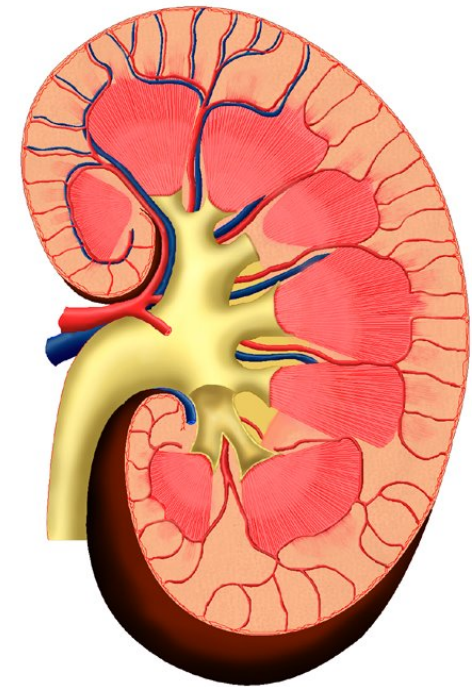


Chemical Examination of Urine

Lecture 2



Renal Block

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Learning objectives:

1. To understand the normal and abnormal chemical composition of urine in relation to renal diseases and conditions
2. To differentiate between pre-renal, renal and post-renal proteinuria with clinical examples of each
3. To acquire knowledge on the types of Glycosuria, hematuria and hemoglobinuria

Urine

is a fluid excreted by most animals including humans

- ✓ It is formed in the kidneys (renal glomeruli)
- ✓ The fluid undergoes chemical changes before it is excreted as urine
- ✓ Normal urine excretion by a healthy person is ~ 1.5 L per day, a decrease in urine output is termed as oliguria, an increase in urine output is termed as polyuria, cessation of urine is termed as anuria .

formation

Is an ultra filtration of plasma, then re-absorption of water and filtrated substances essential to body function.

Normal composition of urine

Urine contains urea, **organic** and **inorganic** constituents:

- Major inorganic salts: Na, K, Cl, **Small amounts** of Ca, Mg, S & phosphates, **Traces** of Fe, Cu, Zn and I₂.
- Major organic constituents: Non-protein nitrogen (NPN) compounds, Organic acids, Sugars, **Traces** of proteins, vitamins, hormones, and pigments.
- It is mainly water (95%) and other solutes (5%).
- Several factors influence the conc. of solutes such as dietary intake, physical activity, body metabolism, endocrine function...etc

Abnormal composition of urine

Proteins: Normal urine contains very little protein (< 200 mg/day) “traces”.

More than this level leads to a condition called **Proteinuria**.

- It is a very important indicator of urinary diseases, BUT it is not always associated with renal diseases.
- Proteins that normally present in the urine are primarily of low-molecular weight proteins that have been filtered and those produced by the genitourinary tract.
- Proteinuria is not always due to a pathology, it could be other conditions like strenuous exercise, dehydration, fever...etc

1- Pre-renal proteinuria: Some abnormal conditions increase plasma protein levels before reaching the kidneys, which increases filtration of these proteins in the kidneys.

This exceeds the normal re-absorptive capacity of renal tubules and resulting in overflow of proteins in the urine.

It is not an indication of an actual renal disease.

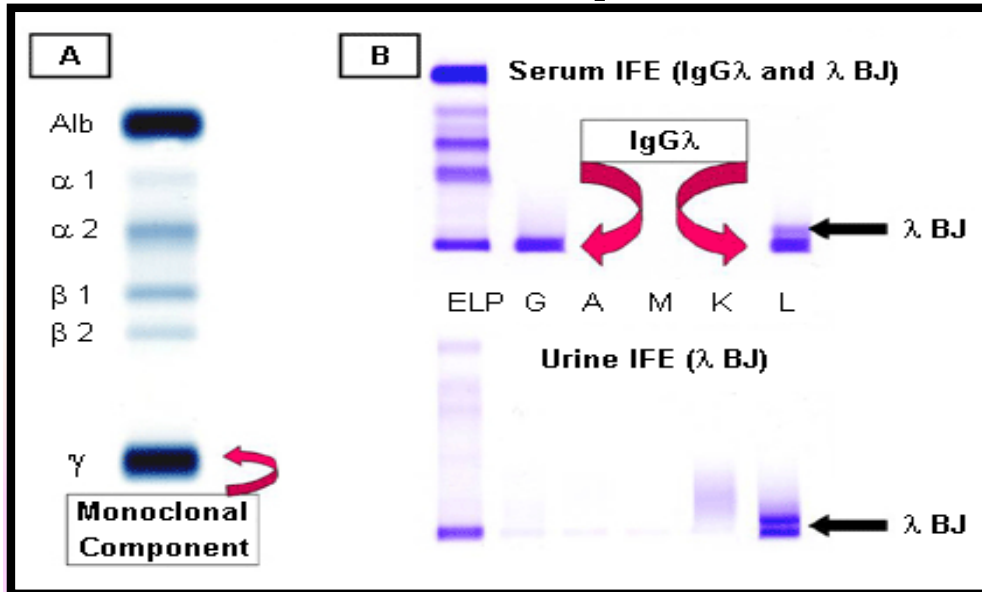
Multiple myeloma causes pre-renal proteinuria

- A proliferative disorder of the immunoglobulin-producing plasma cells
- The serum contains elevated levels of monoclonal light chains (Bence-Jones protein)
- Bence-Jones protein is filtered in kidneys in high amounts, thus exceeding the tubular re-absorption capacity and excreted.
- The Bence-Jones protein coagulate at 40–60 °C and dissolves at 100 °C
- Multiple myeloma cases are diagnosed by using: Serum electrophoresis, Immunoelectrophoresis.

*This slide is for your understanding only

Multiple myeloma

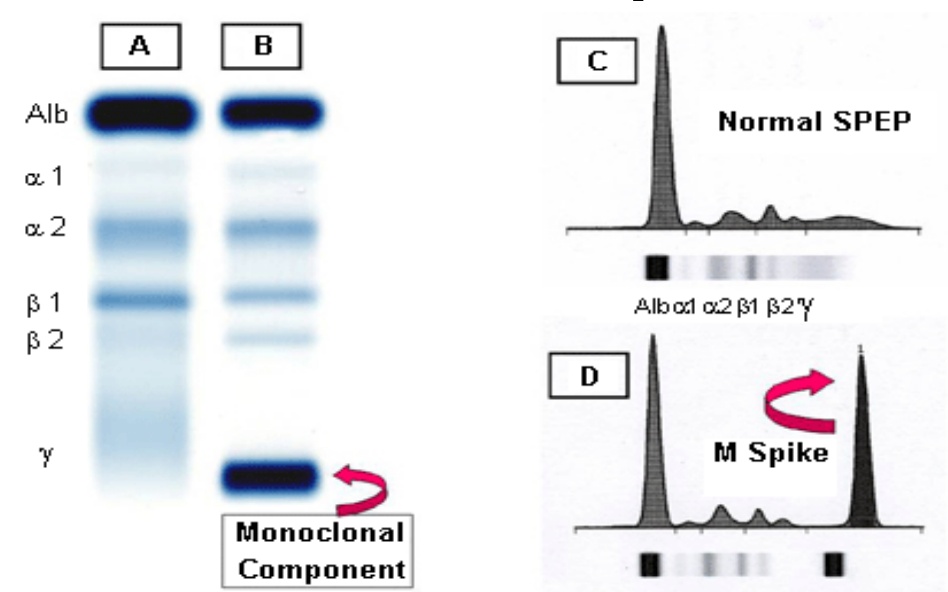
Immunoelectrophoresis



A: serum protein electrophoresis demonstrating the M component.

B: serum and urine immunofixation electrophoresis

Serum electrophoresis



A: normal serum.

B: multiple myeloma showing M component in the gamma region.

C: densitometry tracing of A showing the 5 zones of the high resolution agarose electrophoresis.

D: densitometry of the M component of B, termed the M Spike

For more info click on the link below:
<http://www.youtube.com/watch?v=mN5lvS96wNk>

Abnormal composition of urine

2- renal proteinuria: Associated with renal disease

Glomerular proteinuria

High glomerular permeability, due to damage to the glomerular membrane, which causes impairment to the selective filtration feature and filtration of high molecular weight proteins. (e.g. glomerulonephritis)

Tubular proteinuria

Low tubular reabsorption with normal glomerular permeability, causes excretion of low molecular weight proteins

- (e.g. chronic nephritis)

Orthostatic (Postural) Proteinuria

- Persistent benign proteinuria
- Occurs frequently in young adults due to periods spent in a vertical posture
- Increased pressure on the renal vein in the vertical position or muscular exercise causes orthostatic proteinuria
- Disappears in horizontal posture
- To diagnose the patient is asked to empty their bladder before going to bed and a urine sample is taken in the morning, another one is taken after several hours of standing. Both are tested for proteinuria.

Microalbuminuria:

- Presence of small amounts of albumin in the urine
(20– 200 mg/L)
- Cannot be detected by ordinary urine testing
- Needs special tests for detection
- Early indicator of glomerular affection due to uncontrolled diabetes mellitus or hypertension

Abnormal composition of urine

3- Post-renal proteinuria:

- Proteins added to the urine as it passes through the structures of the lower urinary tract (ureters, bladder , urethra, prostate and vagina)
- Due to Lower urinary tract infection and inflammations that produce protein-containing exudate, trauma, tumors, stones and the presence of blood due to menstrual contamination.

Ketonuria : Presence of ketones, acetone, acetoacetic acid & β -hydroxybutyric acid in urine.

They are intermediates in fat metabolism.

Measurable amounts of ketones are usually not detected in urine because fat is completely broken down into carbon dioxide and water. however, when the carbohydrates as a major source of energy become compromised, fat is metabolized to supply energy and ketones are detected in urine.

1 – Diabetic ketoacidosis

2 – Starvation

3 – Prolonged vomiting

4 – Unbalanced diet: high fat & Low CHO diet

5 – Phenylketonuria (inborn error of amino acid metabolism)

Abnormal composition of urine

Glycosuria : (Presence of sugar in urine)

1- Glucosuria: Presence of detectable amount of glucose in urine

Blood and urine glucose tests are included in all physical examinations

Under normal circumstance all the filtered glucose is reabsorbed so any detectable amounts (hyperglycemia) in urine mean that it has exceeded its renal threshold which is $\sim 160\text{-}180\text{ mg/dL}$.

A normal patient could be presented with glucosuria after a high glucose-content meal.

- Uncontrolled DM :The concentration of glucose in the plasma exceeds the renal threshold
- Renal glucosuria : Normal plasma glucose concentration with proximal tubular malfunction \rightarrow \downarrow renal threshold (gestational diabetes and Fanconi's syndrome)

2- Fructosuria: (Presence of fructose in urine)

- Alimentary causes : High fructose intake
- Metabolic : Low fructokinase or aldolase B in the liver

3- Galactosuria: (Presence of galactose in urine) - Alimentary : High galactose intake

- Metabolic : Low galactokinase or galactose -1- phosphate uridyl transferase in the liver

Abnormal composition of urine

Nitrite : Positive nitrite test is significant of bacteria in urine

Choluria : Presence of bile in urine

1 - Bilirubin / Bile salts: Normally no bilirubin is detected in urine

Bilirubin is detected in:

- Hepatocellular damage
- Obstruction of bile duct: Extrahepatic (Stone), Intrahepatic (hepatic tumors)

2 - Urobilinogen: Normally present in trace amounts in urine.

High urobilinogen is found in: Hemolytic anemia, Hepatocellular damage

Abnormal composition of urine

Blood : blood could be present in the urine in one of two forms: intact RBC or as products of RBC destruction.

any amount greater than five cells per microliter is considered clinically significant.

1 - Hematuria: Presence of detectable amounts of blood in urine

a – Acute and chronic glomerulonephritis

b – Local disorders of kidney & genito-urinary tract (Trauma , cystitis , renal calculi and tumors)

c – Bleeding disorders (Hemophilia)

2 - Hemoglobinuria: Presence of hemolysed blood in urine

a – Hemoglobinopathies: Sickle cell anemia, Thalassemia

b – Malaria (P. falciparum)

c – Transfusion reaction (Blood Incompatibility)

MCQs

1- The presence of intact RBC in urine is termed as:

- A- hematuria
- B- hemoglobinuria
- C- Choluria

2 - One of the clinical presentations of hepatocellular damage is:

- A- Urobilinogen
- B- hemoglobinuria
- C- glucosuria

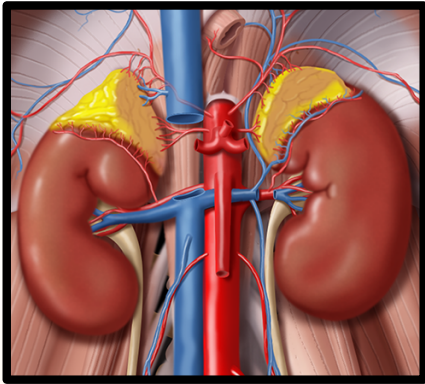
3- A child was presented with Increased pressure on the renal vein in the vertical position and proteinuria

- A- Multiple myeloma
- B- Microalbuminuria
- C- Orthostatic (Postural) Proteinuria

4- Which of the following is a normal major urine component :

- A- Na
- B- protein
- C- glucose

ANS : 1- A 2- A 3- C 4- A



GOOD LUCK

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