Imaging In Renal Hypertension

Thesis
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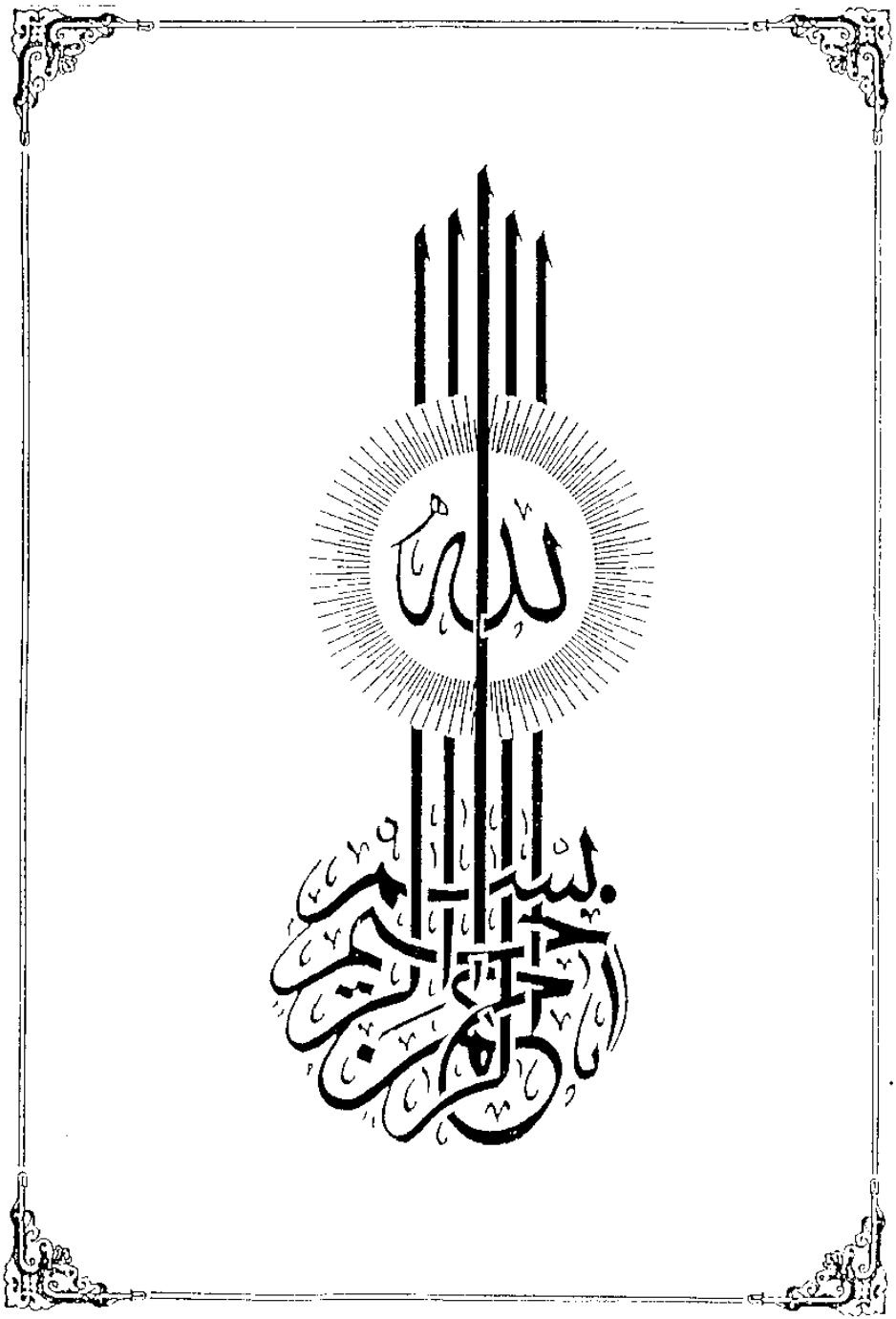
CONTENTS



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Introduction & Aim of the Work

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The kidneys are bean shaped organs lie in the posterior abdominal wall. Consists of outer cortex and inner medulla, and responsible in filtration of waste products from the blood through the nephron. The renal arteries arises from the aorta are responsible for the blood supply of the kidneys.

Blood pressure is dependent upon cardiac output, and total peripheral resistance. The kidney plays an essential role in the regulation of the blood pressure by affecting the blood volume and the peripheral resistance. Any disease affecting the kidney may be responsible for the increase in the blood pressure. The so-called ***renal hypertension.*** Although renal hypertension represents 2% only of secondary hypertension, but it is considered the most important cause of it. Renal hypertension may be due to parenchymal diseases or vascular diseases affecting the kidneys.

Three mechanisms can participate in the normal control of blood pressure by the kidney; 1) the vasoactive substances secreted by the kidney which have pressor effect, 2) the maintenance of extracellular fluid and blood volume, 3) substances secreted by the kidney and normally lower the blood pressure.

Any disease affecting the kidney may derange any of the above factors and thus renal hypertension occurs. The diagnosis of a patient suffering from renal hypertension can be done by many imaging modalities and each modality has its role and specificity in the diagnosis. So conventional and imaging radiological techniques used in the diagnosis of renal hypertension are not competitive but complimentary to each other. Each group of diseases either

parenchymal or renovascular diseases have their specific imaging techniques. Complementation of these techniques are of great help to detect the cause of renal hypertension, and to reach the diagnosis by its ability in observation the specific radiological manifestation of each disease.

The aim of this work is to discuss the mechanisms, the role of the different radiographic, and imaging techniques and their limitations in each disease to reach the proper diagnosis. Thus, selection of the most helpful technique can be done to reach the accurate diagnosis with the least hazards and expense to the patients.

Anatomy of the Kidney

Basic Anatomy Of The Kidney

The kidneys excrete end products of the metabolic activities of the body and excess water, and are thus essential in controlling the concentration of the constituents of the body fluid *(Gray's, 1975).*

They are two reddish brown bean shaped organs situated in the posterior part of the abdomen one on each side of the vertebral column and in the same coronal plane behind the peritoneum *(Merrill's 1986).*

The kidneys lie within Morris triangle which is drawn by two horizontal and two vertical lines. Upper horizontal line opposite the eleven thoracic spine, lower horizontal line opposite the third lumbar spine, and two vertical lines are drawn one inch and three inches from median plane *(El Rakhawy, 1979).*

They lie in an oblique plane from above inferiorly, anteriorly, and laterally. The anterior slant following the curve of the last thoracic vertebra and the superior three lumbar vertebrae. The long axis of each kidney is directed downward and laterally. The transpyloric axis directed posteriorly (Diagram 1). The transpyloric plane pass through the superior part of the hilus of the right kidney and through the inferior part of the hilus of the left kidney. The kidneys normally have two ends. ***Cranial end*** is leveled with the superior border of the twelfth thoracic vertebra, and a ***caudal end*** limits to the level of transverse process of the third lumbar vertebra in sthenic person, they are somewhat higher in hypersthenic person and somewhat lower in those of asthenic habitus. The kidneys are supported in a fairly fixed position by the fascial attachments and by the surrounding organs. They have a respiratory excrusion of approximately one inch and normally drop no more than two inches in the change from the supine to erect position *(Merrill's, 1986).*

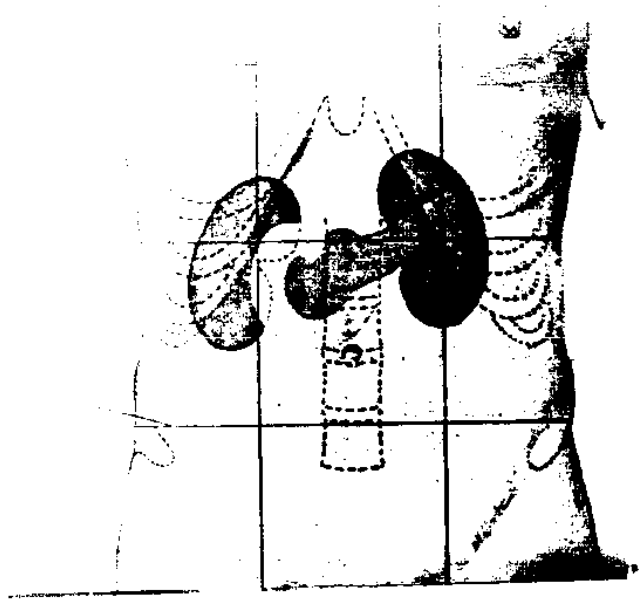

Diagram (1): Position of the kidney *(After Gray's, 1975).*

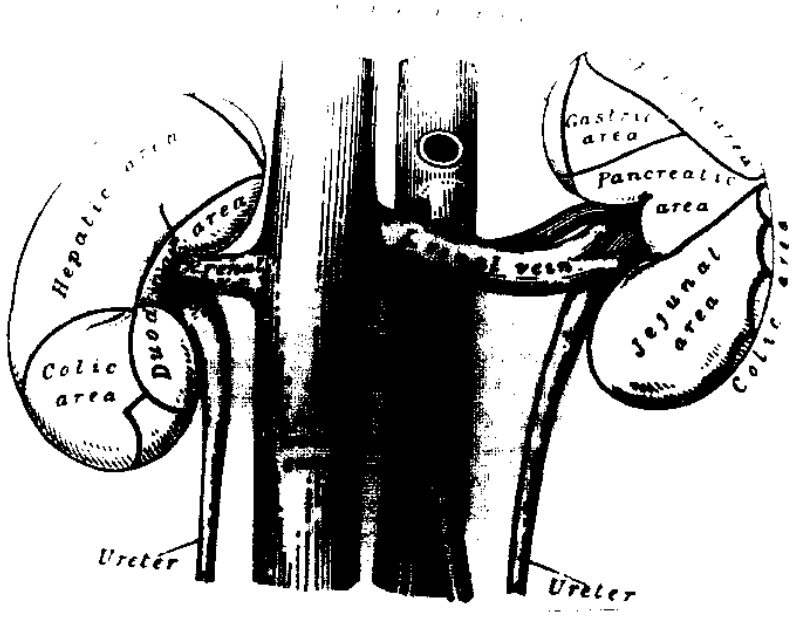

Diagram (2): Anterior relations of both kidneys *(After Gray's, 1975).*

Kidney Size

Normal adult renal size (the means plus or minus two standard position).

Male	Right kidney	Vertical	11.3 - 14.5 cm
		Width	5.4 - 7.2 cm
	Left kidney	Vertical	11.6 - 14.8 cm
		Width	5.3 - 7.1 cm
Female	Right kidney	Vertical	10.7 - 13.9 cm
		Width	5.3 - 7.1 cm
	Left kidney	Vertical	11.1 - 14.3 cm
		Width	5.1 - 6.9 cm

(Meshon, 1978).

Renal Relations

The anterior surface is convex and actually faces anterolaterally related to adjacent viscera, differs on the two sides of the body.

Anterior Relations of the Right Kidney

Right suprarenal gland lies above and medially, right lobe of the liver occupies about $^{3}/_{4}^{th}$ of the surface below the suprarenal area. Descending part of the duodenum lies in a narrow area near the medial border. Right colic flexure lies below and laterally. Part of small intestine lies below and medially. The area in relation with the small intestine and the liver is covered with peritoneum. The suprarenal, duodenal, and colic areas are devoid of peritoneum (Diagram 2) *(Gray's, 1975).*

Anterior Relations of the Left Kidney

Left suprarenal lies above and medially. The splenic area lies above and laterally. The pancreatic area and splenic vessels lie in the quadrilateral field about the middle of the anterior surface. The gastric area lies in triangular area between the suprarenal and the splenic area. The jejunal area lies in the lower medial part. The colic area lies in the lower lateral part. The area adjacent to the

stomach is covered with 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 (Diagram 2) *(Gray's, 1975).*

Posterior Relations of the Kidneys

The posterior surface of each kidney is embeded in fat and is devoid of peritoneal covering. The posterior relations of both kidneys are the same.

The diaphragm occupies the upper part and separate the kidneys from the pleura, 11^{th} and 12^{th} ribs for the left kidney, and only 12^{th} rib for the right kidney. Psoas major in the middle border, transversus abdominus in the lateral border, quadratus lumborum is the area between psoas major and transversus abdominus. Subcostal vessels, last thoracic nerve, iliohypogastric nerve, ilioinguinal nerve passing through the posterior surface (Diagram 3) *(Gray's, 1975).*

The Lateral Border

The lateral border of each kidney is convex. The lateral border of the left kidney is covered superiorly with greater sac of peritoneum which separate it from the spleen. And below this, it is in contact with the descending colon. The lateral border of the right kidney is separated by peritoneum of the greater sac from the right lobe of the liver *(Gray's, 1975).*

The Medial Border

The medial border of each kidney is concave. In its central part there is a deep vertical fissure termed the hilus which contain: Renal vein in front, renal artery in the middle, and renal pelvis behind. Commonly one of the branches of the renal artery enter the hilus behind the renal vessels. The hilus leads into a

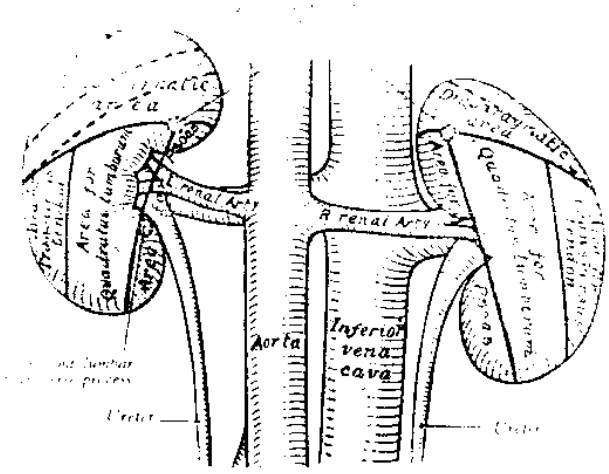

Diagram (3): Posterior relations of both Kidneys *(After Gray's, 1975).*

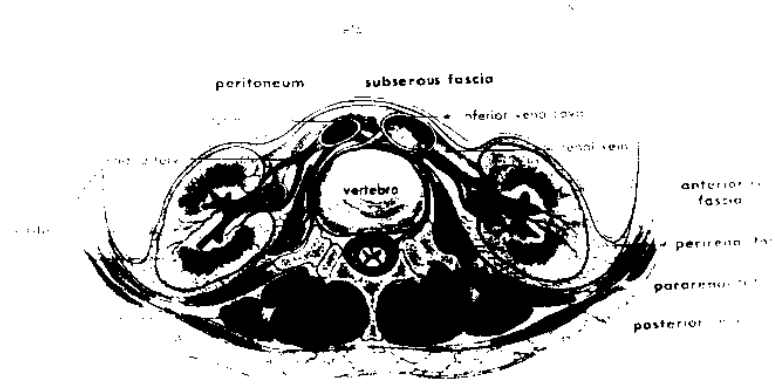

Diagram (4): Transverse section showing the kidney and renal fascia *(After Gouch, 1985).*

central recess named ***renal sinus*** which is lined by a continuation of the kidney capsule in which renal papillae which is numerous nipple like elevations indent the wall of the sinus. The renal pelvis extend outside the hilus to become the ureter. Within the sinus it divides into major calyces then to minor calyces *(Gray's, 1975).*

The hilum lies on the transpyloric plane ± 4 cm from the midline *(Grobbler, 1977).*

The Superior Pole

Is thick and rounded as it is neared to the median plane than the lower pole. It is related to the suprarenal gland.

The Inferior Pole

Smaller and thinner than the upper pole. Extend within 2.5 cm above the iliac crest *(Gray's, 1975).*

Fascial Connection

The kidney and the suprarenal gland are embeded within the so-called peri-renal space which is closed by the perirenal fascia ***(Gerota's fascia).*** It consists of anterior and posterior layers formed by a splitting of the retro-peritoneal fat tissue and extends over the anterior and posterior surfaces of the kidneys. The anterior layer is fused with the peritoneum or with the connective tissue behind the colon, duodenum, and pancreas. Laterally, the two fascial layers unite firmly and are continuous with the retroperitoneal tissue. Superiorly, the anterior and posterior layers fuse at the upper pole of the kidney and extend upward to form a special compartment for the suprarenal gland. Medially, the two layers also fuse except for a small area in the vicinity of the ureter. The layers merge medially into the mass of connective tissue surrounding the inferior vena cava, aorta, and renal vessels. There is no connection between the

peritoneal spaces of the right and left sides. The renal fat or adipose capsule lies between the kidney and its fascial sheath. The layer of fat lying outside the renal fascia is called peri-renal fat (Diagram 4 & 5), *(Grobler, 1977).*

General Renal Structure

Merrill's (1986) stated that the kidney is composed of an outer cortical substance and an inner medullary substance and is covered by a thin layer of fibrous tissue which is prolonged inward to line the renal sinus. The medullary substance composed mainly of the collecting tubules which give it a striated appearance and consists of 15 cone-shaped segment called renal pyramids. Its base directed to the circumference of the kidney and its apex converge to the renal sinus. The cortical substance lies between the periphery of the organ and the bases of the medullary substance, and extend medially between the pyramids to the renal sinus. The essential microscopic components of the kidney is the ***"Nephron"*** which consists of Bawman's capsule, which is invaginated by a cluster of blood capillary called the ***"glomerulus"*** which is formed by afferent vessels from the renal artery entering the capsule and dividing into capillary which unite to form the efferent vessels which leave the capsule and passes on to form the capillary networks that communicate to form the renal vein. The glomerulus serves as a filter for the blood permitting water and dissolved substances to pass through the wall of the capillaries into the capsule which changed by renal tubules into urine by passing in the proximal convoluted tubule, descending and ascending loop of Henle (medulla). Distal convoluted tubules which open in straight collecting tubules that begin in the cortex, converge towards the renal pelvis and unit along their courses, so that, each group within the pyramid forms a central tubule that opens at the apex, and drains into minor calyx which are from seven to twelveth in number. The calyces are cup-shaped stem arising from the side of apices of renal pyramids. Each calyx enclosing one or more