Pathology – Acute Renal Failure

Renal Block

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Please notice that:

- Green Color: explanation
- Highlighted words: very important

Recommended References:

- Robbins Basic Pathology
- Golijian – Rapid Review Pathology
- Pathology made ridiculously easy
- Core Pathology

- 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 die 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 die 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 die predominant type and have glomeruli situated in die outer cortex.

(2) Juxtamedullary nephrons: have glomeruli located at the corticomedullary junction. These nephrons have long loops of Henle penetrating deep into die medulla.

URINARY TRACT STRUCTURE

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

*The previous points were all Histology and Anatomy, so nothing important. They are just mentioned here for you to understand the following topics.

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 abnormalities of the kidney which include:

1) Non-formation of one kidney (unilateral agenesis), which is compatible with a normal life (and may only be discovered incidentally at autopsy)
2) Congenital absence of both kidneys, which usually leads to death in utero.
3) 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 diseases of the kidney are clinically very important because they are common, hard to diagnose, and confusable with tumors. They include:

(1) Cystic renal dysplasia

- This condition is not related to cancer in any form but is a congenital anomaly. It has to immature mesenchymal cells where you can find fat and cartilage that usually appear in the kidney.
- 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

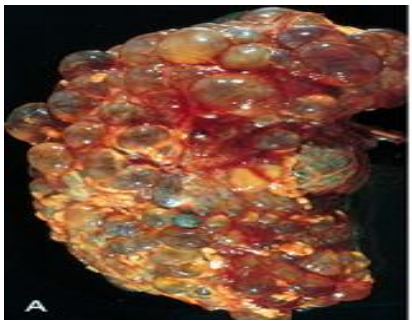
- Progressive distention of kidney by enlarging cysts.
- 1-2 cases per 1000 live births.
- Usually present in adults.
- Caused by mutation in two genes PKD1 (85% of cases: chromosome 16) and PKD2 (155 of cases, chromosome 4) (maybe also PKD3 in rare cases).

  PKD1 Encodes a protein called polycycstin-1 and PKD2 Encodes a protein called polycycstin-2 that act like a cell-cell adhesion molecule → defects in cell-matrix interactions → altering of growth, differentiation, and tubular cells. → Cyst formation.

- 10% new mutations.
- Maybe associated with cysts in liver, pancreas, spleen and cerebral/coronary artery and aneurysms.
- About 10% require dialysis/transplantation because the disease causes chronic renal failure.

Clinical course:

- Not until a persons 40s do the symptoms appear
- A person may feel flank pain, or a dragging sensation.
- Pain maybe severe in case of hemorrhage or obstruction of one of the cysts.
- Besides declined renal function, the 2 most important complications are hypertension and urinary infection.



These gross photos of a kidney affected by Autosomal dominant polycystic disease. Kidneys may enlarge to weigh about 4kg, instead of being normally 150g. When they reach such large sizes they are palpable in the abdomen and even extend to the pelvis.

(3) Autosomal recessive polycystic kidney disease

- The disease is subcategorized into: perinatal, neonatal, infantile, juvenile according to the time of appearance of associated hepatic lesions.
- Rare, 1 case per 20,000 live births.
- Gene on chromosome 6
- Liver also always affected.
- Patients who survive birth develop liver cirrhosis (congenital fibrosis of the liver).
- Large kidneys at birth (may cause death soon after birth due to renal failure).
- An infant may also quickly die from pulmonary failure.

(4) Medullary sponge kidney

- Dilated collecting ducts give "spongy" appearance.
- 1 case per 5000 in a population.
- May present with renal infections in adult life.
- No obvious genetic link.

ACUTE TUBULAR NBCROSIS - is the most common cause of acute renal failure (acute renal shutdown).

Other causes of renal failure include:

- RPGN (Rapidly progressive glomerulonephritis)
- Polyarthritis nodosa
- Papillary necrosis
- Drug induced interstitial nephritis
- Diffuse cortical necrosis

Acute renal failure is manifested clinically by oliguria (low output of urine, It is clinically classified as an output below 300-500ml/day) or anuria (no urine flow) with recent onset of azotemia (serum 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 (complete cessation of ventricular contractions and ejection of blood by the heart) 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) 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 (causing septicemia), trauma or hemorrhage. Another associated condition is crush injury (Crush injury: an injury that occurs when a body part is subjected to a high degree of force or pressure) 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 substance used to preserve car engines, is extremely toxic when ingested and can result not only in acute tubular necrosis but also in renal oxalosis (generalized deposition of calcium oxalate in renal or extrarenal tissues) . with massive intratubular oxalate crystal deposition that can be visualized under polarized light.

Pathogenesis: The events believed to happen in acute tubular necrosis, whether ischemic or nephrotoxic, are causative by two means: 1) tubular injury 2) severe disturbance in blood flow as explained in the diagram here: