**ALADE EMMANUEL ADEMOLA**

**18/MHS07/006**

**PHARMACOLOGY**

**ASSIGNMENT**

1. **Discuss the renal handling of glucose and electrolyte**
2. **Discuss the physiology of micturition**
3. **The renal handling of glucose :**The kidney contributes to glucose homeostasis through processes of gluconeogenesis, glucose filtration, glucose reabsorption, and glucose consumption. Each of these processes can be altered in patients with type-2 diabetes (T2DM), providing potential targets for novel therapies. Recent studies have indicated that the kidney is responsible for up to 20% of all glucose production via gluconeogenesis. In patients with T2DM, overall glucose production increases by as much as 300%, with equal contributions from hepatic and renal sources. This increased production contributes not only to increased fasting glucose in T2DM patients but also to raised postprandial glucose because, in contrast to the liver, glucose ingestion increases renal gluconeogenesis. Under normal circumstances, up to 180 g/day of glucose is filtered by the renal glomerulus and virtually all of it is subsequently reabsorbed in the proximal convoluted tubule. This reabsorption is effected by two sodium-dependent glucose cotransporter (SGLT) proteins. SGLT2, situated in the S1 segment, is a low-affinity high-capacity transporter reabsorbing up to 90% of filtered glucose. SGLT1, situated in the S3 segment, is a high-affinity low-capacity transporter reabsorbing the remaining 10%. In patients with T2DM, renal reabsorptive capacity maladaptively increases from a normal level of 19.5 to 23.3 mmol/l/min. Once glucose has been reabsorbed into the tubular epithelial cells, it diffuses into the interstitium across specific facilitative glucose transporters (GLUTs). GLUT1 and GLUT2 are associated with SGLT1 and SGLT2, respectively.

**The renal handling of electrolyte:** The effect of long-term ethanol feeding on the activity of (Na + K)-ATPase in cortex and outer medulla and fractional excretion of electrolytes in remnant kidney of adult rats after unilateral nephrectomy were studied. Wistar adult rats were fed 20% (v/v) aqueous ethanol solution as sole drinking fluid for 8-10 weeks. Right kidney was removed under ether anaesthesia. The animals were subjected to an acute NaCl loading by means of a continuous infusion given 2, 7 and 14 days after nephrectomy. Renal handling of electrolytes was estimated from fractional excretion of sodium and potassium. After the infusion the animals were killed and (Na + K)-ATPase and Mg2+-ATPase activities were measured in the cortex and outer medulla of the remnant kidney. Two days after nephrectomy both groups showed a gradual increase of renal (Na + K)-ATPase activity reaching 60 percent at day 14. Mg2+-ATPase activity did not change with respect to basal values. Compared to basal values the fractional excretion of sodium after nephrectomy, dropped in both groups but more significantly in the ethanol-fed rats than in the control group. Fractional excretion of potassium did not change in the control group after nephrectomy while the ethanol-fed group displayed a significative decrease at days 7 and 14. According to our results the rise in renal (Na + K)-ATPase activity is consistent with the renal sodium retention found in ethanol-fed rats.

## **Physiology of micturition: Micturition**

At its most basic level, micturition is a simple reflex (Silverthorn, 2003) which is displayed by infants who are not toilet-trained (Fig 3).

When the volume of urine in the bladder reaches about 250ml, stretch receptors in the bladder walls are stimulated and excite sensory parasympathetic fibres which relay information to the sacral area of the spine. This information is integrated in the spine and relayed to two different sets of neurones. Parasympathetic motor neurones 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 neurones supplying the external sphincter via the pudendal 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 fibres in the bladder wall. These fibres convey information on the degree of bladder fullness via the spine to the higher centres 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 (Martini, 2002).

The brain is able to override the micturition reflex by inhibiting the parasympathetic motor nerve fibres to the bladder and reinforcing contraction of the external sphincter (Martini, 2002). 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 centres 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 manoeuvre (forced expiration against a closed glottis) (McLaren, 1996). Contraction of the strong pelvic floor muscles can stop urine in mid-flow. The sound of running water also encourages micturition (Silverthorn, 2003) 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 (Martini, 2002) 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 (McLaren, 1996).

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 (McLaren, 1996).

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 tumours 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 centres allow us to determine the right time and place to allow this important physiological function to occur.