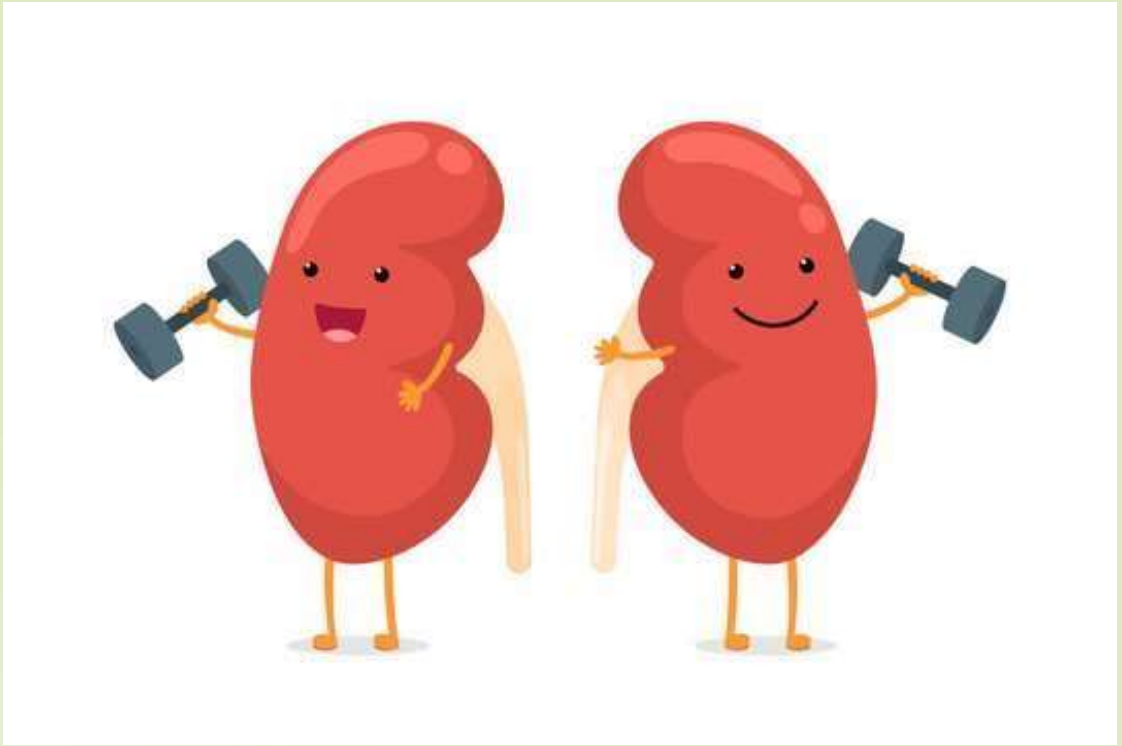

RENAL FUNCTION TEST

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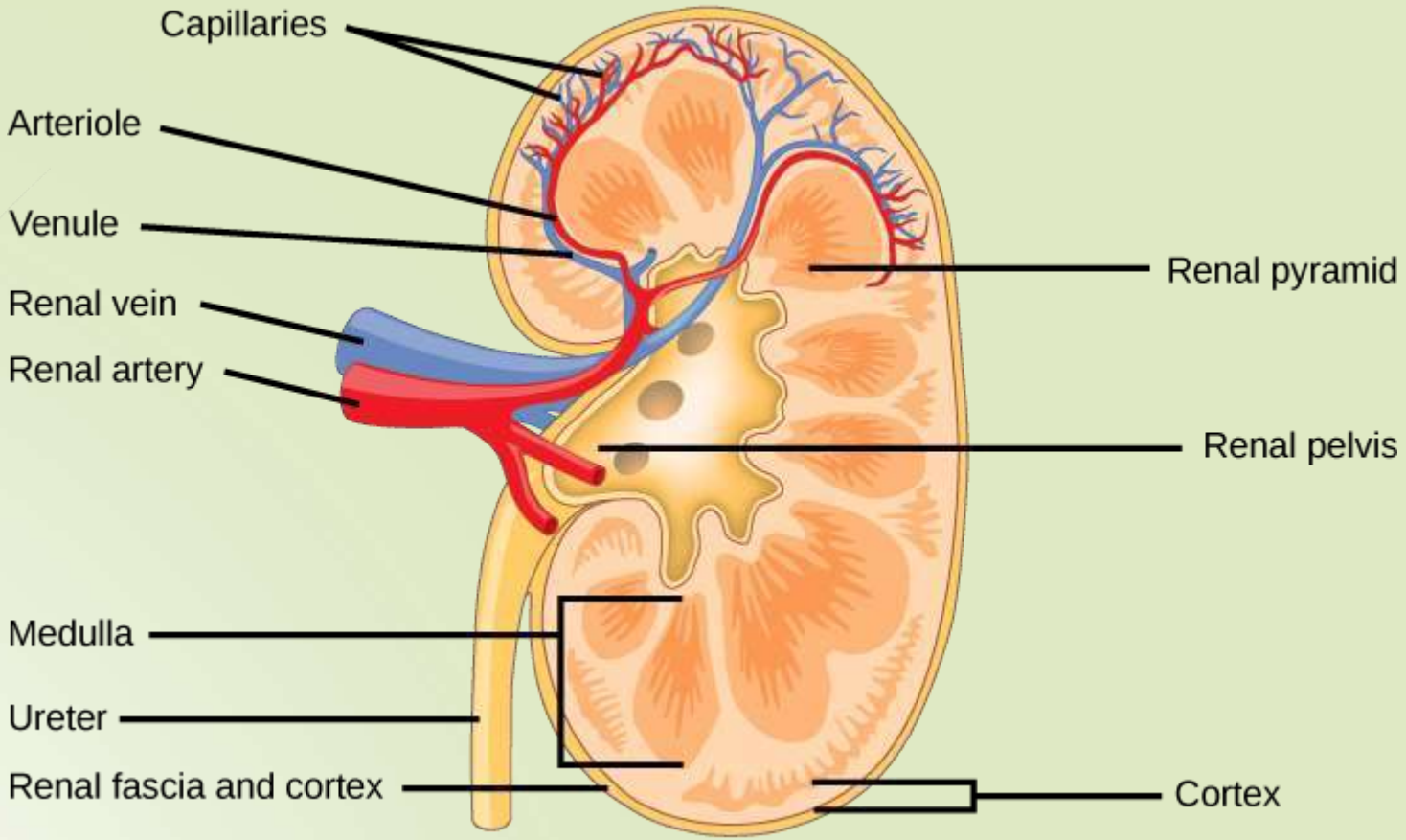

Figure 1. The internal structure of the kidney is shown. (credit: modification of work by NCI)

- Externally, the kidneys are surrounded by three layers:
  a. Renal fascia
  b. Perirenal fat capsule
  c. Renal capsule
- Internally, the kidney has three regions:
  a. An outer cortex
  b. A medulla in the middle
  c. Renal pelvis in the region called the hilum of the kidney
- Hilum is the concave part of the bean-shape where blood vessels and nerves enter and exit the kidney.
- Renal cortex is granular due to the presence of nephrons—the functional unit of the kidney.

Objectives

- Enumerate the functions of kidney
- Discuss the biochemical test which are done to assess the function of kidney
- Discuss the abnormalities in biochemical tests associated with renal impairment

Kidney Functions

- Excretory
- Homeostatic
- Endocrine
- Metabolic

Renal Function

I. Excretory Functions

- Formation and excretion of urine
  - ✓Glomerular filtration
  - ✓ Tubular reabsorption
  - ✓ Tubular secretion
- Excreting toxic substances in synergy with liver

II. Homeostatic function

- Regulation of blood volume
- Regulation of blood pH
- Regulation of serum electrolytes; Na, K, Cl and Ca
- Reabsorption of essential nutrients

Renal Function

III. Endocrine function
- Erythropoietin
- Renin Angiotensin system
- Vitamin D activation
- Degradation of hormones like insulin and aldosterone

IV. Metabolic function
- Along with liver site for gluconeogenesis

Renal function tests; Why needed?

- To assess functional capacity of kidneys
- To diagnose renal impairment
- To assess the severity and progression of renal impairment
- To assess the effectiveness of treatment

Causes of renal disease

1. Pre-renal
    a. Any condition that results in reduced blood flow to kidneys
        - Severe blood loss
        - Hemolysis
2. Renal
    a. Damage to renal tissue, glomerular basement membrane or tubules
        - Glomerulonephritis
        - Diabetic or hypertensive nephropathy
        - Tubular damage due to toxic substances
3. Post Renal
    a. Obstruction to urine outflow
        - Ureteric or urethral stone
        - Prostatic cancer

Renal function test

Can be divided into:

1. Test for glomerular function
    a. Serum Urea
    b. Serum Creatinine
    c. Clearance tests
2. Tests for tubular function
    a. Urine concentration test
    b. Dilution test
    c. Para amino hippuric acid clearance test
    d. Acidification test
3. Urine examination
    a. Important for assessing both glomerular and tubular function

Renal function test

The following parameters are commonly included in assessing renal function:

- Serum Urea
- Serum Creatinine
- Serum Uric acid
- Total protein
- Serum albumin
- Serum electrolytes
  i. Sodium (Na)
  ii. Potassium (K)
  iii. Chloride (Cl)
  iv. Phosphate (PO4)
  v. Calcium (Ca)

Renal Function Tests

- Complete hemogram
  i. Hemoglobin
  ii. Total RBC
  iii. RBC indices
    - MCH
    - MCV
    - MCHC
    - PCV
    - RDW
  iv. ESR

Routine urine examination

1. Physical appearance
   - Colour
   - pH
   - Specific gravity
2. Analytes
   - Protein
   - Glucose
   - Ketones
   - Bilirubin
   - Urobilinogen
   - Leucocyte
   - Nitrite
3. Microscopy
   - RBC
   - Pus cells
   - Epithelial cells
   - Casts
   - Crystals
4. 24 hour urine protein
5. Albumin/creatinine ratio (ACR)

Clearance test

- Clearance of substance is defined as the volume of plasma that is cleared of that substance in unit time.
- Inulin clearance accurately measures GFR as it is neither secreted or absorbed by the renal tubules.
- However it is not routinely done in patients.
- In clinical setting estimated GFR (eGFR) is more commonly used; it is calculated from serum creatinine value.

Estimated GFR

- The Cockcroft-Gault formula for estimating creatinine clearance (CrCl) is routinely as a simple means to provide a reliable approximation of residual renal function in all patients with CKD. The formulas are as follows:
- CrCl (male) = ([140-age] × weight in kg)/(serum creatinine × 72)
- However this has been extensively modified and there are online calculators of eGFR from serum creatinine and body weight of patients.
- The eGFR is used to determine the stage of chronic kidney disease.

Changes in serum analytes in kidney disease

1. Serum Urea and creatinine
   - They both are increased in renal disease.
   - Urea increases more in glomerular disease as compared to creatinine.
   - Urea is a less reliable indicator than creatinine as it is affected by many factors such as;
     a. Protein intake
     b. Dehydration
     c. Muscle breakdown
2. Serum Uric acid
   - It may increase in chronic kidney disease but not sufficient to cause gout.
   - However raised uric acid is a bad prognostic indicator for chronic renal disease.

Changes in serum analytes in kidney disease

3. Total protein and albumin
   - Both serum total protein and albumin is decreased in chronic kidney disease (CKD) due to increased proteinuria.
   - Even though proteinuria may also be seen in acute kidney disease but it usually does not alter the total protein and albumin.
4. Serum electrolytes
   - Sodium is decreased (hyponatremia) and potassium is increased (hyperkalemia) in chronic kidney disease (CKD) as kidney reabsorb sodium in exchange of potassium.
   - Chloride and phosphate is increased in CKD.
   - Calcium is decreased as vitamin D is deficient.

Changes in hemogram and urine analysis in kidney disease

- RBC count and hemoglobin is decreased in advanced stages of kidney disease due to deficiency of erythropoietin.
- Urine examination reveals:
  i. Proteinuria is seen in both acute and chronic kidney disease as well as kidney infection.
  ii. Proteinuria can be of two types:
    - ✓ In the initial stages very less amount of albumin escapes into urine; microalbuminuria (30 to 300 mg/day)
    - ✓ Frank proteinuria (when it is greater than 300 mg/day)
    - ✓ Best evaluated in 24 hour urine sample
    - ✓ In spot urine albumin/ creatinine ratio is used to evaluate proteinuria

Changes in hemogram and urine analysis in kidney disease

i. Presence of RBC may indicate glomerulonephritis , acute nephritis, kidney infection.

ii. Presence of pus cells, esterase positivity, nitrites may indicate bacterial infection.

Tests for tubular function

I. Urine concentration test
   - In CKD kidneys loses the ability to concentrate urine.
   - Specific gravity is measured in urine.
   - Low fixed specific gravity is indicative of chronic kidney disease.

II. Dilution test
   - After overnight water deprivation patient is asked to take 1200ml of water in half hour, urine specific gravity is measured in samples collected over next 4 hours. At least one sample should show sp gr of 1.003 or below

Tests for tubular function

III. Para amino hippuric acid clearance test
   - PAH is unique in that it is completely excreted in one passage through kidney as it is both filtered and secreted.
   - Therefore clearance of PAH is a measure of renal plasma flow.

IV. Acidification test
   - In this the ability to acidify urine is tested after administering 0.1g/kg ammonium chloride gelatin coated samples.


Thank You