NAME- AFABOR MARIAN OGHENERUME

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QUESTION

WRITE A SHORT NOTE ON MICTURITION

We depend on micturition (urination) to eliminate organic waste products, which are produced as a result of cell metabolism in the body. The urinary system also regulates the concentrations of sodium, potassium, chloride and other ions in the blood as well as helping to maintain normal blood pH, blood pressure and blood volume. This article will concentrate on how urine is produced, stored in the bladder and excreted from the body, and will summarize some of the problems that may cause urinary incontinence.

Formation of urine

There are two kidneys which are bean-shaped and are approximately 10cm long, 5.5cm wide and 3cm thick. Each kidney weighs about 150g and has a marked indentation medially - the hilus - where the renal artery and renal nerves enter and the renal vein and ureter leave. Between them, the kidneys make approximately 30ml or more of urine every hour.

Approximately 25 per cent of the cardiac output goes to the kidneys where organic waste products are removed in the million or so nephrons in each kidney. Normal urine production, therefore, depends on normal blood flow to the kidneys. The nephron is the functional unit of the kidney. Nephrons permit the passage of some substances out of the body but restrict the passage of others, for example, blood cells and large proteins.

Filtration

As blood flows through the glomerulus (a capillary network that forms part of the nephron), much of the fluid and waste products in the blood are forced out through the walls of the capillaries, filtered, and then flow into the Bowman's capsule. The Bowman's capsule is a double-walled endothelial cup that surrounds the glomerulus. This glomerular filtrate (about 125ml per minute) consists of water, glucose, waste salts such as sodium and potassium, and urea. Urea is the most abundant waste product excreted by the Kidneys and is formed from ammonia, a highly toxic substance. Ammonia is formed in the liver from the breakdown of amino acids.

Absorption

Much of the glomerular filtrate, including most of the water, is reabsorbed into the capillaries surrounding the proximal and distal convoluted tubules, the loop of Henle and the collecting tubules. All of the glucose will be reabsorbed unless blood glucose levels are high more than 8.9 mill moles per liter (mmol/l) or 160 milligrams per deciliter (mg/dl) in which case some glucose will be excreted in the urine. Sodium is also reabsorbed but the amount varies, depending on how much the body requires to maintain a constant concentration of sodium ions in the blood.

Secretion

This is the final stage of urine formation, and occurs at the distal and collecting tubules. Substances either diffuse or are actively transported out of the capillaries and into the collecting tubules to be excreted in the urine. Hydrogen ions, potassium ions, ammonia and some drugs are all secreted at this stage and the kidneys play an important role in maintaining the acid-base balance within the body.

Final composition of urine

The final composition of urine is the result of filtration, absorption and secretion by the nephrons. The kidneys produce, on average, one and a half liters of urine each day - this is mostly composed of water, is straw colored and has a specific gravity of 1.005 to 1.030.

Urea, uric acid, creatinine, sodium chloride and potassium ions are all normal constituents of urine. Blood, ketones and glucose are not, and their presence may indicate disease.

The ureters

Urine passes from the kidneys to the bladder through the ureters where it is stored until it is eliminated via the urethra. Urine is moved along the ureters to the bladder by peristaltic contraction and gravity. The ureters are muscular tubes about 30cm long. They are firmly attached to the posterior abdominal wall and are retroperitoneal; they do not enter the peritoneal cavity. The ureteral openings into the bladder are flattened (slit-shaped) rather than round. This is due to the oblique angle at which the ureters enter the bladder, which helps to prevent the back-flow of urine into the ureters when the bladder contracts.

Storage of urine

The bladder is a hollow, muscular sac which sits in the pelvis. In males, the base of the bladder lies between the rectum and pubic symphysis while in females the base is below the uterus and anterior to the vagina. The bladder stores urine and can contain approximately one litre when full. It is held in position by the peritoneum surrounding it (though only its top surface lies within the peritoneum) and by strong umbilical ligaments.

The bladder is lined by mucosa. This is particularly thick in the area around the ureter openings and the junction with the urethra, where the mucosa acts as a funnel to channel urine into the urethra when the bladder contracts. During micturition, strong muscles in the bladder walls (the detrusor muscles) compress the bladder, pushing its contents into the urethra.

Control of bladder emptying

The opening, described as the neck of the bladder, between the bladder and the urethra, is closed by two rings of muscle - the internal and external sphincters. The internal sphincter contains smooth muscle fibers and the normal muscle tone of these fibers keeps it contracted; it is therefore not under voluntary control. The external sphincter is formed of a circular band of skeletal muscle which is supplied by the pudenda nerve and is under voluntary control. These fibers remain contracted, as a result of central nervous system stimulation, except during micturition when they relax.

The urethra

The urethra leaves the bladder at its most inferior point and extends from there to the outside of the body. In women, this exits near the anterior wall of the vagina and is 3-5cm long. Because the urethra is short and exits so close to the anus, women are particularly prone to urinary tract infections.

In men, the urethra extends to the tip of the penis, a total distance of up to 20cm (Martini, 2002). It has four sections:

- The prostatic urethra, which passes through the center of the prostate gland;

- The membranous urethra, the short middle portion, goes through the muscular pelvic floor;

- The bulbar urethra, which is surrounded by corpus spongiosum. Contraction of these muscle fibers assist with emptying the urethra at the end of micturition;

- The penile urethra, which reaches the tip of the penis.

MICTURITION

At its most basic level, micturition is a simple reflex which is displayed by infants who are not toilet-trained. When the volume of urine in the bladder reaches about 250ml, stretch receptors in the bladder walls are stimulated and excite sensory parasympathetic fibers which relay information to the sacral area of the spine. This information is integrated in the spine and relayed to two different sets of neurons. Parasympathetic motor neurons are excited and act to contract the detrusor muscles in the bladder so that bladder pressure increases and the internal sphincter opens. At the same time, somatic motor neurons supplying the external sphincter via the pudenda nerve are inhibited, allowing the external sphincter to open and urine to flow out, assisted by gravity.

Control of micturition

Children and adults have considerable control over when and where they pass urine. They can also increase or decrease the rate of flow and even stop and start again, so micturition is clearly more than just a simple reflex. This control is learnt in infancy and involves other sensory fibers in the bladder wall. These fibers convey information on the degree of bladder fullness via the spine to the higher centers of the brain, the thalamus and cerebral cortex. This causes us to become aware that we need to pass urine and of the urgency of the situation. These links between the spine and cerebral cortex are not established until about two years of age and it is suggested that toilet-training is therefore not physiologically possible until that time.

The brain is able to override the micturition reflex by inhibiting the parasympathetic motor nerve fibers to the bladder and reinforcing contraction of the external sphincter. The internal sphincter will not open until the external sphincter does.

The increase in bladder volume increases stretch receptor and nerve activity, making the sensation of pressure more acute. When it is convenient, the brain centers remove the inhibition and permit micturition under our conscious control. When the bladder contains about 500ml, pressure may force open the internal sphincter; this in turn forces open the external sphincter and urination occurs whether it is convenient or not.

We can increase the rate of urine flow by contraction of the abdominal muscles and by the performance of Valsalva's man oeuvre (forced expiration against a closed glottis). Contraction of the strong pelvic floor muscles can stop urine in mid-flow. The sound of running water also encourages micturition but some people cannot urinate in the presence of others, no matter how great their need.

After micturition, less than 10ml of urine remains in the bladder and the cycle begins again.

Potential problems associated with micturition

For normal micturition to occur we need:

- Intact nerve pathways to the urinary tract;

- Normal muscle tone in the detrusors, sphincters and pelvic floor muscles;

- Absence of any obstruction to urine flow in any part of the urinary tract;

- Normal bladder capacity;

- Absence of environmental or psychological factors which may inhibit micturition.

Loss of any of these normal functions may result in incontinence or urgency to micturate.

Neurological disorders may include stroke, Alzheimer's disease or any condition where nerve pathways to and from the spine and brain are blocked or injured. The neurotransmitter acetylcholine (ACh) is involved in the relaying of nerve signals in micturition. ACh can be blocked with the drug atropine, so the detrusor muscle will not contract and retention of urine will occur.

Stress incontinence can occur at any age. It occurs when abdominal pressure rises, for example when sneezing or coughing. The normally acute angle between the bladder and urethra is lost when abdominal pressure rises slightly, causing pressure in the bladder to rise.

Laxity and weakness of muscles at the bladder neck, around the urethra and in the pelvic floor will mean that incontinence occurs with relatively small pressure changes. Stress incontinence can occur in men following prostatectomy, and in women after childbirth and during the menopause due to decreased oestrogen secretions.

Renal stones, inflammation and an enlarged prostate gland may all obstruct the flow of urine and may result in frequency of micturition and retention of urine. Bladder tumors and pregnancy also reduce normal bladder capacity. Environmental and psychological factors can also affect a patient's ability to pass urine.

Conclusion

Micturition requires the coordinated activity of sympathetic, parasympathetic and somatic nerves. It also requires normal muscle tone and freedom from physical obstruction and psychological inhibition. Control from our higher brain centers allow us to determine the right time and place to allow this important physiological function to occur.