ACUTE RENAL FAILURE
IN SURGICAL PRACTICE

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in General Surgery

By

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بسم الله الرحمن الرحيم

INTRODUCTION

I N T R O D U C T I O N

Acute renal failure is a frequent and dramatic clinical syndrome. It is an important problem of interest to the surgeon. It produces a wide variety of serious and potentially lethal disorders. The significance of the syndrome is accentuated by the fact that it is one of the few instances of organ failure that is completely reversible. Hence, it demands maximal understanding and effort on the part of physicians.

Acute renal failure is characterized by a sudden deterioration of renal function sufficient to cause a significant rise in blood urea and creatinine. Irrespective of the cause, the effects of renal failure are the same. They are mediated primarily through retention of the nitrogenous products of protein metabolism, fluid overload, hyperkalaemia, and acidosis, and secondly because these primary effects diminish resistance to infection, delaying in wound healing and impairment of coagulation process.

In surgical practice the majority of patients with acute renal failure were found in the post-operative period or after trauma. The proper diagnosis would necessitate a knowledge of the renal function preoperatively or early in the postoperative period in all patients at risk. Thus, any pre-existing impairment will be recognized and treated. The occurance of renal failure will also be easily diagnosed postoperatively if the base line is know before hand.

This essay is made to explain the syndrome of acute renal failure met with during surgical practice and its proper managment. The embryology and anatomy of the kidney will be summarized. The physiology of the kidney with its role in regulating the fluid and electrolyte balance and pH of the blood will be described. The different causes of acute renal failure, whether pre-renal, renal, or post-renal and their early and proper diagnosis will have the way to the optimal methods to be applied in their treatment.

EMBRYOLOGY

AND

ANATOMY

EMBRYOLOGY OF THE KIDNEY

The kidney formation pass through three embryonic phases (Fig. 1) 1) The Pronephros is a vestigial structure that disappears completely by the fourth week except for its primary duct. This gains connection to 2) The Mesonephric Tubules and becomes the mesonephric duct. Most of the mesonephric tubules degenerate except few of the cranial tubules persist as the efferent ductules of the testis and the lobules of the head of the epididymis. The persistant mesonephric duct itself will become the canal of epididymis, ductus deferens and ejaculatory duct. Where the mesonephric duct bends to open into the cloaca, the ureteric bud develops, starts to grow cranially, and meets 3) The Metanephric Blastoma. The junction of the metanephric blastoma with the ureteric bud will form the kidney and its collecting system.

During cephalad migration and rotation, the metanephric tissue enlargs, with rapid internal differentiation into small vesicular masses that will later differentiate into uriniferous tubules. Simultaneously, the cephalad end of the ureteric bud expands within the metanephros to form the renal pelvis. Numerous outgrowths from the renal pelvic dilatation develop, branch and rebranch, and finally connect the differentiating metanephric vesicular masses, establishing continuity of the secreting and collecting ducts. (Tanagho & Smith, 1979).

The manner of meeting and joining of the secreting and collecting ducts is unknown. Failure to join is the probable cause of congenital polycystic disease of the kidney (Last, 1981).

Other congenital anomalies as congenital absence of one kidney must be remembered, especially if the other normal kidney is affected by disease or obstruction, it will lead to renal failure.

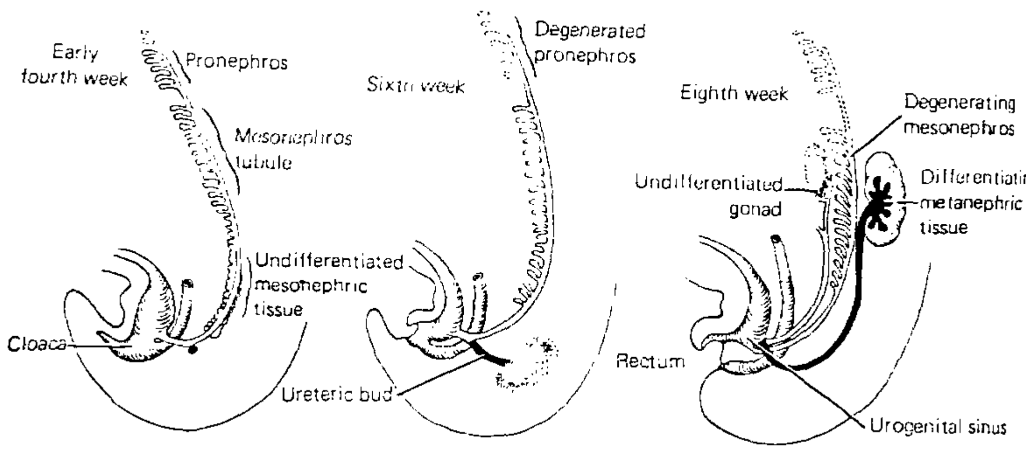


Figure 43–1. Schematic representation of the development of the nephric system. Only a few of the tubules of the *pronephros are seen early in the fourth week, while the mesonephric tissue differentiates* into mesonephric tubules that progressively join the mesonephric duct. The first sign of the ureteric bud from the mesonephric duct is seen. At 6 weeks, the pronephros has completely degenerated and the mesonephric tubules start to do so. The ureteric bud grows dorsocranially and has met the metanephrogenic cap. At the eighth week there is cranial migration of the differentiating metanephros. The cranial end of the ureteric bud expands and starts to show multiple successive outgrowths.

824

(Fig. 1): From: Current Surgical Diagnosis and Treatment. Page 824, 4th edition, 1979

ANATOMY OF THE KIDNEY

Gross structure: (Fig. 2)

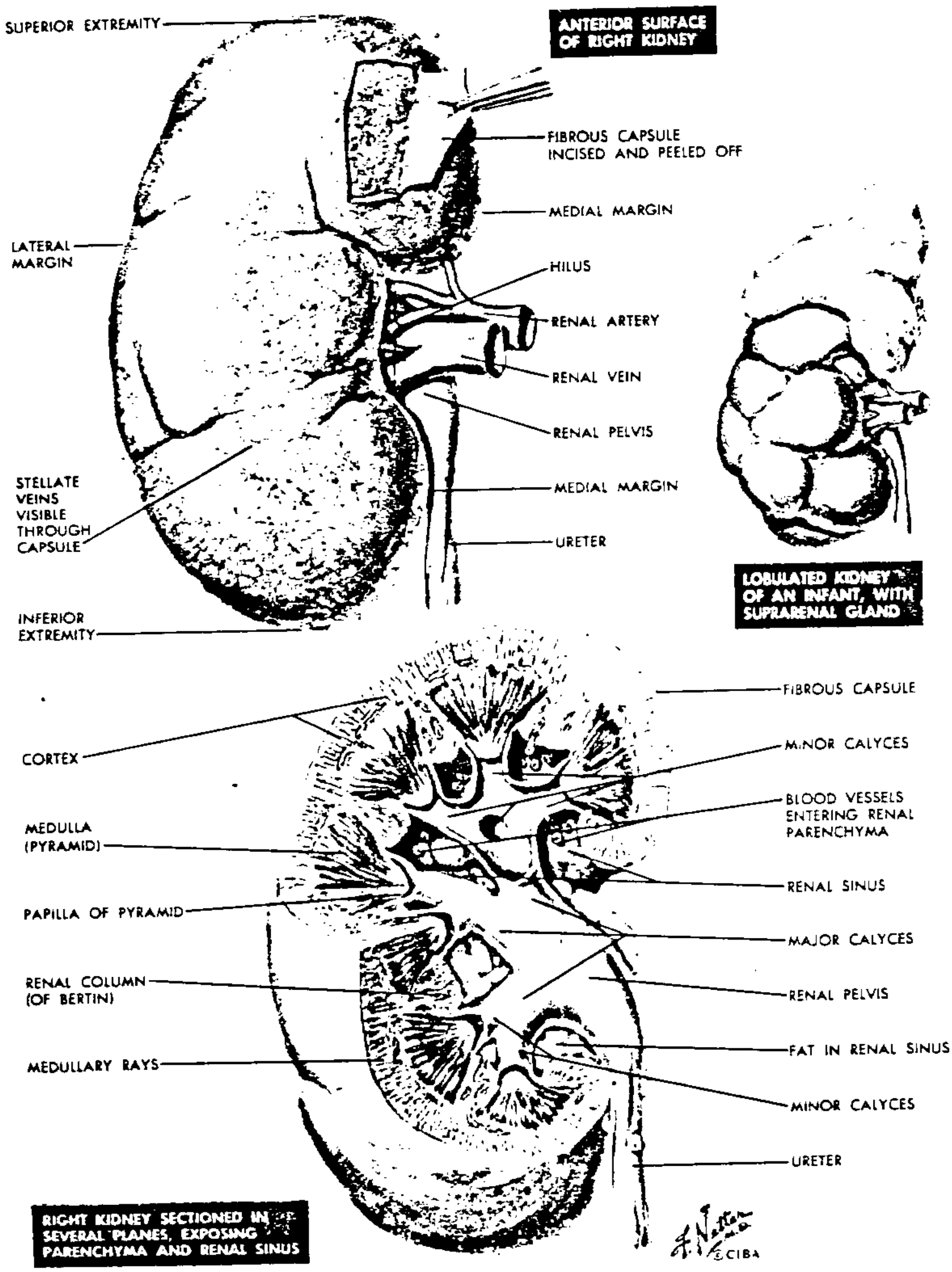
The kidneys are two reddish-brown organs situated in the posterior part of the abdomen, one on each side of the vertebral column, behind the peritoneum. Each kidney is about 11 cm. in length, 6 cm. in breadth, and about 3 cm. in anteroposterior thickness. In the adult male the weight of the kidney averages about 15 gm. (Gray, 1973).

Short vessels of large diameter connet the kidneys to the abdominal aorta and the inferior vena cava. These vessels enter the renal parenchyma at the hilus, the region from which the final urine leaves the kidney in the renal pelvis and ureter. (Beeuwkes & Rosen, 1982).

The kidney has an internal medulla and an external cortex:

The renal medulla consists of a number of pale, striated, conical masses, termed the renal pyramids, their apices form prominant papillae projecting into the interior of the calices. Each minor calyx recieves from one to three papillae. The terminal collecting ducts open on the top of the papillae (ducts of Bellini).

The renal cortex lies immediately beneath the fibrous capsule and dips in between adjacent pyramids, the parts dipping in between the pyramids are named renal columns. (Gray, 1973).



N31-68 Vol. 6 — The Kidney — Gross Structure — Drs. Rhodin and Bergmann

Fig. 2: From: Nephrology, An approach to the patient with renal disease. chapter 1, page 4, 1982.

Surface anatomy:

In the recumbant position, the outline of each kidney can be projected to the anterior or posterior surface of the abdominal wall as follows, bearing in mind that the right kidney is a littler lower (about 1.25 cm) than the left.

A) Anterior surface

The center of the hilus is approximately on the trans-pyloric plane, about 5 cm from the median plane and slightly medial to the tip of the ninth costal cartilage. The hilus of the left kidney is just above the transpyloric plane and that of the right kidney just below it. (Fig. 3)

B) Posterior surface

The center of the hilus lies opposite the lower border of the spine of the first lumber vertebra, about 5 cm from the median plane. The lower pole is usually a little (2.5cm) above the highest part of the iliac crest. (Gray, 1973).

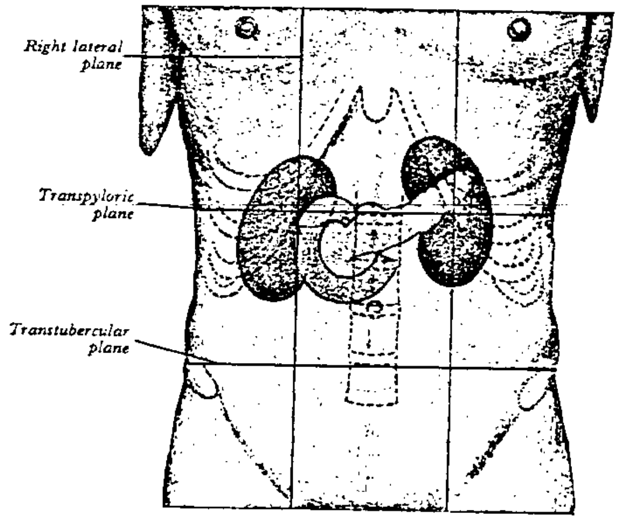
Renal relations:

1) The anterior surface (Fig. 4)

It is convex, and actually faces anterolaterally. Its relations to adjacent viscera differ on the two sides of the body.

A) Anterior surface of right kidney

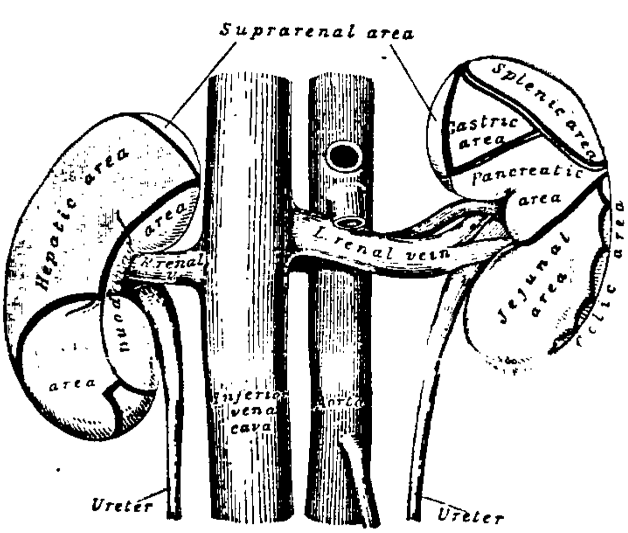
It is related to the right suprarenal gland, renal impression of the right lobe of the liver, the descending part of the duodenum, right colic flexure and the small intestine. The area in relation with the small intestine



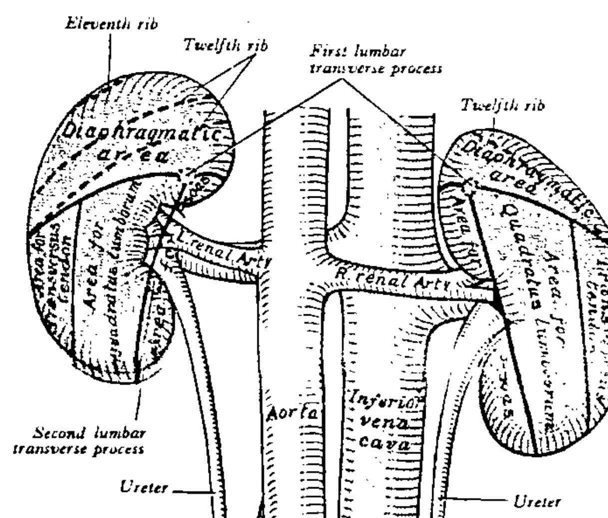
8.145 Surface projections of the duodenum, pancreas and kidneys. The lower ribs and the lumbar vertebrae are also indicated.

Fig. 3: Surface Anatomy, Anterior Surface

THE KIDNEYS RENAL RELATIONS



8.146 The anterior surfaces of the kidneys, showing the areas related to neighbouring viscera.



8.147 The posterior surfaces of the kidneys, showing the areas of relation to the posterior abdominal wall.

Fig.4: Fig. 5:

From: Gray's Anatomy, 35th edition, Longman 1973.

and almost the whole area in contact with the liver are covered with peritoneum (with the intervention of the renal fascia). The suprarenal, duodenal and colic areas are devoid of peritoneum.

B) Anterior surface of left kidney

It is related to the left suprarenal gland, stomach, renal impression of the spleen, the body of the pancreas and the splenic vessels, the commencement of the descending colon, and the coils of the jejunum. The area adjacent to the stomach is covered with the peritoneum of the omental bursa, while the areas in relation to the spleen and the jejunum are covered with the peritoneum of the greater sac. The suprarenal, pancreatic and colic areas are devoid of peritoneum. (Gray, 1973).

2) The posterior surface (Fig. 5)

It is directed posteromedially. It is embedded in fat, and is devoid of peritoneal covering. It lies upon the diaphragm, the medial and lateral lumbocostal arches, the psoas major, the quadratus lumborum, and the aponeurotic tendon of the transeversus abdominis, the subcostal vessels, and the last thoracic,ilio-hypogastric and ilio-injuinal nerves.

The right kidney rests upon the twelfth rib, the left on the eleventh and twelfth. The diaphragm separates the kidney from the pleura, which descends to form the costo-diaphragmatic recess. (Gray, 1973).

<u>Blood supply of the kidney</u>: (Fig. 6)

The kidney is abundantly supplied with blood by the renal artery, which is a branch of the abdominal aorta. Before or immediately after entering the kidney at the hilum, each artery divides into several branches, which enter the renal parenchyma separately. These branches travel up the renal columns as interlobar arteries. When these arteries reach the boundary zone between the cortex and medulla, they divide laterally and form the arch, or arcuate arteries. From the convexity of these arches, the interlobular arteries (cortical) enter the cortex, giving off at intervals minute afferent arteries, each of which branches out as the capillaries of the glomerulus. These capillaries re-unite to form an efferent arteiole much smaller than the afferent arteriole. The efferent arteriole breaks up in a close meshwork, or plexus of capillaries, which are in close approximation withboth the convoluted tubule in the cortex and the loop of Henle in the medulla. These capillaries unite to form the interlobular veins (cortical) and medullary veins, which pour their contents into the arcuate veins lying between the cortex and medulla. The arcuate veins converge to form the interlobar veins. These merge into the renal vein, which emerges from the kidney at the hilum and opens into the inferior vena cava. (Kimber, Gray, and Stackpole, 1977).