

Chapter 5

RENAL FUNCTION TESTS

Functions of kidney are following:

A. Excretion of:

1. Waste products of metabolism eg urea, uric acid, creatinine.
2. Toxic substances eg phenol, glucuronides, sulphates.
3. Drugs eg salicylates.

B. Reabsorption of Substances Vital to Body eg Glucose, Amino Acids.

C. Maintenance of Constancy of Mileu Interior by:

1. Regulation of water balance.
2. Regulation of electrolyte balance.
3. Regulation of acid base balance.

D. Erythropoiesis:

1. Production of erythropoietin.

E. Vitamin D Metabolism:

1. Formation of 1,25 OH dehydroxy cholecalciferol.

F. Regulation of Blood Pressure:

1. Renin angiotensin aldosteron.
2. Prostaglandin production.

ASSESSMENT OF RENAL FUNCTION

Aim:

Tests are performed to know:

1. Whether glomeruli, tubules or renal blood flow is dysfunctioning.
2. Are there any extra renal factors involved in production and maintenance of renal disease?
3. What is state of renal reserve?

Classification of Renal Function Tests:

A. Tests of Glomerular Function:

1. Glomerular filtration rate or creatinine clearance.
2. Proteinuria.
3. Cell count and type of cast.

B. Tests of Tubular Function:

1. Specific gravity of urine.
2. Osmolality of urine.
3. Concentration, dilution tests.
4. Urinary acidification.
5. Urinary electrolyte estimation.
6. Amino acids in urine.
7. Types of cells and casts.

C. Test of Renal Blood Flow:

1. Para amino hippurate clearance.

D. Biochemical Examination:

1. Urea.
2. Uric acid.
3. Creatinine.
4. Blood glucose.
5. Ketones.
6. Serum calcium.

E. Tests of Renal Structural Integrity:

1. Intravenous urogram.
2. Renal scan.
3. Renogram.
4. Renal angiogram.
5. Renal ultrasonogram

F. Renal Biopsy:

1. For histopathologic confirmation of deranged renal function.

CREATININE CLEARANCE

Definition:

Amount of plasma cleared of creatinine in unit time.

Method of measuring glomerular filtration rate by creatinine clearance:

24 hours urinary collection is done. Urinary creatinine is measured.

Plasma creatinine is measured.

$CC = UV/P$.

U = Urinary creatinine.

V = Urine flow per minute.

P = Plasma creatinine.

Falacy:

In very high serum creatinine levels some amount of creatinine may get secreted by tubules.

Roughly GFR is calculated by formula:

In male: $120/\text{Serum creatinine}$.

In female: $100/\text{Serum creatinine}$.

Serum creatinine starts rising only when GFR falls by 50%.

PROTEINURIA

Protein excretion by healthy kidneys:

In preterm < 50 mg/24 hour. Children < 10 year < 100 mg/24 hour. Children 10-18 year upto 300 mg/24 hour.

Incidence of proteinuria estimated by Rudolph in 1967 is 6.3%.

Persistent proteinuria is abnormal.

Causes of abnormal proteinuria:

A. Elevated Concentration of Proteins in Plasma:

1. Eg multiple plasma infusions in coagulation disorders.

B. Addition of Proteins to Tubular Fluid:

1. Tamm Horsefall uromucoid.
2. Hypokalemic nephropathy.

C. Inadequate Tubular Reabsorption of Filtered Proteins:

1. Wilson disease.
2. Fanconi syndrome.
3. Renal tubular acidosis.
4. Galactosemia.

D. Increased Glomerular Permeability:

1. Selective in minimal lesion glomerulonephritis.
2. Nonselective in other glomerulonephritis.

Methods of detecting proteinuria:

1. Heat coagulation (Richard Bright).
 2. Chemical coagulation:
 - i. 3% sulphosalicylic acid.
 - ii. Ethalon phosphotungstic acid.
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Fallacies of Turbidometric Tests:

Presence of urates and phosphates, X ray contrast media, penicillin, tolbutamide metabolites.

1. Dipstick method.
2. Electrophoretic examination of urine:
 - i. Glomerular proteinuria: Albumin, transferrin, gamma globulin, alpha 2-glycoproteins.
 - ii. Tubular proteinuria: Alpha 2 globulin, beta globulin, lysozymes.
3. Transferrin and immunoglobulin G clearance:
 - i. Selective proteinuria: Ratio 0.2.

TESTS OF RENAL CONCENTRATION

1. Specific Gravity:

Measurement of urinary specific gravity and osmolality after fluid deprivation: All fluids are withheld for 12 hours following which urinary specific gravity should rise to over 1020.

Indications:

1. Fanconi syndrome.
2. Wilson disease.
3. Pyelonephritis early stage.

Test should be done cautiously in diabetes insipidus. If weight loss is more than 3% test is terminated.

2. Pitressin 0.5 units per kg intramuscular at 6 pm. Measure specific gravity after 10 hours.

3. D deaminovasopressin 10 micro gm in infants. 20 micro gm in children given intranasal. Effect in 2 hours.

1. Age 7-40 days: Urinary concentration 600-1100 mOsm/kg.
2. Age 2 months to 3 years: Urinary concentration 416-463 m osm/kg.
3. Age 3 years to 16 years: Urinary concentration 870-309 m osm/kg.

TESTS OF URINARY ACIDIFICATION

Ammonium chloride is administered 0.1 gm per kg. In next 4-8 hours urinary pH is measured hourly. Normal < 5.3

1. Preterm 1-3 weeks age: 5.96
2. Term 1-3 weeks age: 5
3. 1-12 months age: < 5
4. 3-15 years age: < 5.5

Test:

Give oral water 60 ml per square meter body surface area per hour. Take control urine specimen. Give ammonium chloride 75-150 m eq per square meter

body surface area. Value of this test is limited in routine clinical evaluation of renal function.

Test is useful in Fanconi syndrome and renal tubular acidosis where there is defect in secretion of H⁺ ions by renal tubules.

MEASUREMENT OF RENAL PLASMA FLOW

1. Para Amino Hippurate Clearance: (Wolf modification of Fick formula)

$$RPF = (UX - VX) \cdot V / AX - VX$$

UX = urinary concentration.

VX = concentration in renal vein.

AX = arterial concentration.

V = urinary flow rate.

Method: Priming dose of PAH 8 mg per kg. Maximum rate of transport of PAH is 80 mg per minute per 1.73 square meter surface area of body equivalent to plasma concentration of 10-14 mg per dl. Amount of PAH reduces in proportion of renal insufficiency.

2. I131 Hippuran. Single injection. Dose 40 mci per square meter body surface area.

3. Diffusible gas indicator for measuring renal plasma flow. An inert gas is introduced into kidney. RPF is determined by rate at which gas is washed out of kidney.

TESTS OF RENAL STRUCTURAL INTEGRITY

1. Intravenous Urogram:

In newborn due to low glomerular filtration rate associated with immaturity of renal function there is poor or no visualization of upper tracts.

There are two phases of nephrogram:

1. Vascular phase is useful in diagnosis of vascular, renal or intra abdominal tumors.
2. Tubular phase is useful in differential diagnosis of renal neoplasm and cysts.

Total body opacification: Following high dose of contrast medium liver and spleen are also visualized. Best seen in infants and children. Useful in diagnosis of subclinical ascites and solid intra abdominal tumor from cyst.

2. Radionuclide Renogram:

Aim: To assess individual function of abnormal kidney in presence of normal or near normal contralateral kidney.

1. Reno vascular hypertension.

2. Hydronephrosis.
3. Atrophic pyelonephritis.
4. Congenital hypoplastic kidney.
5. Following ureteric reimplantation.

Method: Usual water intake. Child kept prone. Oral lugol solution 1 hour prior. Intravenous Hippuran 131. Dose 2 μ ci per pound. Exposure at 3-5 minutes interval for 30 minutes.

Analysis: First phase. Initial rapid rise in count rate. Reflects radioactivity in renal vessels and parenchyma.

Second phase. Less rapidly rising count rate. Radioactivity in renal tubules.

Third phase. Excretory renogram. Rapid decline in count rate.

With onset of renal functional impairment second phase rises less steeply.

3. Renal Ultrasonogram:

Noninvasive safe procedure. No discomfort. No patient preparation. Diagnostic method of choice in patients with contrast medium hypersensitivity.

Indications:

1. Congenital anomalies:
 - i. Renal agenesis.
 - ii. Horseshoe kidney.
 - iii. Crossed ectopic kidney.
 - iv. Ureteric duplication.
 - v. Congenital urachal anomalies.
2. Space occupying lesions:
 - i. Cystic kidney.
 - ii. Neoplastic mass.
 - iii. Inflammatory mass.
 - iv. Obstructive uropathy.
3. Before renal biopsy to outline kidney accurately.
4. Renal trauma:
 - i. Perirenal and perivesical haematoma and urinoma.
 - ii. Laceration of kidney.
5. Renal transplant:
 - i. Diagnosis of acute rejection by cortical edema.
 - ii. Haematoma, abscess.
 - iii. Diagnostic accuracy 95%.

4. Renal Biopsy:

Indications:

1. Persistent haematuria or proteinuria.
2. Atypical severe acute glomerulonephritis.

3. Steroid resistant nephrotic syndrome.
4. Hereditary nephropathies.
5. Acute or chronic renal insufficiency of uncertain cause.
6. Renal hypertension.
7. Evaluation of renal involvement in systemic diseases eg systemic lupus erythematosus, polyarteritis nodosa, Henoch Schonlein purpura, diabetes mellitus, secondary amyloidosis, haemolytic uraemic syndrome.
8. Evaluation of renal allograft.

Contraindications:

1. Major:
 - i. Bleeding diathesis.
 - ii. Solitary kidney.
 - iii. Anticoagulant therapy.
 - iv. Intra renal tumor.
2. Minor:
 - i. Hydronephrosis.
 - ii. Perinephric abscess.
 - iii. Acute intrarenal infection.
 - iv. Severe anaemia.
 - v. Small contracted end stage kidney.

