RENAL FAILURE

ESSAY

SUBMITTED IN PARTIAL FULFILMENT

FOR

THE MASTER'S DEGREE IN ANESTHESIOLOGY

BY

MAGDA HAROUN MAKAR

M.B,B Ch.

SUPERVISED BY

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FACULTY OF MEDICINE
AIN SHAMS UNIVERSITY

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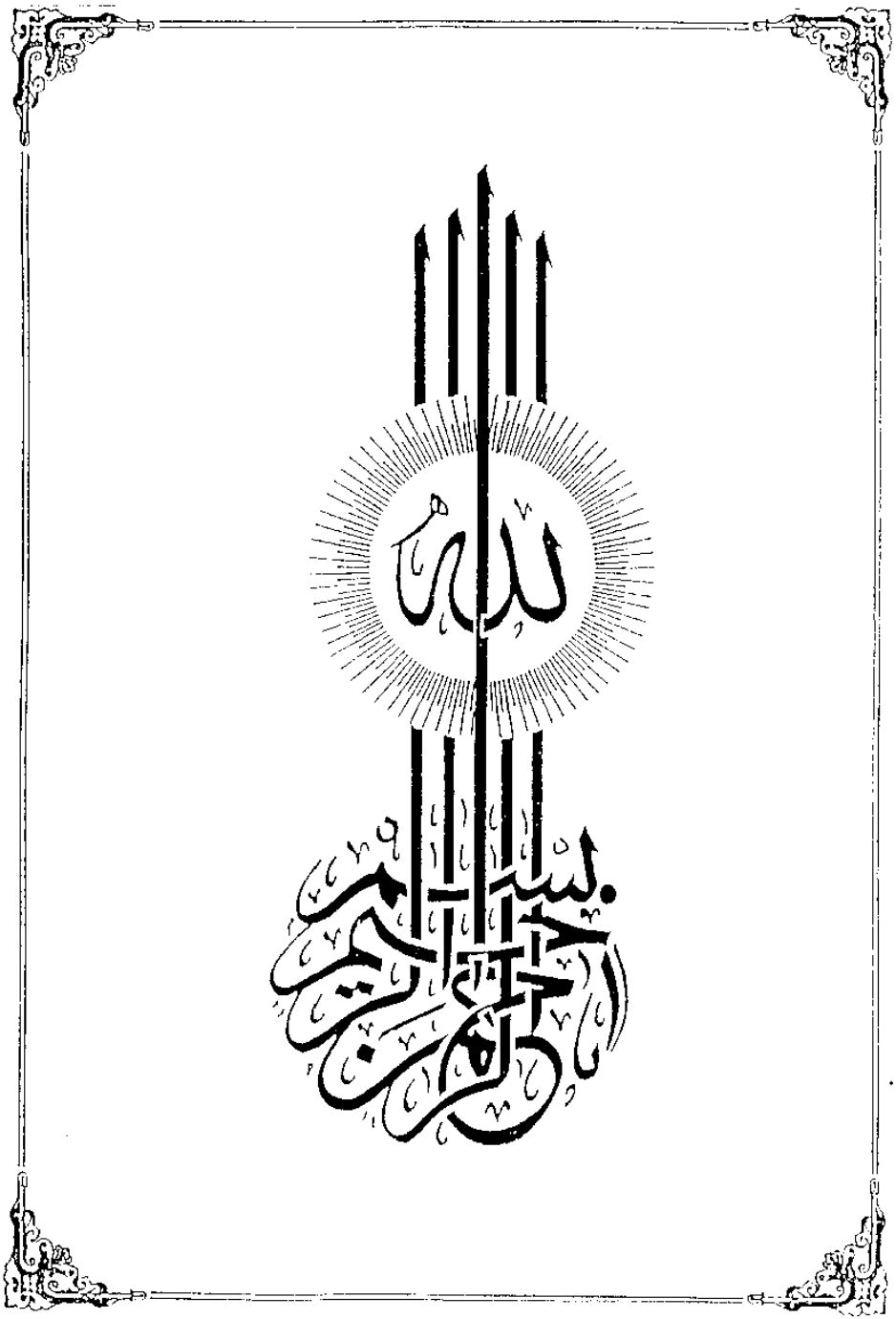


ACKNOWLEDGMENT

I wish to express my depest gratitude to my professor Dr. Samir M. Badir, Professor of anaesthesiology, faculty of medicine, Ain-Sams University. His keen supervision, his continuous advice and his generous help were invaluable.

Special thanks go to Dr. Mona Y. Halim Assistant Professor of anaesthesiology for her devoted help and true understanding. I will always be indebted to her not only for her help in this work but much more beyond.

Finally I would like to express my thanks to the faculty, staff and Colleagues of anaesthesiology Department for their ever available help and understanding.

Magda Maroun

1984

C O N T E N T S

ANATOMY OF THE KIDNEY

ANATOMY OF THE KIDNEY

Anatomical and histological considerations:

The kidneys are retroperitoneal organs on the upper part of the posterior abdominal wall opposite the bodies of 4 vertebrae (T_{12} & L_1, 2 and 3). Each kidney has a hilum in its medial border, through which the renal vessels and the ureter pass.

Gross anatomy:

Each kidney is covered with a thin fibrous capsule and is divided into outer cortex and inner medulla.

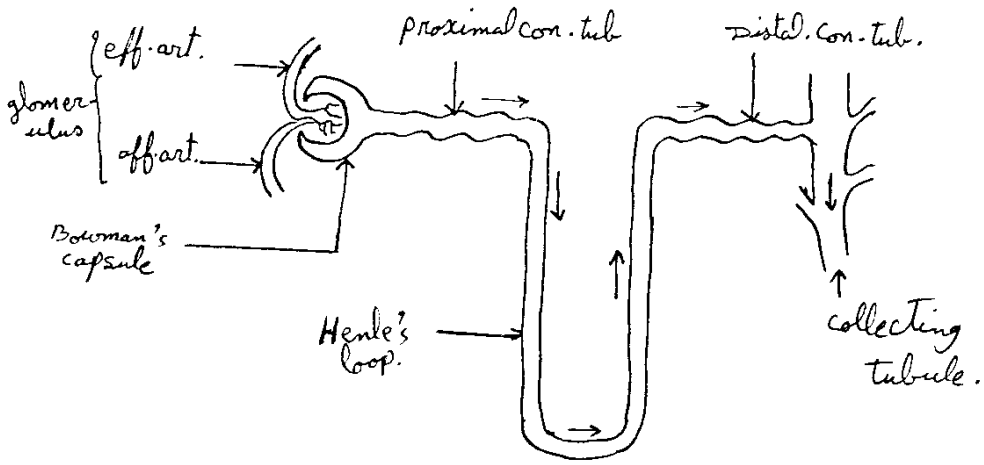
The medulla consists of about 10 - 15 medullary pyramids. Striations extending from the bases of the pyramids into the cortex are called medullary rays, The cortical masses which dip in between the pyramids are called columns of Bertini.

The pelvis of the ureter divides into 2 or 3 major calyces which branch into 7 minor calyces.

The parenchyma of the kidney:

It consists of the urineferous tubules, formed of nephrons and collecting tubule.

The nephron:



It is the functional and structural unit of the kidney (about 30 - 40 mm long 1- 3 millions in each kidney). Each nephron is formed of: Malpighian corpuscle, proximal and distal conuoluted tubules and the loop of Henle. According to anatomical location nephrone may be divided into; cortical nephrons and juxtamedullary nephrons.

The cortical nephron is generally characterized by a glomerulus, situated in the outer two thirds of the cortex, a loop of Henle that extends only a little distance into the medulla, the presence of a juxtaglomerular apparatus.

The juxtamedullary nephron:- Despite the lack of

juxtaglomerular apparatus (JGA) of muscular afferent arteriole and of property of autoregulation, the properties of the proximal tubule of the juxtamedullary nephron are thought to be qualitatively similar to those of the cortical nephron. The thin-walled water permeable salt impermeable, descending limb of the loop of Henle passes dipping towards the medullary tip.

The Malpighian renal corpuscle:

Each Malpighian corpuscle consists of Bowman's capsule and a glomerulus of blood capillaries (about 50 tortous capillaries). The visceral layer of Bowman's capsule is in close contact with the endothelium of the blood capillaries.

This endothelium is thin, fenestrated and surrounded by a definite basment membrane which separates the blood in the capillaries from the glomerular filtrate. It acts as a dialyzing membrane.

Juxtaglomerular apparatus:

This is a complex structure present in the wall of the afferent arteriole and is composed of:

- Juxtaglomerular cells:- Myoepithelial granular cells present in the wall of the afferent arteriole in close contact with its blood.

- Macula densa: Simple cubical cells of the distal convoluted tubule of the nephron when it comes in contact with the Malpighian corpuscle.
- The polar cushion: They are small cells with pale nuclei present in the concavity between the afferent and efferent arterioles. They are in close contact with the juxtaglomerular cells as well as with the macula densa.

The convoluted tubules of the nephron:

1. Proximal tubule: It is 15 mm in length, more convoluted than the distal tubule and is lined with cuboidal cells having apical brush borders due to microvilli which are rich in phosphatase enzymes. The cells have basal mitochondrial striations and deeply acidophylic highly granular cytoplasma with rounded basal nuclei.

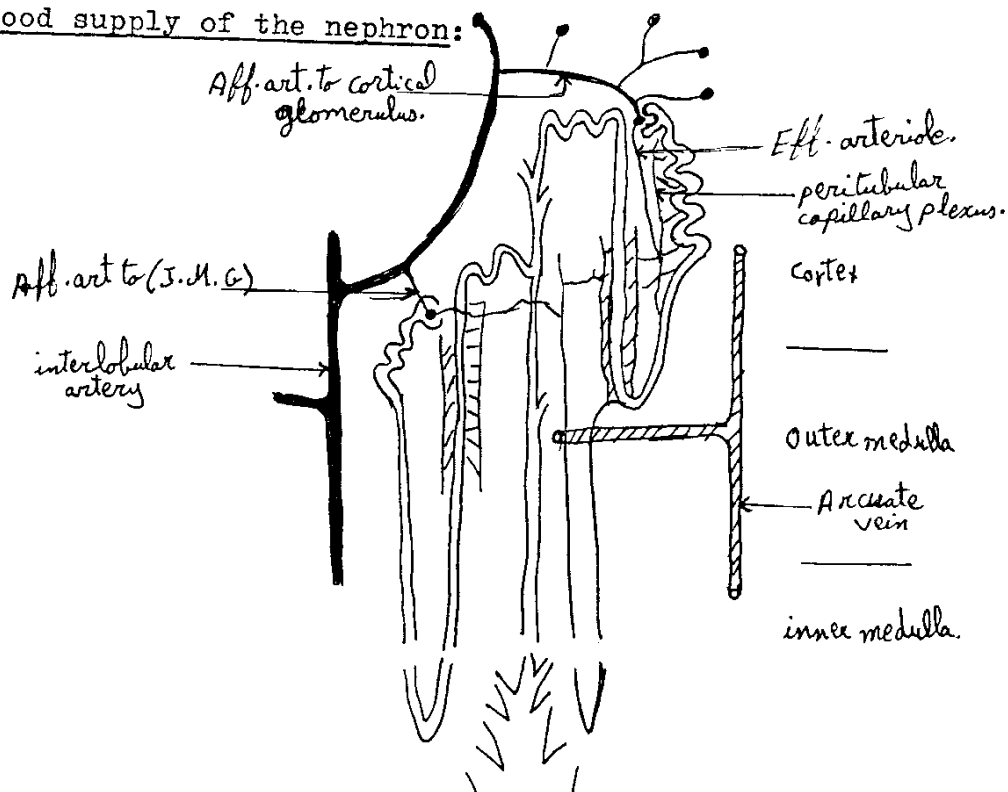
2. Distal tubule: 5 mm in length, lined with cubical 5 - 8 cells (up to 20 cells at the macula densa). With less acidophylic and less granular cytoplasm.

3. The loop of Henle: It is formed of a thin loop which is U shaped about 10 - 20 mm in length. It connects the proximal with distal convoluted tubules and is formed of a descending limb a thin striaght limb dipping deep in medulla in juxtaglomerular nephron while in cortical nephrons it is shorter.

The collecting tubule of the kidney:

A collecting tubule drains 5 - 10 nephrons, they join each other to form the ducts of Bellini. There are small collecting tubules (45 microns) and large ones (100 microns in diameter).

Blood supply of the nephron:



The renal artery, arises from the aorta and enters the kidney at its hilum where it divides into 3 main branches which again divide to give interlobar arteries which run between the pyramids of the kidney.

Each one divides into arcuate arteries present at

the boundary zone between the cortex and medulla. Each arcuate artery gives rise to interlobular arteries, the later are present in the cortex between the lobules of the kidney. Each one gives many afferent arterioles to the Malpighian corpuscles.

The afferent glomerular arteries enter the Bowman's capsules forming the capillary loops (glomerulus). These capillaries are collected again to form the efferent arterioles which carry filtered blood, so they divide into capillaries to supply the convoluted tubules and thus are known as peritubular capillaries. There are a series of long, striatght capillaries called the vasa recta, which descend towards the papillae forming a capillary plexus, then ascend towards the cortex again and drain into the interlobular veins.

The peritubular capillaries are then collected as peritubular venules which collect to form the interlobular veins. The interlobular veins collect to form the arcuate veins which collect of form the interlobar veins. The interlobar veins collect to form the renal vein which opens into the inferior vena cava.

Renal blood flow:

In normal resting young adult the kidneys recive

20 - 30% of the cardiac out put i.e. about 1200 ml blood per minute. The kidneys utilise only 8% of the total oxygen consumption of the body (renal venous blood is bright red due to the low extraction of oxygen).

Nerve supply:

The kidney has a sympathetic supply which is derived from the 12th thoracic to 2nd lumber segments of spinal cord. The adrenergic fibres are predominantly vaso-constrictor in action being distributed to the afferent and efferent arteries.

Nerve fibres have also been shown to terminate close to juxta-glomerular apparatus.

Cholinergic fibres have been found in the kidneys but their exact function is not known.

R E N A L P H Y S I O L O G Y

RENAL PHYSIOLOGY

The kidneys are commonly described as excretory organs, but the assignement of such a limited role scarcely does them justice. They are primarily organs which regulate volume and composition of the internal fluid environment, their excretory function is incidental to their regulatory function.

The elaboration of urine depends on three basic processes:-

- Glomerular ultrafiltration.
- Tubular reabsorption.
- Tubular secretion.

Glomerular ultrafiltration:

Ultrafiltration of plasma at glomerulus is the first step in the elaboration of urine. Composition of glomerular filtrate is virtually identical to that of the plasma differing in that it contains only about 5 mg/100 ml or less of protein (Dirks et al., 1964). The volume and rate of production of the glomerular filtrate depends on the intracapillary glomerular pressure being sufficiently high to overcome the resistance to flow