ROLE OF UITRASONOGRAPHY AND DUPLEX IN DETECTION OF RENAL ALLOGRAFT COMPLICATIONS

Essay

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Master Degree of ***Radiodiagnosis***

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INTRODUCTION

Chronic renal failure is an irreversible condition, in which kidneys lose their function. Chronic renal failure may lead to common global health problem with end stage renal disease. Treatments provided are dialysis or renal transplantation. Due to marked improvement of graft survival, the treatment of choice is renal transplantation ***(Tubulin & Dodd, 1995)*.**

However, Kidney transplantation may be followed by number of complications of parenchymal, urological, and vascular nature. Early diagnosis of these complications may determine the survival of the graft. As graft recipients are fragile patients and they need decisive studies for fear of allograft failure, therefore the diagnostic tool used to assess allograft dysfunction should be non invasive as possible ***(Bair et al., 1994).***

Color duplex sonography is the most easy and rapid non-invasive investigation to evaluate vascular complications and perfusion of the transplanted kidney ***(Hollenbeck, 1994*).** It provides early and sensitive indicator of acute rejection, which is a major prequisite before the decision for renal biopsy. It also provides very important information regarding the flow situation of the tranplanted kidney. The accuracy of color Doppler ultrasonography for detection of main renal transplant artery stenosis is excellent with sensitvity 92% and specificity 99% ***(Helenon et al., 1994).***

AIM OF THE WORK

The aim of this study is to evaluate the use of ultrasonography and duplex for the early detection of renal allograft complications.

Chapter 1

NORMAL RENAL ANATOMY

NORMAL RENAL ANATOMY

Each kidney is of a characteristic shape possessing superior and inferior poles, a gently convex lateral border, and an indented medial border. The anterior and posterior surfaces are usually smoothly convex. The medial border of each kidney presents an oval aperture, the hilum, which is connected to the renal pelvis and contains renal vessels, lymphatics and nerves. Each kidney is closely invested by a continous covering of fibrous tissue, the renal capsule. The fat immediately adjacent to the renal capsule is named the "Peri-renal fat". This adipose tissue is enclosed by the renal fascia, which is itself covered both anteriorly and posteriorly by the para- renal fat ***(Gosling & Dixon, 1995)***.

The renal size

The adult kidney measures approximately 11 cm from pole to pole, 6 cm from medial to lateral border (the left kidney is usually wider due to presence of splenic hump) and 3 cm from anterior to posterior surface. The parenchymal thickness should not be less than 12 mm. The renal length according to age can be calculated using the following equations:

< 1 year of age : $4.98 + 0.155 \times$ age (in months)

>1 year of age : $6.79 + 0.22 \times$ age (in years)

Ratio between renal length and distance between first four lumbar transverse processes = 1.04 ± 0.22

By measuring renal length, width and antero-posterior diameters from the longitudinal and transverse scans, the renal volume can be assessed using the formula:

$$V = 0.49 \times L \times W \times AP$$

Where : V = Renal volume

L = Renal length

W = Renal width

AP= Antero-posterior diameter

Normal values of adult renal volume:

Right kidney: 147 ± 38 cc

Left kidney: 154 ± 37 cc

(McGahan and Goldberg, 1997)

An increase in renal volume has been reported post transplantation , with an increase of 16% at the end of the 2nd week and 22% at the end of the 3rd week of renal transplantation ***(Hericak et al, 1987).***

As early as 48 hours after surgery, a baseline sonographic examination is performed to determine renal size, calyceal pattern and extra-renal fluid collection. ***(Hagen, 1995)***.

Within the kidney, the upper expanded end of the ureter is known as the “renal pelvis” which divides into two or three major calyces, each of which divides further into two or three minor calyces. Each minor calyx is indented by the apex of a medullary pyramid called the “ renal papilla”. The kidney is composed of an internal medullary portion and external cortical substance. The medullary substance consists of a series of striated conical masses, called the “ renal pyramids”, and their bases are directed towards the outer circumference of the kidney. Their apices converge towards the renal sinus, where their prominent papillae project into the lumina of the minor calyces. As the pelvis leaves the renal sinus, it rapidly becomes smaller and ultimately merges with the ureter, which is about 25 cm long [Fig.1.1]. ***(Hagen, 1995)***

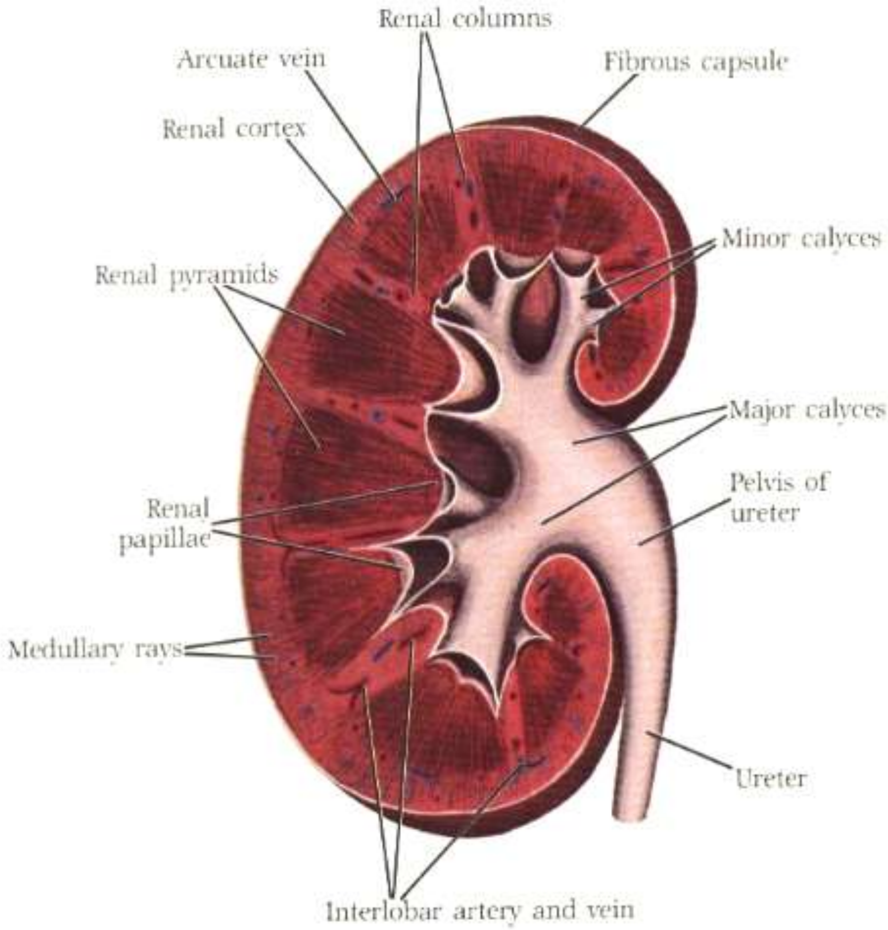

Fig. 1.1 : Internal structure of the kidney ***(Quoted from: Hagen, 1995)***

The vascular supply

The arterial supply to the kidney is through the main renal artery. The main renal arteries arise from the abdominal aorta and they are single in 75 % of cases. Arterial duplication is more common on the right side. Both renal arteries almost lie between the upper edges of the first and third lumbar vertebrae, the right renal artery is more often found slightly higher than the left one, even though the right kidney itself is usually lower. The inferior adrenal artery is the first branch of the main renal artery ***(Ryan & Mcnicholas, 1994).***

The renal artery divides within the hilum into 2 branches, a dorsal and a ventral branch (segmental arteries), which subdivide in the kidney into several interlobar arteries, which run through the medulla towards the cortico-medullary junction ***(Hagen, 1995).*** At the cortico-medullary junction, they acquire an arched course and are known as the (arcuate arteries), which run parallel to the surface of the kidney at the region between the cortex and medulla **[Fig. 1.2 , 1.3].** From the arcuate arteries arise the "interlobular arteries" that pass outwards towards the surface of the organ. The interlobular arteries break into afferent arterioles of the glomeruli, which divide into tuft of capillaries. These capillaries reunite to form narrow efferent arteriole. The course of the efferent arteriole is as follows:

- *In cortical nephron*: it divides into peri-tubular capillaries to supply the tubules with arterial blood.
- *In juxta-medullary nephron*: it runs parallel to the loop of henle forming the vasa recta ***(Becuwkes et al, 1991)***

The peri-tubular capillaries and vasa recta drain their blood into the venous plexus. The venous plexus drains into the interlobular veins to drain into the arcuate veins to renal vein ***(Becuwkes et al, 1991)***.

<u>The Lymphatic Drainage</u>

The renal lymphatic drainage is abundant, follows the blood vessels through the renal columns to exit the renal parenchyma, and forms several large lymphatic trunks within the renal sinus. Communicating lymphatics from the renal capsule and peri-nephric tissues join the trunks as they exit the renal hilum in close association with the renal blood vessels. In addition, lymphatics from the renal pelvis and upper ureter may also join the renal lymphatic trunks. There are often two or more lymph nodes at the renal hilum associated with the renal vein. From the right kidney , the lymphatic trunks drain primarily into inter-aortocaval and lateral paracaval lymph nodes ***(Kabalin, 1992)*** **[Fig. 1.4].**

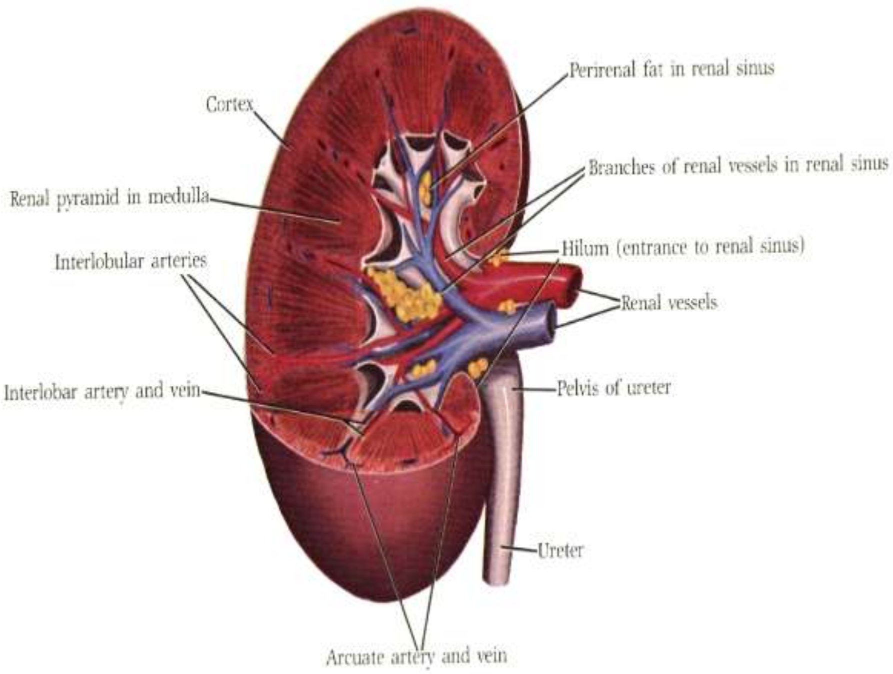

Fig. 1.2 : Longitudinal section showing the internal structures and vasculature of the kidney ***(Quoted from: Snell, 1988)***