

Micturition and Defecation, Neuro-Chemical Control

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ABSTRACT

The urinary bladder and the urethra; the rectum and the anal canal have the same embryologic anatomical source, from the cloaca. They share the same nerve supply and have systemic sensory and proprioceptors (mechanoreceptors) in the muscle responsive to mechanical changes.

Toilet training switches the toilet control, supervised by the CNS, from para-sympathetic to mainly sympathetic control. Acquired high sympathetic tone at the Internal Urethral Sphincter (IUS) and the Internal Anal Sphincter (IAS) keeps both sphincters contracted and the urethra and anal canal empty and closed all the time. Voluntarily or in need with proper social circumstances, controlled by intact healthy CNS, the IUS and/or the IAS relax and the urethra and the anal canal will open to allow pass of urine, flatus and/or feces. The neurotransmitter at the sympathetic nerve endings is nor-epinephrine, which can be deficient in cases of nocturnal enuresis.

The IUS and the IAS are collagen-muscle tissue cylinders. In women both sphincters are closely related to the vagina, and are subject to lacerations from vaginal delivery. Lacerated sphincters as a result of Child-Birth Trauma (CBT) become weak and cannot stand against sudden rise of abdominal pressure resulting in Urinary Incontinence (UI) and/or Fecal Incontinence (FI).

Keywords: Micturition; Defecation; Fecal Incontinence (FI); Internal Anal Sphincter (IAS); External Anal Sphincter (EAS); Central Nervous System (CNS); Sympathetic Nerves; Parasympathetic Nerves

INTRODUCTION

The urinary bladder is the site of storage of the urine and so is the rectum which is the store for the flatus and feces. Embryologically they both develop from the cloaca. Early in the fourth-fifth week embryonic development, the urogenital septum grows caudally into the cloaca dividing it into two compartments the urogenital sinus ventrally and the rectum and hind gut dorsally. By the fifth week of embryo life the division of the cloaca is complete into the allantois, the urogenital sinus ventrally and the rectum and the hind gut dorsally. In conclusion, the urinary bladder-the urethra ventrally and the rectum and the anal canal dorsally have a common origin. The urethra and its two sphincters the Internal Urethral Sphincter (IUS), and the External Urethral Sphincter (EUS); the anal canal and its two sphincters, the Internal Anal Sphincter (IAS), and

the External Anal Sphincter (EAS) have a common origin from the embryonic mesoderm. They share the same origin and the same neuro-vascular supply. The detrusor muscle and the rectal muscle layer, as smooth muscle, have exciter nerve supply from the pelvic parasympathetic nerves. The IUS and the IAS are innervated (as smooth plain muscles) from the autonomic nervous system, the thoraco-lumbar sympathetic chain. While the EUS, and the EAS are voluntary striated muscle are innervated from the somatic voluntary nervous system. The neuro-muscular transmitter is nor-epinephrine at both the IUS and the IAS. The neuro-transmitter in the nerve endings to both the EUS and EAS is acetyl-choline. The urinary bladder is formed partly from the endodermal cloaca and partly from the ends of the Wolffian ducts. In other words, the allantois takes no share in its formation. After the separation of the rectum from the dorsal part of the cloaca, the ventral part becomes the

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primary urogenital sinus. The urogenital sinus, in turn, divides into the superficial definitive urogenital sinus and the deeper anterior vesico-urethral portion [1-7].

Toilet training

Toilet training switches voiding and defecation from parasympathetic control to mainly sympathetic control supervised by the high Central Nervous System (CNS).

Before toilet training sensations of full bladder travels along sensory nerves S. 2, 3 & 4 to the sacral centers in the spinal cord, response by exciter impulses through the pelvic parasympathetic emptying the bladder [8-10].

As well emptying of the full rectum follows the same neuro-muscular sequel of voiding.

Toilet training induces and maintains high sympathetic tone at both the IUS and the IAS keeping both sphincters contracted and the urethra and the anal canal empty and closed supervised by the CNS. The neuro-transmitter at the neuro-muscular junctions is nor-epinephrine. Because of the nature of smooth muscle of both the IUS and the IAS continuous contraction doesn't lead to fatigue and relaxation.

The IUS and the IAS structure

Both sphincters are collagen-muscle tissue cylinders. The collagen forms the chassis of the sphincter with the plain muscle contracting and relaxing the sphincters and so opening and closing the urethra and the anal canal [11-20]. The IUS extends from the urinary bladder neck to the perineal membrane in both men and women. The IAS surrounds the anal canal and is surrounded in its lower part with the voluntary External Anal Sphincter (EAS). The IAS has collagen extensions to the bottom skin. At the recto-anal zone there are special sensory nerve endings for sensations of tension, texture of the contents and their nature gas or matters, touch, temperature and friction. There are proprioceptors (mechanoreceptors) in the muscle of both IUS and IAS responsive to mechanical changes as pressure disturbances [1].

Sensations of full bladder, and/or, full rectum travel along systemic sensory nerves and induce sensations of desire to empty [7]. According to available social circumstances, the person can postpone the emptying process or proceed. Delaying emptying is by voluntarily increasing the sympathetic tone at the IUS and the IAS confirming closure of both sphincters, in addition, through the CNS, inhibiting the cholinergic stimulations of the bladder and the rectum waiting for favorable social circumstances.

Urinary incontinence

Urinary incontinence can be due to fault in the sphincter (IUS) or the controlling mechanism.

The controlling mechanism

1. Lesions affecting the CNS e.g. spinal bifida, stroke, SLE, MS, paraplegia.

2. Peripheral neuropathy e.g. in diabetes mellitus.
3. Damage of the proprioceptors, in the neuron or in the neuron and the dendrite innervating it.
4. Lack of the neurotransmitter (lack of the nor-epinephrine as in patients suffering from nocturnal enuresis). Those patients either suffer from complete absence of nor-epinephrine, day and night enuresis; or partial absence which is much commoner, night enuresis [11].
5. Severe fear will lead to sympathetic failure; this will cause urinary and/or fecal incontinence. Temporary sympathetic failure can as well be due to getting drunk, high fever, deep anesthesia and coma.

The IUS

1. Lacerations which affect the IUS e.g. fracture pelvis, but more commonly Child-Birth Trauma (CBT).
2. Atrophy of the collagen e.g. congenital collagen atrophy, but most probably hormone deficiency like after menopause.

Childbirth trauma (CBT)

Is the commonest cause of urinary troubles among women [21-24]. Difficult vaginal delivery, repeated frequent labors not giving time for self-repair of tissues and instrumental labor can cause lacerations in the collagen chassis of the IUS causing its weakness and inability to stand sudden rise of abdominal pressure. Urine in the urethra gives urgent desire to void (Over Active Bladder-OAB) or urine dripples from the urethra on sudden increase of abdominal pressure (SUI). Once the woman feels wet, embarrassment induces reflex general sympathetic activity that increase the tone in the IAS closing the urethra preventing further leak of urine.

The internal anal sphincter (IAS): The IAS has a strong collagen chassis with collagen strands to the skin of the buttocks; plain muscle fibers are present and intermingle with the collagen chassis.

Lacerations which affect the IAS are mostly due to Child-Birth Trauma (CBT), but can be due to anal intercourse. The lacerations affect the collagen chassis and lead to its weakness causing Fecal Incontinence (FI). CBT lacerates the collagen chassis of the IAS, together with the posterior vaginal wall and the perineum leading to posterior vaginal wall prolapse and different degrees of perineal lacerations.

DISCUSSION

Voiding and defecation are complex neuro-muscular mechanisms controlled by intact healthy CNS. There are at least two types of nerve receptors, first are proprioceptors (mechanoreceptors) in the muscles (detrusor, both IUS and EUS; rectal muscle, both anal sphincters IAS and EAS) which are responsive to mechanical changes in the muscle as pressure (tension) disturbances. Second there are systemic sensory nerve endings (S. 2, 3 & 4) in the urinary bladder and the rectum carrying volume changes to the sacral centers and the CNS. The person can voluntarily, without feeling the desire to evacuate, go

to the toilet and empty the bladder and rectum by inhibiting the high sympathetic tone gained by toilet training.

Incontinence can be due to neurological causes and/or muscular causes (damage, atrophy or lacerations of the IUS and/or the IAS). Both sphincters are collagen-muscle tissue cylinders. Both sphincters are liable to lacerations from childbirth trauma.

The collagen vitality is hormone dependent and atrophy can occur due to estrogen deficiency after menopause.

In cases of constipation and gaseous distension of the colon and rectum, neural disturbance can affect proprioceptors (mechanoreceptors) and their neuronal transmission leading to blurred sensations of fullness and causes frequent desire to void small amounts of urine, Over Active Bladder (OAB) [25].

The orientation ability of the high CNS centers may be blurred by fatigue, fever and senility and sensations of full rectum may be sensed as full bladder and leads to OAB.

Neural transmission can be temporarily disturbed by factors as getting drunk or severe fear leading to urinary and/or fecal incontinence.

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