closed and empty all the time.

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INTRODUCTION

Thelower urinary tract (LUT) is composed of the urinary bladder, the urethra and urethral sphincters. Storage of urine and voiding involves complex interactions between the bladder, urethra, urethral sphincters, and nervous system. The urinary bladder has an adult capacity of 400 to 600 ml of urine. Classically, the urinary bladder serves to store or expel the urine by way of relaxation or contraction of the detrusor muscle, respectively. Storage of urine is achieved by bladder relaxation and contraction of both urethral sphincters (the internal and the external urethral sphincters. Micturition happens, when the bladder contracts with relaxed bladder neck and the external urinary sphincter, allowing for unobstructed expulsion of urine. Bladder storage and emptying, as well as coordinated contraction or relaxation of the urinary sphincters, are under the control of the sympathetic, parasympathetic, and somatic nervous systems (Ouslander, 2004; Andersson, 2007; Andersson and Hedlund, 2002; Petros *et al*., 1993; Petros *et al*., 1992; Petros *et al*., 1991; Rawal *et al*., 1981; Remy *et al*., 2005; Romsing *et al*., 2005; Ryan *et al*., 1984; Singh *et al*., 2008; Thomas *et al*., 2004; Thor and Donatucci, 2004; Baldini *et al*., 2009; Basse *et al*., 2000; Benoist *et al*.,1999; Cataldo and Senagore, 1991). Storage of urine is under sympathetic control via impulses transmitted through the hypogastric nerve. The pelvic parasympathetic nerve is the principle conduit of the parasympathetic input for the LUT and allows for coordinated voiding by stimulating bladder contraction with sphincter relaxation. The somatic nervous system, through the pudendal nerve, allows for the contraction or relaxation of the external urinary sphincter (striated pelvic diaphragm muscle under voluntary control). These nerves are lower motor neurons and are under the control of spinal reflexes and upper motor neuron input from the central nervous system 1.

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Patho-physiology: (Abdel Karim El Hemaly *et al*., 2014; Abdel Karim *et al*., 2014; Abdel Karim *et al*., 2014; Abdel Karim M. El Hemaly *et al*., 2014; Abdel Karim M. El Hemaly *et al*., 2012; Abdel Karim M. El Hemaly *et al*., 2011; Abdel Karim M. El Hemaly *et al*., 2009; Abdel Karim M. El Hemaly *et al*., 2010)

Recently we put forward a new concept to explain the physiology of micturition. We can divide micturition in two stages. First stage in infancy and early childhood, (Figure 1),

as the urinary bladder is full, stretch receptors send the sensations to the sacral centers along sensory nerves S 2, 3 &4. Then exciter impulses from the pelvic parasympathetic stimulate detrusor contraction and urine will leak through the urethra with a relaxed external urethral sphincter.

The second stage of micturition: (Figure 2)

The mother starts toilet training for her offspring at about two years old. By learning and training, he will build up high alpha-sympathetic tone at the internal urethral sphincter (IUS) keeping it contracted and the urethra closed all the time.

The internal Urethral Sphincter (IUS)

The IUS is a collagen-muscle tissue cylinder that extends from the bladder neck down to the perineal membrane in both men and women. The strong collagen chassis is responsible for the high wall tension of the urethra, which partially creates the high urethral pressure (high Pura). The muscle is a network of plain muscle fibers that lie on top and intermingle with the collagen fibers in the middle of the chassis. The muscle has its nerve supply from the thoracic-lumbar sympathetic nerve plexus (T10-L2). Toilet training in early childhood creates high alpha-sympathetic tone at the IUS, that keeps the IUS contracted and the urethra closed and empty all the time until there is a need or a desire to void in favorable circumstances. The two factors, the high wall tension and the acquired high alpha-sympathetic tone create the high urethral pressure (high Pura), which is much higher than the pressure in the urinary bladder (Pves). The IUS in women is intimately lying on the anterior vaginal wall. In men, the prostate surrounds its upper part that increases the urethral pressure. Sensations of bladder fullness travel along the pelvic sensory nerves (S2, 3 and 4) to the CNS. This allows theperson, according to the social circumstances available, tochoose either to retain the urine to a later time until favorablesocial circumstances allow, or to void.

If she chooses to retain, three neuromuscular actions take place:

1. Increase of the alpha-sympathetic tone to the IUSconfirming closure of the urethra.
2. The second action is inhibition of the parasympatheticimpulses to the detrusor muscle inhibiting itscontractions.
3. The third action is increase of the tone of the externalurethral sphincter (EUS) which is a skeletal muscleinnervated by voluntary NS.

When appropriate time and place are available then,controlled by the CNS, synergistic actions between thesomatic and the autonomic nervous systems fourneuromuscular actions take place:

1. Lowering of the high alpha-sympathetic tone at the IUSrelaxing the sphincter and opening the urethra,
2. Relaxing the EUS, which is a striated muscle, innervatedby somatic nerve supply,
3. Activating pelvic parasympathetic nerves to contract thedetrusor muscle and empty the UB,
4. The EUS (compressor urethrae) acts to propagate andpropel the stream of urine and at the end to squeeze theurethra to expel the last drops of urine.

High urethral pressure (Pura) that is much higher thanvesical pressure (Pves) is the main factor that keeps urinarycontinence.

Patho-Physiology

Anybody action is a nerve muscle action controlled by healthy alert brain (CNS). Toilet training leads to acquire and keep high alpha-sympathetic tone at the IUS, which keeps the sphincter contracted, and the urethra closed and empty until there is a need or a desire to void with favorable suitable social circumstances. This is achieved when the post-ganglionic alpha-sympathetic fibers produce nor-epinephrine (NE) that acts on receptors on the muscle fibers of the IUS. Failure of the alpha-sympathetic nerve fibers to produce NE, this leads to nocturnal enuresis. When the failure is complete, this will lead to enuresis day and night; this happens in about 10% of enuretic children. The majority of enuretic children (90%) have partial production of NE; therefore, they only wet themselves when sleeping. During daytime, when they feel urine about to leak, embarrassment, will initiate reflex sympathetic activity, which will induce contraction of the IUS preventing day enuresis. The partial weak alpha-sympathetic tone gained will be lost during sleep, and voiding will happen.

Those children are heavy sleepers, they go to deep sleep rapidly; it may be due to general lack of NE. Therefore, giving those children alpha-sympathomimetic drugs like ephedrine will cure the trouble. Ephedrine has a dual action, it acts on the receptors as agonist, and it acts on the alpha-sympathetic nerve fibers to stimulate them to produce NE. It may have another effect on the brain and CNS, as an analeptic, it restores normal sleep in those children.

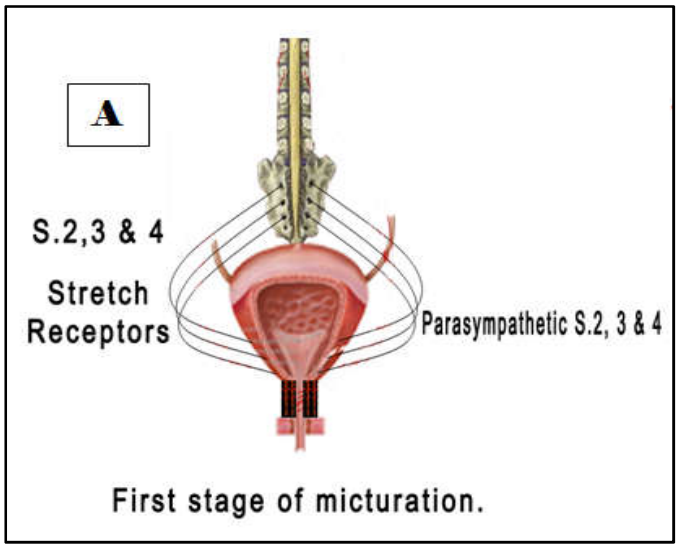

Figure 1. First stage is a sacral spinal reflex action. When the urinary bladder is full, stretch receptors induce afferent impulses along sacral sensory nerves S2, 3&4 to the sacral center. Efferent exciter impulses along the pelvic parasympathetic induce detrusor contraction and urine leak through the urethra with a relaxed external urethral sphincter

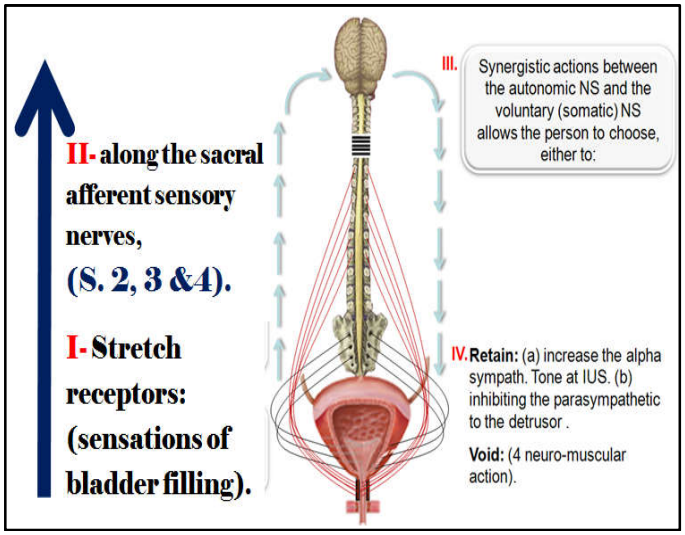

Figure 2. Diagram that shows how the CNS controls the steps taken in the second stage of micturition. Sensations of bladder filling travels along the pelvic sacral nerves S.2, 3&4. Controlled by the CNS, depending on the social circumstances, synergistic neuromuscular actions take place. If time and place do not allow voiding, the person will increase the alpha sympathetic tone at the IUS. He will also inhibit the pelvic parasympathetic preventing detrusor contractions. In addition, he will confirm closure of the external urethral sphincter (EUS).When social circumstances allow, he will inhibit the high alpha sympathetic tone at the IUS, thus opening the urethra. He will activate the pelvic parasympathetic inducing detrusor contractions. He will relax the EUS thus allowing voiding. The EUS tone increase to allow propulsion and ejection of the stream of urine and at the end of micturition to squeeze the urethra from the last few amount of urine

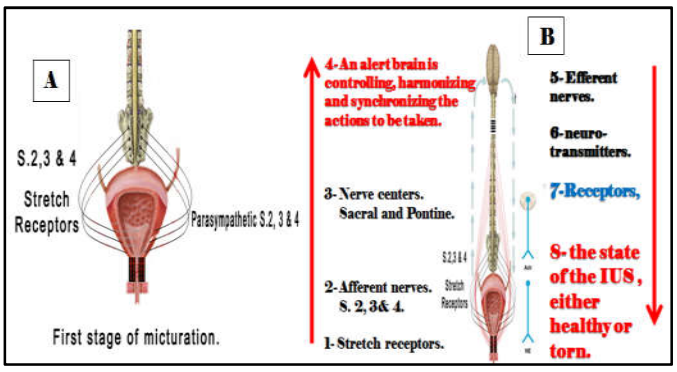

Figure 3. Micturition consists of two stages. The first stage, (A) in infancy and early childhood, before toilet training, stretch receptors from the bladder, when the bladder is full travel along sensory nerves, S. 2, 3 & 4 to the spinal center. Pelvic spinal para-sympathetic nerves S. 2, 3 & 4 cause detrusor contractions and emptying of the bladder. The second stage (B), after toilet training, the person will gain high alpha-sympathetic tone (T. 10-L. 2) at the IUS, that keeps the sphincter contracted and the urethra empty and closed all the time

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