**Clinical Chemistry**

**INVESTIGATION OF RENAL FUNCTION**

***Function of the kidney:***

The function unit in the kidney is the nephron, shown in Figure 1. The kidney regulate Extra Cellular Fluid (ECF) volume and electrolyte composition to compensate for wide daily variations in water and electrolyte intake. They form urine in which the potentially toxic waste products of metabolism are excreted. The functions of the kidneys therefore include:

1- Regulation of water, electrolytes and acid-base balance.

2-Excretion of the products of protein and nucleic acid metabolism: urea, creatinine, creatine, uric acid, sulphate and phosphate.

The kidneys are also endocrine organs, producing a number of hormones, and are subject to control by other (Fig. 1). Arginine vasopressin (AVP) acts to influence water balance, and aldosterone affects sodium reabsorption in the nephron. Parathyroid hormone promotes tubular reabsorption of calcium, phosphate excretion and synthesis of 1,25 dihydroxycholecalciferol, which regulates calcium absorption by the gut.



**Fig. 1: Endocrine links in the kidney.**

***TESTS OF GLOMERULAR FUNCTION:***

The glomerular filtration is an ultrafiltrate of plasma, and has the same composition as plasma without most of the proteins. Plasma is filtered by the glomeruli at a rate of approximaltely 140 ml/minute. A normal glomerular filtration rate (GFR) will depend on there being normal renal blood flow and pressure. GFR is directly related to body size, and consequently is higher in men than women. It is also affected by age, declining in the elderly.

If the GFR falls due to restriction of the renal blood supply, or as a result of destruction of nephrons by renal disease, there is retention of the waste products of metabolism in the blood. In chronic disease. A new ‘steady state’ is reached with a constant elevation in the serum concentration of substances such as urea and creatinine. As the renal disease progresses, urea and creatinine concentration may increase slowly over many months.

**Creatinine clearance:**

An estimate of the GFR can be calculated from the creatinine content of a 24-hour urine collection, and the plasma concentration within this period. The ‘clearance’ of creatinine from plasma is directly related to the GFR.

The GFR is calculated as follows:

**GFR = U × V/P**

U = urine concentration of creatinine

P= serum or plasma concentration of creatinine

V= urine flow in ml/min

Note: that these be in the *same units*.

A common mistake is to consider V as urine volume, which it is not. It is the urine volume collected in 24 hours, and this figure is divided by 24 x 60 to give the volume produced per minute.

Serum urea concentration is less useful as s measure of glomerular function. Dietary protein intake affects serum urea concentration. Gastrointestinal bleeding will cause serum urea to be elevated, and this does not indicate that glomerular filtration is compromised. Urea is reabsorbed in the tubules. This reabsorption increases at low urine flow rates.

**Proteinuria:**

The glomerular basement membrane does not usually allow passage of albumin and large proteins. A small amount of albumin, usually less than 25 mg/24h, is found in urine. When larger amounts, I excess of 250 mg/24h, are detected, significant damage to the glomerular membrane has occurred. Quantitative urine protein measurements should always be made on complete 24-hour urine collections. Albumin excretion in the range 25-300 mg/24h is termed microalbuminuria.

**Renal Acidosis:**

Renal acidosis may be characterized as follows:

1-Type I. there is a defective hydrogen ion secretion in the distal tubule which may be inherited or acquired.

2- Type II. The capacity to reabsorb bicarbonate in the proximal tubule is

reduced.

3- Type III. Bicarbonate reabsorption by the renal tubule is impaired as a

consequence of aldosterone deficiency, aldosterone receptor defects, or

drugs which block aldosterone action.

**Glycosuria**:

The presence of glucose in urine when blood glucose is normal usually reflects the inability of the tubules to reabsorb glucose because of the a specific tubular lesion. Here, the renal threshold (the capacity for the tubules to reabsorb the substance in question) has been reached. This is called renal glycosuria and is a benign condition.

**Aminoaciduria:**

Normally, amino acids in the glomerular filtrate are reabsorbed in the proximal tubules. They may be present in urine in excessive amount because the plasma concentration exceeds the renal threshold, or because there is specific failure of normal tubular reabsorptive mechanisms., such as in the inherited metabolic disorder, cystinuria, or more commonly because of acquired renal tubular damage.

**Renal Stones:**

Renal stones produce severe pain and discomfort, and are common causes of obstruction in the urinary tract (Fig. 2). Chemical analysis of renal stones is important in the investigation of why they have formed. Types of stone include:

1- *Calcium phosphate*: may be a consequence of primary hyperparathyroidism or renal tubular acidosis.

2- *Magnesium, ammonium and phosphate*: these are often associated with

urinary tract infections.

3- *Oxalate*: may be a consequence of hyperoxaluria.

4- *Uric acid*: may be a consequence



**Fig. 2: Renal stone.**

***ACUTE RENAL FAILURE:***

Renal failure is the cessation of kidney function. In acute renal failure (ARF), the kidneys fail over a period of hours or days. Chronic renal failure (CRF) develops over months or years and leads eventually to end stage renal failure (ESRF). ARF may be reversed and normal renal function regained, whereas CRF is irreversible.