THE CONTRACTED BLADDER

Essay

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Of The Master Degree In
(Urology)

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بسم الله الرحمن الرحيم

سبحانك لا علم لنا إلا ما علمتنا إنك أنت العليم الحكيم

صدق الله العظيم

(سورة البقرة الآية ٣٢)

بسم الله الرحمن الرحيم

Contracted bladder

Descending cystogram

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Contents

PHYSIOLOGY OF THE BLADDER

Physiology of the Urinary Bladder

Campbell's, "1986" stated that the physiology of the urinary bladder is incompletely understood. The twin function of the urinary bladder of urine storage and expulsion are governed in part by a complex arrangement of reflex interactions . This interplay provides for coordination between the smooth and the striated muscle components,resulting in voiding with low intraurethral resistance as well as voluntary control of bladder function. The physiology of the urinary bladder can be classified into; the neuro-physiology of the reflex mechanisms,the physiology of the urinary detrusor and the physiology of periurethral striated muscle. (*Bradley "1986"*).

The neuro-physiology of reflex Mechanisms

This can be further divided into the central nervous system pathways and the peripheral innervation of the urinary bladder.

A- The central nervous system pathways

Those specific nuclei and pathways in the central nervous system that clinical and experimental studies have demonstrated as significant in urinary bladder control. They include the cerebral cortex, the thalamus, the basal ganglia, the limbic system , the cerebellum, the thoracolumber spinal cord and the conus medullaris.

1 - The cerebral cortex

Electrical stimulation of specific areas of the cerebral cortex in the animals initiates or inhibits urinary detrusor contraction. Ablation of specific areas of the cerebral cortex in the human results in cystometric changes, these cystometric observations revealed that destruction of a specific area of the anteroinferior portion of the prefrontal area produced an uncontrolable detrusor reflex or hyperreflexia. Electro encephalographic responses to bladder filling in humans have suggested the role of the cerebral cortex in bladder function.

2- The thalamus

These subcortical nuclei have been demonstrated to be intimately concerned with the physiology of the cerebral cortex, so they can be assumed to relay ascending impulses from the urinary bladder to the cerebral cortex. However, their role in integration of these impulses is unknown.

3- The basal ganglia

The basal ganglia have been demonstrated in both the animal and the human to influence the function of the detrusor. Other studies demonstrated that basal ganglia influences were mediated through the dorsolateral tegmental nucleus of the pons, the brain stem center for detrusor reflex contractions.

4- The limbic system

The role of the limbic system is that of control of emotional response by integration of autonomic and somatic influences. Electrical stimulation of portions of the limbic system has revealed suppression and facilitation of urinary detrusor function, however abnormalities of bladder function have not been reported in patients with unilateral or bilateral temporal lobectomy or in patients with temporal lobe epilepsy.

5- The cerebellum

The cerebellum regulates muscle tone and coordination of movement. Precisely how this is accomplished to secure coordinated contraction of the detrusor muscle with reciprocal relaxation of the periurethral striated muscle during voiding is unknown. This effect of cerebellar function on the urinary bladder is believed to be due to activation of neurons in the fastigial nucleus that transmit inhibitory impulses to the neurons of the dorsolateral tegmental nucleus of the pons. Cerebellar lesions in humans, with consequent detrusor hyperreflexia have been reported.

6- The brain stem

A specialized portion of the brain stem has been defined anatomically in the experimental animal as the nucleus in which detrusor reflex contraction is organized. This nucleus has been designated as the caudal portion of the dorsolteral tegmental nucleus of the pons and is distinct from the nucleus locus ceruleus. Whether the same designation applies to humans a waits further study. Two other nuclei in the brain stem may be implicated in voiding ; the giganto-cellularis and the vestibular nucleus which need further study to be confirmed.

7- Thoracolumbar spinal cord

The neurons of the intermediolateral cell column of the thoracolumbar spinal cord receive sensory impulses from two sources:

1- Bladder afferent impulses routing over sacral afferent pathways and a spinal cord pathway

2- Bladder afferent impulses travelling in afferent axons in hypogastric nerve.

The precise role of these afferents is undefined, but two possibilities have been suggested:

A- That these afferent impulses to thoracolumbar neurons generate motor impulses in the hypogastric nerve. These impulses relay to the pelvic ganglia, where they inhibit pelvic nerve transmission through the ganglia.

B- That hypogastric nerve afferent impulses travel to the thoracolumbar spinal cord.

Neurons in the intermediolateral cell column initiate impulses that produce either contraction of the smooth muscle of the proximal urethra by stimulating alpha-adreno receptors or relaxation By stimulation of beta-adreno receptors.

8- The conus medullaris

The physiologic responses of the neurons of the gray matter of the conus medullaris are a function of the output of the neurons of the detrusor nuclei and the out put of the neurons of the pudendal nuclei.

The physiologic mechanisms associated with afferent input to the detrusor nuclei include:

1- Long routing of afferent impulses from bladder tension receptors to the brain stem.

2- Pudendal and other somatic impulses are also conducted to detrusor motoneurons.

3- Gating of input . This effect was attributed to activation of interneurons in the sacral spinal cord. The pudendal nuclei located in the lateral portion of the ventral gray matter of the sacral spinal cord is also concerned, as stimulation of the pudendal afferents are associated with excitatory postsynaptic potentials in pudendal motoneurons, pudendal afferents reorganize with segmental and supraspinal routing of afferent impulses. This is analogus to other skeletal muscle afferents.

B- The peripheral innervation of the urinary bladder

Peripheral mechanisms include the physiology of the pelvic ganglia, neuromuscular innervation of the urinary detrusor , periurethral striated muscle and the sensory innervation of the lower urinary tract .

1 - Pelvic ganglionic transmission

Excitatory transmission resulting from activation of nicotinic acetylcholine receptors suggests that the pelvic ganglion acts as a high pass filter with maximum facilitation at a preganglionic stimulus. Frequency of 20 - 30 Hz. Stimulation of the hypogastric nerve acts to depress pelvic ganglionic transmission. Activation of vesical afferents in the pelvic nerve by bladder distension or electrical stimulation results in inhibition of the detrusor muscle and inhibition of pelvic ganglionic transmission.

2- neuro muscular transmission in the urinary detrusor muscle

Understanding of the physiology of the urinary bladder has been considerably enhanced by intracellular muscle studies of neurotransmission. Application of stimulating electrical pulses to the axonal innervation produce two episodes of depolarization. The early excitatory junction potential was unaffected by blocking agents, including atropine and guanethidine. The late potential was enhanced by administration of neostigmine and blocked by atropine. This profile of results suggests that two neurotransmitters are released at neuromuscular endings in the detrusor muscle. The first is non cholinergic and non adrenergic in its properties, and the second is acetylcholine. These results account for the classic atropine resistance of the urinary detrusor. No inhibitory responses have been observed in the urinary detrusor muscle in response to stimulation of the motor innervation . The mechanism of coordination of detrusor muscle contraction to produce smooth rise in intravesical pressure is unknown. Stretch induced depolarization may contribute to this response. (*Uvelus & Gabella, "1980"*) .

3- Physiology of the smooth muscle of the proximal urethra

Urodynamic, roentgenographic and urethral pressure profile data indicated the importance of sympathetic impulses in producing urethral dilation during detrusor contraction. (*Kaneko et. al, "1980"*) .

4- Physiology of the periurethral striated muscle

The periurethral striated muscle consists of slow twitch fibers. The process of neuromuscular transmission proved to be only partly cholinergic and to be resistant to total blockade by neuromuscular blocking agents. The periurethral striated muscle and striated portion of the rectal sphincter act in concert. (*Bradley et. al. "1974"*) .

5- Physiology of muscle spindles

The morphology of a muscle spindle comprises two muscle groups at either end of a spindle. The muscles contract in response to action potentials in their gamma axonal innervation, when this occurs tension is generated on the sensory endings in the equatorial region of the spindle. Changing its sensitivity with sudden applied stretch to the spindle from the surrounding skeletal muscle, impulses are generated that pass in the sensory axons to the spinal cord. Increased activity in the gamma efferents to bladder distension has been described. (*Bradley "1986"*) .

The function of the bladder

The function of the bladder can be summarised under the following:

1- Bladder filling. 2- Bladder emptying.

3- The physiology of continence. 4- Urodynamic aspects.

1- Bladder filling

During slow filling of the bladder it accommodates an increasing volume of the fluid at a constant pressure, but the mural tension increases as the volume of the fluid rises "Laplace low". This adaptation of the detrusor muscle to the increasing distension has been correllated with the elastic properties of the smooth muscles. During the filling of the bladder sensory impulses result from stimulation of both tension receptors located in the layers of the collagen surrounding smooth muscle bundles, and stretch receptors in the pelvic floor musculature. These sensory impulses activate many areas in the central nervous system. When the bladder is full to capacity the urge to micturation occur with a rapid rise in the vesical pressure, which is associated with detrusor contraction due to afferent impulses via the parasympathetic nerve, which can be inhibited by the higher centers for a certain level.

2- Bladder emptying

When micturation is desired a complex coordination occurs with relaxation of the pelvic floor striated muscles from reflex depression of the pudendal motor nerve discharge, with contraction of the detrusor muscle which in turn actively opens the bladder neck and allows voiding to occur. The detrusor contract smoothly and isometrically and an active tension