Renal Function Tests

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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

• Excretory Functions
  • Formation and excretion of urine
    • Glomerular filtration
    • Tubular reabsorption
    • Tubular secretion
  • Excreting toxic substances in synergy with liver

• 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

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

• 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

• Pre-renal
  • Any condition that results in reduced blood flow to kidneys
    • Severe blood loss
    • Hemolysis

• Renal
  • Damage to renal tissue, glomerular basement membrane or tubules
    • Glomerulonephritis
    • Diabetic or hypertensive nephropathy
    • Tubular damage due to toxic substances

• Post Renal
  • Obstruction to urine outflow
    • Ureteric or urethral stone
    • Prostatic cancer

This list not exhaustive, these are only few common causes of renal disease
Renal function test

• Can be divided into two categories
  • Test for glomerular function
    • Serum Urea
    • Serum Creatinine
    • Clearance tests
  • Tests for tubular function
    • Urine concentration test
    • Dilution test
    • Para amino hippuric acid clearance test
    • Acidification test
• Urine examination
  • Important for assessing both glomerular and tubular function
Renal function test

- The following parameters are commonly included in assessing renal function (the normal values/reference range is mentioned)
  - Serum Urea (15-45 mg/dl)
  - Serum Creatinine (0.6 – 1.2 mg/dl)
  - Serum Uric acid (males 3.5-7.2 mg/dl, females 2.6-6 mg/dl)
  - Total protein (6.4-8.1 g/dl)
  - Serum albumin (3.2-4.6 g/dl)
  - Serum electrolytes
    - Na (136-146 mEq/L)
    - K (3.5-5.1 mEq/L)
    - Cl (101-109 mEq/L)
    - Phosphate (2.8-4 mg/dl)
    - Calcium (8.8-10.2 mg/dl)
Renal Function Tests

• Complete hemogram
  • Hemoglobin
  • total RBC
  • RBC indices
    • MCH (Mean corpuscular hemoglobin)
    • MCV (Mean corpuscular volume)
    • PCV (Packed cell volume)
    • MCHC (Mean corpuscular Hemoglobin concentration)
    • RDW (Red cell distribution width)
  • ESR
Routine urine examination

• Physical appearance
  • Colour
  • pH
  • Specific gravity

• Analytes
  • Protein
  • Glucose
  • Ketones
  • Bilirubin
  • Urobilinogen
  • Leucocyte
  • Nitrite

• Microscopy
  • RBC
  • Pus Cells
  • Epithelial cells
  • Casts
  • Crystals

• 24 hour urine protein
• Albumin/creatinine ration (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

• 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;
    • Protein intake
    • Dehydration
    • Muscle breakdown

• 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

• 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

• 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
  • Proteinuria is seen in both acute and chronic kidney disease as well as kidney infection
  • 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
  • Presence of RBC may indicate glomerulonephritis, acute nephritis, kidney infection
  • Presence of pus cells, esterase positivity, nitrites may indicate bacterial infection
Tests for tubular function

• 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

• 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

• 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

• Acidification test
  • In this the ability to acidify urine is tested after administering 0.1g/kg ammonium chloride gelatin coated samples
Thank you