PATHOLOGY OF THE KIDNEY AND URINARY SYSTEM

- ACUTE KIDNEY INJURY -

BY

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LECTURE ONE:

- **NORMAL ANATOMY AND HISTOLOGY OF THE KIDNEY.**
- **PATHOLOGY OF CONGENITAL AND CYSTIC RENAL DISEASES.**
- **ACUTE RENAL FAILURE.**

The kidneys are retroperitoneal organs. Each adult kidney weighs 120 to 150 grams and is covered by a thin capsule of connective tissue and a layer of perinephric fat. Through the hilus of each kidney pass a renal artery and vein, lymphatics, a nerve plexus and the renal pelvis which divides into three major and several minor calyces.

On cut section, the kidney reveals two sections: the reddish brown cortex and the lighter medulla. The medulla is formed into medullary rays and 10 to 20 pyramids whose most distal ends is called the papillae which project into the calyces of the upper collecting system.

NEPHRON

Each kidney is composed of approximately 1 million nephrons, the basic functional unit of the kidney. The nephron components are as follows:

1. The glomerulus with its afferent and efferent arterioles, consists of a tuft of capillary loops that protrude into Bowman's capsule. The glomerular tuft has several components.
   (a) The mesangium is a supporting structure composed of cells and matrix.
   (b) The glomerular capillary loops are endothelial-lined tubes, which are covered with basement membrane and visceral epithelium and held in place by the mesangium.
   (c) The glomerular basement membrane (GBM) and visceral epithelial cells together comprise the ultrafiltration barrier necessary for urine formation.

2. The renal tubule begins as Bowman's capsule and consists of the proximal convoluted tubule. Loop of Henle, distal convoluted tubule and collecting duct (the last of which conveys urine to the renal pelvis and ureter).

3. The interstitium is a connective tissue consisting of reticular fibers and interstitial cells, lymphatics, blood vessels and nerves.

There are two distinct types of nephrons:

(1) Cortical nephrons: they are the predominant type and have glomeruli situated in the outer cortex.
(2) Juxtamedullary nephrons: have glomeruli located at the corticomedullary junction. These nephrons have long loops of Henle penetrating deep into the medulla.

URINARY TRACT STRUCTURE

The urinary tract connects to the kidney at the renal pelvis and consists of the ureters, urinary bladder and urethra.

CONGENITAL AND CYSTIC RENAL DISEASES

Learning Objectives:

You should:

- Have a working knowledge of the embryology of the kidney and urinary tract.
- Be able to apply this to the more common abnormalities.

There are numerous possible congenital abnormlaties of the kdieny from non-formation of one kidney (unilateral agenesis), which is compatible with a normal life (and may only be discovered incidentally at autopsy) to congenital absence of both kidneys, which usually leads to death in utero. Sometimes the upper or lower poles of the kidneys are fused (forming a so-called "horseshow kidney). This type of kidney malformation may be found in fetuses/children who have chromosomal abnormalities such as Turner's syndrome (45x). Congenital cystic disease of the kidney is clinically very important and include:

(1) Cystic renal dysplasia
- ❖ Commonest cystic renal disease in children.
- ❖ Caused by disorganized renal development.
- ❖ Can be unilateral or bilateral.
- ❖ Often associated with poorly formed ureter.
- ❖ Rarely part of a syndrome.

(2) Autosomal dominant polycystic kidney disease
- ❖ Progressive distention of kidney by enlarging cysts.
- ❖ 1-2 cases per 1000 live births.
- ❖ Usually present in adults.
- ❖ Caused by mutation in two genes PKD1 (85% of cases: chromosome 16) and PKD2 (155 of cases, chromosome 4) (? also PKD3 in rare cases).
- ❖ 10% new mutations.
- ❖ Maybe associated with cysts in liver, pancreas, spleen and cerebral/coronary artery and aneurysms.
- ❖ About 10% require dialysis/transplantation.

(3) Autosomal recessive polycystic kidney disease
- ❖ Rare, 1 case per 20,000 live births.
- ❖ Gene on chromosome 6.

- ❖ Liver also always affected.
- ❖ Large kidneys at birth (may cause death soon after birth due to renal failure).

(4) Medullary sponge kidney
- ❖ Dilated collecting ducts give "spongy" appearance.
- ❖ ? 1 case per 5000 populatioan.
- ❖ May present with renal infections in adult life.
- ❖ No obvious genetic link.

ACUTE TUBULAR NECROSIS – is the most common cause of **acute renal failure (acute renal shutdown).**

Acute renal failure is manifested clinically by oliguria or anuria (no urine flow) with recent onset of azotemia (elevated urea and creatinine). The condition is mainly manifested by acute tubular necrosis. Acute renal failure can be caused by prerenal, renal or postrenal causes.

1. This condition is reversible. Necrotic renal tubular cells are replaced by new cells in approximately 2 weeks, with complete return of renal function to normal if the patient is maintained on dialysis. Proper medical management results in complete recovery, otherwise the syndrome is potentially fatal.
2. This condition can also lead to cardiac standstill from hyperkalemia, most often during the initial oliguric phase. Oliguria from acute tubular necrosis must be distinguished from oliguria due to prerenal causes: such as reduced blood volume or dehydration.
3. **Causes and predisposing factors**: The acute condition is most frequently precipitated by **renal ischemia**, which is often caused by prolonged hypotension or shock, most often induced by gram-negative sepsis, trauma or hemorrhage. Another associated condition is crush injury with myglobinuria. Myoglobinuria also can be observed after intense exercise, but this is not of clinical consequence.

   Other causes may include direct injury to the proximal renal tubules from mercuric chloride, gentamicin, and several other toxic substances. Ethylene glycol (antifreeze) is extremely toxic when ingested and can result not only in acute tubular necrosis but also in renal oxalosis with massive intratubular oxalate crystal deposition that can be visualized under polarized light.