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NURSING SCIENCE

200 LEVEL

PHS212

Explain the process of Micturition.

Micturition

Micturition or urination is the process of expelling urine from the bladder. This act is also known as voiding of the bladder. The excretory system in humans includes a pair of kidneys, two ureters, a urinary bladder and a urethra. The kidneys filter the urine and it is transported to the urinary bladder via the ureters where it is stored till its expulsion. The process of micturition is regulated by the nervous system and the muscles of the bladder and urethra. The urinary bladder can store around 350-400ml of urine before it expels it out.

Micturition has two discrete phases: the storage/continence phase, when urine is stored in the bladder; and the voiding phase, where urine is released through the urethra. These phases require coordinated contraction/relaxation of the bladder and urethral sphincters, which are all under control of the sympathetic, parasympathetic and somatic nervous systems.

STORAGE PHASE

The storage phase of micturition is controlled at the highest level by continence centres of the brain. These in turn control the continence centres of the spinal cord. Storage of urine requires relaxation of the detrusor muscle of the bladder, and simultaneous contraction of both the internal (IUS) and external (EUS) urethral sphincters.

The bladder and IUS are primarily under the control of the sympathetic nervous system. The EUS is under the control of the somatic nervous system.

Sympathetic innervation

To stimulate storage, impulses from the cerebral cortex travel to the pons. The pons is responsible for coordinating the actions of the urinary sphincters and the bladder, and the area involved in the storage phase is the pontine continence centre (in the L-Region of the pons).

From here, signals are sent to the sympathetic nuclei in the spinal cord, and finally to the detrusor muscle and internal urethral sphincter (IUS) of the bladder.

The impulses travel from the spinal cord to the bladder via the sympathetic hypogastric nerve (nerve roots T10-L2). At the bladder, this stimulates:

*Relaxation of the detrusor muscle in the bladder wall – via stimulation of β3-adrenoreceptors in the fundus and the body of the bladder.

*Contraction of the internal urethral sphincters – via stimulation of α1-adrenoreceptors at the bladder neck.

Somatic Innervation

The EUS is under voluntary somatic control. In the storage phase, impulses travel to the EUS via the pudendal nerve (nerve roots S2-S4) to nicotinic (cholinergic) receptors on the striated muscle, resulting in contraction of the sphincter.

This coordinated relaxation of the detrusor muscle and contraction of the urethral sphincters allows the bladder to fill with urine, store it for many hours. As the bladder fills, the folds in the bladder walls (rugae) flatten and the walls distend, increasing the capacity of the bladder. This means that as the bladder fills, it expands, allowing the inner (intra-vesical) pressure to remain the constant and lower than urethral pressure. This process known as receptive relaxation is vital to the storage of urine and prevents leakage during this phase.

Voiding phase

During this stage, both the urinary bladder and the urethra come into play together. The detrusor muscle of the urinary bladder which was relaxing so far starts to contract once the bladder's storage capacity is reached.

The urethra is controlled by two sets of muscles: The internal and external urethral sphincters. The internal sphincter is a smooth muscle whereas the external one is skeletal. Both these sphincters are in a contracted state during the filling stage.

the process of micturition is governed by both the nervous and muscular systems. Within the nervous system, the process is governed by the autonomous nervous system and the somatic system. Once the urinary bladder reaches its maximum capacity, the stretch receptors in the walls of the bladder send an impulse via the pelvic nerve to the brain via the spinal cord.

Micturition is also known as the voiding phase of bladder control and it is typically a short-lasting event. Urinary flow rate in a full bladder is:

*20-25ml/s in men

*25-30ml/s in women

Whilst the capacity of the bladder varies from roughly 300-550ml, afferent nerves in the bladder wall signal the need to void the bladder at around 400ml of filling.

The micturition reflex is ultimately generated from the level of the spinal cord after it receives reflexes from the pontine region in the brain. Once the bladder and the urethra receive the signals to empty the bladder, the two sphincters relax and the detrusor muscle causes the contractions of the bladder.

Along with these muscles, the muscles of the abdomen also play a role by putting pressure on the bladder wall. This leads to complete emptying of the bladder.

Regulation of Micturition

Passing of urine is under parasympathetic control. Bladder afferents signals ascend through the spinal cord and then project to the pontine micturition centre and cerebrum. Upon the voluntary decision to urinate, neurones of the pontine micturition centre fire to excite the sacral preganglionic neurones.

There is subsequent parasympathetic stimulation to the Pelvic Nerve (S2-4) causing a release of ACh, which works on M3 muscarinic ACh receptors on the detrusor muscle, causing it to contract and increase intra-vesicular pressure. The pontine micturition centre also inhibits Onuf's nucleus, with a resultant reduction in sympathetic stimulation to the internal urethral sphincter causing relaxation.

Finally, a conscious reduction in voluntary contraction of the external urethral sphincter from the cerebral cortex allows for distention of the urethra and the passing of urine. In the female, urination is assisted by gravity, while in the male, bulbospongiosus contractions and squeezing along the length of the penis helps to expel all of the urine.

Voluntary control

The mechanism by which voluntary urination is initiated remains unsettled .One possibility is that the voluntary relaxation of the muscles of the pelvic floor causes a sufficient downward tug on the detrusor muscle to initiate its contraction. Another possibility is the excitation or disinhibition of neurons in the pontine micturition center, which causes concurrent contraction of the bladder and relaxation of the sphincter.

There is an inhibitory area for micturition in the midbrain. After transection of the brain stem just above the pons, the threshold is lowered and less bladder filling is required to trigger it, whereas after transection at the top of the midbrain, the threshold for the reflex is essentially normal. There is another facilitatory area in the posterior hypothalamus. In humans with lesions in the superior frontal gyrus, the desire to urinate is reduced and there is also difficulty in stopping micturition once it has commenced. However, stimulation experiments in animals indicate that other cortical areas also affect the process.

The bladder can be made to contract by voluntary facilitation of the spinal voiding reflex when it contains only a few milliliters of urine. Voluntary contraction of the abdominal muscles aids the expulsion of urine by increasing the pressure applied to the urinary bladder wall, but voiding can be initiated without straining even when the bladder is nearly empty.

Voiding can also be consciously interrupted once it has begun, through a contraction of the perineal muscles. The external sphincter can be contracted voluntarily, which will prevent urine from passing down the urethra.

Experience of urination

The need to urinate is experienced as an uncomfortable, full feeling. It is highly correlated with the fullness of the bladder. In many males the feeling of the need to urinate can be sensed at the base of the penis as well as the bladder, even though the neural activity associated with a full bladder comes from the bladder itself, and can be felt there as well. In females the need to urinate is felt in the lower abdomen region when the bladder is full. When the bladder becomes too full, the sphincter muscles will involuntarily relax, allowing urine to pass from the bladder. Release of urine is experienced as a lessening of the discomfort.

TECHNIQUES FOR MICTUTITION

Due to the positions where the urethra exits the body, males and females often use different techniques for urination.

Male urination:

Most males prefer to urinate standing while others prefer to urinate sitting or squatting. Elderly males with prostate gland enlargement may benefit from sitting down while in healthy males, no difference is found in the ability to urinate.

For practising Muslim men, the genital modesty of squatting is also associated with proper cleanliness requirements or awrah.

Female urination:

In human females, the urethra opens straight into the vulva. Hence, urination can take place while sitting or squatting for defecation.

Clinical disorders

*Urinary retention; the inability to initiate urination

*Overactive bladder; a strong urge to urinate, usually accompanied by detrusor overactivity

*Interstitial cystitis; a condition characterized by urinary frequency, urgency, and pain

*Prostatitis, an inflammation of the prostate gland that can cause urinary frequency, urgency, and pain

*Benign prostatic hyperplasia, an enlargement of the prostate that can cause urinary frequency, urgency, retention, and the dribbling of urine

*Urinary tract infection(UTI)which can cause urinary frequency and dysuria

*Polyuria, abnormally large production of urine, associated with, in particular, diabetes mellitus (types 1 and 2), and diabetes insipidus

*Oliguria, low urine output, usually due to a problem with the upper urinary tract

*Anuria refers to absent or almost absent urine output.