Chapter one

1.1 Introduction

Renal transplantation has grown rapidly over the past 30 years, resulting in an inadequate supply of organs to meet the ever-increasing demand. (Pozniak M, et al, 1998 May-Jun). Marked improvements in early graft survival and long-term graft function have made kidney transplantation a more cost- effective to dialysis. (Collins B., et al June 2012). This has led to an increase in the number of living donors. Another reason for the increase in living donors is the better outcome as compared to cadaveric donor transplant Advances in imaging technology now allows safe, rapid, and relatively non-invasive evaluation of potential living donors. (Pozniak M, et al, 1998 May-Jun).

The aims of preoperative evaluation of living kidney donors is to show that the donor will retain a normal kidney unilateral nephrectomy, to demonstrate that the kidney transplanted has no major abnormality and to outline its vascular anatomy. (Rankin S., 2008). Renal transplantation has become the treatment of choice for most patients with end-stage renal disease (ESRD). (Collins B., et al June 2012).Helical computed tomographic (CT) angiography is a fast, minimally invasive evaluation of potential renal transplant donors. Helical CT, combined with low-osmolar intravenous contrast materials, has enabled CT angiography to depict arterial and venous anatomy accurately. (Kawamoo S., et al, 2004).

CT angiography allows the radiologist to provide the transplant surgeon with precise preoperative anatomy of the renal vasculature, thus reducing the risks and complications associated with the harvesting procedure and improving the chances for a successful outcome. Anatomic assessment of the donor kidney is performed prior to transplantation to aid selection of which kidney to use and to plan the surgical approach.

In addition, volume-rendered CT angiography accurately displays the normal and variant renal vascular anatomy, which is crucial to detect before surgery. (Urban B.,and Fishman E., March 2001).

CT angiography allows the visualization of renal arteries in multiple and projections so that the renal arteries can be observed in their entirety (Dev G., and Kirmani O, 2001).

However, accurate radiologic interpretation depends on the radiologists experience level, attention to detail, and commitment to careful image evaluation. (Pozniak M, et al, 1998 May-Jun).

Taking all the above into account, the main drawbacks of renal CT angiography are the exposure to ionizing radiation and the use of potentially nephrotoxic iodinated contrast material. (Hazirolan T., et al, February 2010).

1.2 Problems of the study

Renal tract well demonstrated by CTA to see blood vessels that supply kidney but any problem appear during the CTA (stone, torsion,..etc) will interrupt the study, also diabetic patient needs special preparation so candidates for renal transplantation udergo an extensive evaluation to identify factors that may have an adverse rffect on outcome . virtually all transplant programs have a formal committee thay meet regularly to discuss the result of evaluation and select medically suitable

candidates to place on the waiting list.(emedicine . Medscape.com).

1.3 objective of study

1-3-1 General objectives

To assess potential kidney donors by renal CT angiography to determine their suitability to undertaking the procedure

1-3-2 Specific objectives

i. To evaluate the potential donor renal anatomy for detection of any renal anomaly that renal precludes them from being a donor.

ii. To assess the renal vascular anatomy to guide the surgeon accurately in the case of normal variants.

iii. To assess the pelvi-calyceal system and ureters at the same procedure.

iv. To determine the CT protocol that will fulfil all these objectives.

1.4 significant of the study:

Renal transplantation is the treatment of the choice for the patient with end-stage renal disease (ESRD), and also for patient with chronic renal disease so renal transplantation is important for increase living of the patient was suffering from renal disease

1-5 over view of the study

To make the aim of the project stated above true. Thesis falls into five chapter: chapter one which is an introduction, deal with theoretical form worked of the study, it present of study problem and objective of study, and thesis outcome, chapter tow deal with theoretical background of renal tract, review of the instrumentation and the technique which include renal tact assessment by conventional X-ray, CT, MRI and U/S. And finally literature review, while chapters three discuss the material and method. And chapter four include presentation of the results and the end chapter

five deals with discussion, recommendation, conclusion of the study perfumed as well as future work.

Chapter two

Theoretical background

2.1 Anatomy of the renal system

2.1.1 The kidneys

The kidneys are retroperitoneal organs lying in the paravertebral gutters of the posterior abdominal wall. Each kidney measures approximately 11cm in length. The left kidney may be 1.5 cm longer than the right; it is rare for the right kidney to be more that 1 cm longer than the left. The upper poles lie more medially than the lower poles. The kidney is made up of a medulla: the inner two-thirds and a cortex: the outer one-third, surrounded by a fibrous capsule. The middle third of the medial border contains a hilum, a narrow slit through which travel nerves, fat, renal vessels, renal pelvis (becoming the ureter) and lymphatics. There are columns of cortical tissue (columns of Bertin) which extend medially within the substance of the kidney, separating the medulla into pyramids. The pyramids project into the minor calyces which lead into the major calyces and thereafter into the pelvis to form the ureter. (Cross J., et al, 2001)

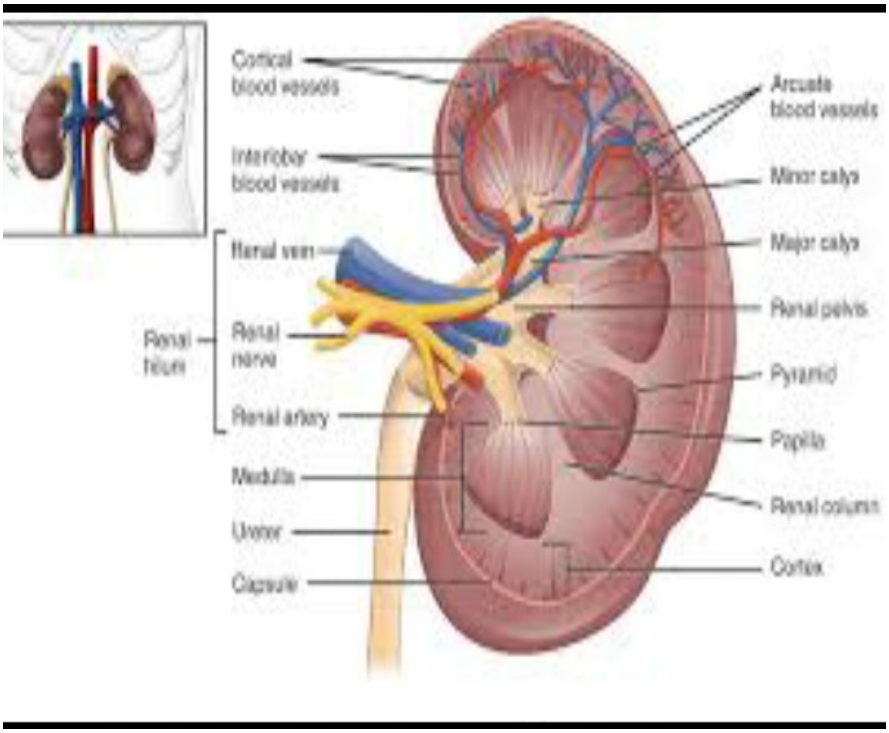

Figure1: show kidney anatomy (www.googel.com/ kidney anatomy)

2.1.2 Relations of the kidneys

The right kidney is related anteriorly to the liver, right suprarenal gland, second part of the duodenum and the ascending colon. The left kidney is

posterior to the stomach, spleen, jejunum, descending colon and pancreas. Posteriorly, both kidneys are adjacent to the costodiahragmatic recess, the twelfth rib, diaphragm, psoas and quadratum lumborum muscles.

The renal arteries typically arise from the abdominal aorta at the superior margin of L2, immediately caudal to the origin of the superior mesenteric artery. The right renal artery is longer and straighter than the left and courses posterior to the inferior vena cava. Both renal arteries have 2 divisions, which pass anterior and posterior to the renal pelvis. Within the renal hilum, the arteries divide inconstantly into five segmental branches which traverse the renal sinus and pierce the medulla between the pyramids. These interlobar branches pass through the medulla to the cortico-medullary junction where they become arcuate arteries. These arteries from arcs but do not anastomose to form arcades and the arcs runalong the base of the pyramids.

At the hilum there are five or six interlobular veins which join to form the renal veins inside the kidney.The left renal vein is five times longer than the right and passes anterior to the aorta. This leaves the renal hilum anterior to the renal pelvis. The left renal vein is receives also the inferior phrenic, gonadal and suprarenal veins of the ipsilateral side. (Cross J., et al, 2001)

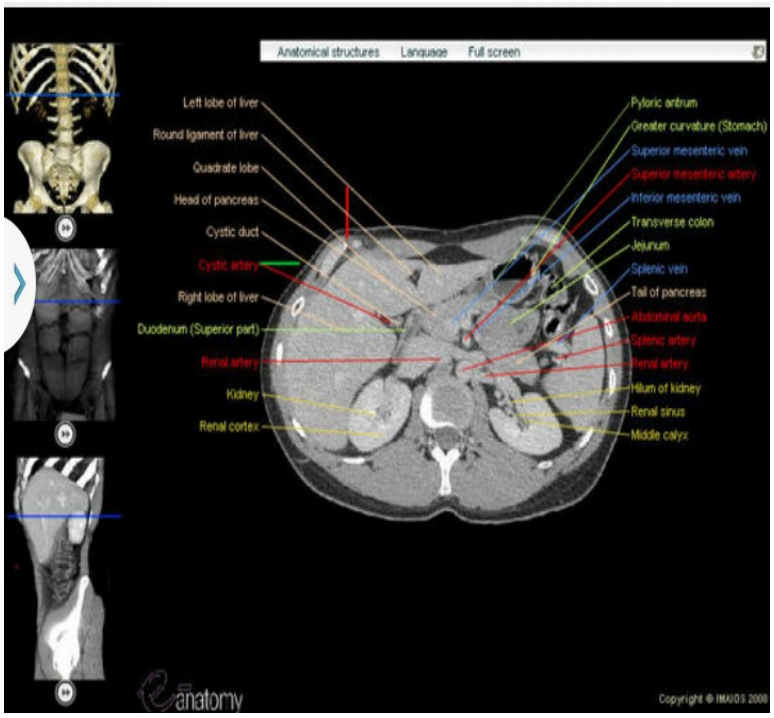

Figure 2: Relations of the kidneys (www.googel .com/relation of kidney)

2.1.3 The ureters

The ureter is the tubular extension of the renal collection system which passes inferiorly and medialy to connect the kidney with the bladder. Each is 25 cm long with a lumen of approximately 2-4 mm in diameter. It is divided into 3 parts, an abdominal, pelvic and intravesical part. Each ureter passes inferiorly and anterioly from the renal pelvis within the retroperitoneal alveolar tissue to the bifurcation of the common iliac artery. It continues closely related to the internal iliac vessels on the lateral pelvic side walls until it reaches a point anterior to the ischial spines where it turns anteriorly and medially to enter the urinary bladder posteriorly.

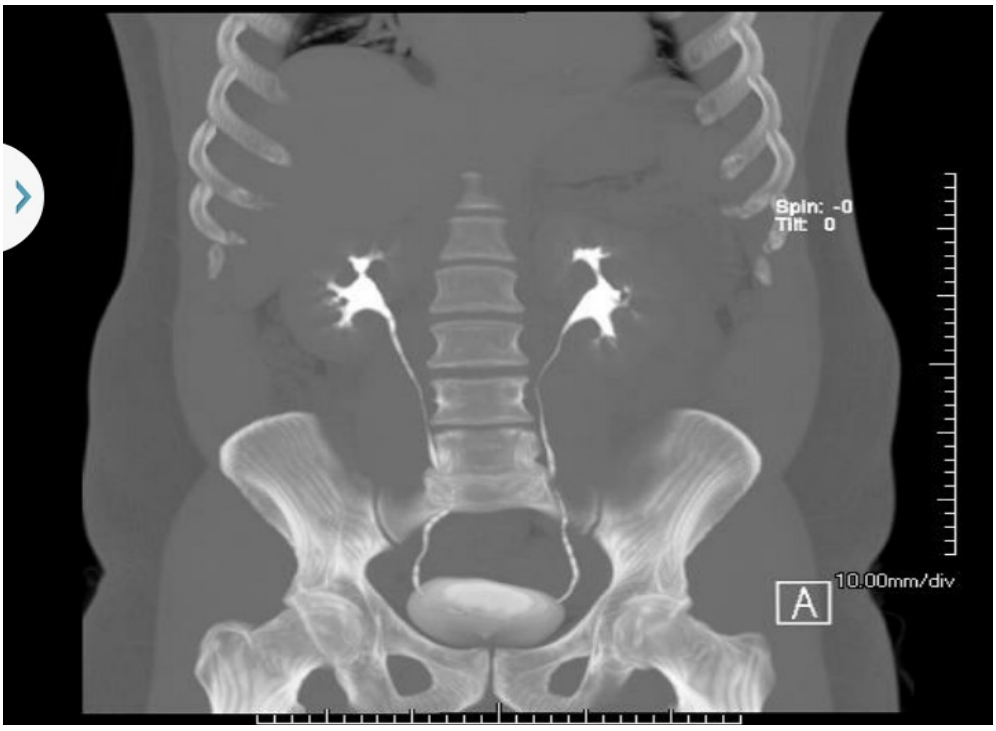

Figure 3: Normal kidneys and ureters (www.googel .com /kidney and ureter by CTU coronal cut)

2-1-4 Blood supply of the ureters

The upper ureter is supplied by the ureteric branch of the renal artery and the lower ureter by branches from the superior and inferior vesicle, middle rectal and uterine arteries. The intervening part is supplied by branches from the gonadal artery, often with contributions from the common iliac artery.

2-1-5 Relations of the ureter

The ureter lies on the psoas fascia, closely adherent to the posterior pariental peritoneum. Deep to the ureter is the psoas muscle which separates it from the transverse processes of the lumbar vertebrae. The ureter usually lies just medial to the tips of the transverse processes. The anterior are different on the two sides of the body. On the right the ureter is crossed by the second part of the duodenum, gonadal vessels, root the mesentery and terminal ileum. On the left the ureter lies deep to the loops of jejunum and the sigmoid mesocolon. The inferior vena cava is medial to the right ureter while the left ureter lies lateral to the aorta. The inferior mesenteric vein lies close to the medial aspect of the left

Ureter and crosses it anterior before joining the splenic vein. Within the pelvis, the relations depend on the sex. In males, the ureter passes anterosuperior to the seminal vesicle and hooks caudal to the vas deferens just before entering the urinary bladder. In females, the ureter passes close to the lateral fornix of the vagina and is just lateral to the cervix. Before entering the urinary bladder it passes in the base of the broad ligament. The intrevesical part of the ureters passes obliquely through the bladder wall, which acts as a valve. (Cross J., et al, 2001)

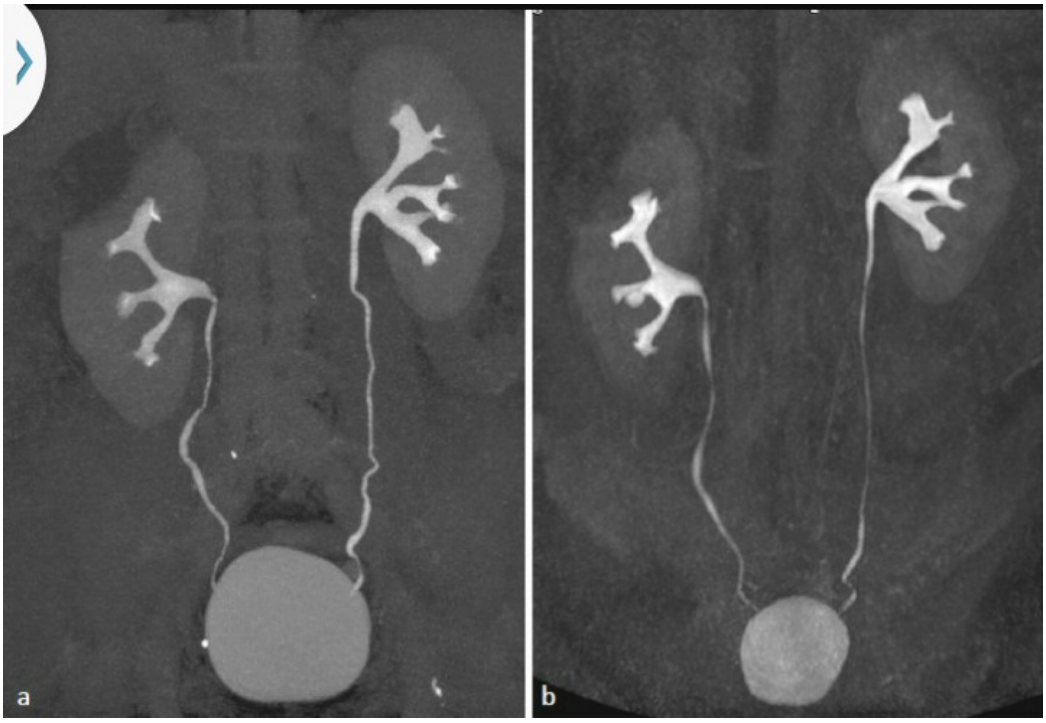

Figure 4: Normal urinary tract (www.googel .com/ normal urinary tract)

2.1.6 The urinary bladder

The urinary bladder lies immediately posterior to the pubic bones. When full it is roughly spherical but when empty it approximates to a pyramidal shape. The superior surface of the bladder is covered in peritoneum and loops of ileum and/or sigmoid colon. The base of the blader receives the ureters at its inferomedial angle. This rests on the prostate inferiorly. Blood supply of the

bladder is from the superior and inferior vesical arteries which arise from the internal iliac arteries. The venous drainage is to the vesical venous plexus which communicates inferiorly with the prostatic venous plexus and drains superiorly into the internal iliac veins. (Kabala J., 2002)

2.1.7 Normal variants and developmental abnormalities of the renal tract

2.1.8 Kidneys

Numerary renal anomaly

Supernumerary kidney

Complete/ partial renal duplication

Abortive calyx

Unicalyceal (unipapillary) Kidney

Renal underdevelopment

Congenital renal hypoplasia

Renal agenesis

Renal dysgenesis

Renal ectopia

Longitudinal renal ectopia: pelvic, sacral, lower lumbar, intrathoracic

Crossed fused renal ectopia

Renal fusion: horse-shoe, discoid (pancake) kidney

Renal cystic disease: multicystic kidneys, polycystic kidneys, medullary cystic disease,

Persistent fetal lobulation

Renal pseudotumours: dromedary hump, prominent column of Bertin

Renal involvement in systemic disorders: tuberous sclerosis (angiomyolipomas), van Hippel-Lindau disease (renal cysts). Sutton D., 2002. Textbook of Radiology and imaging, Dahnert W., 2007).

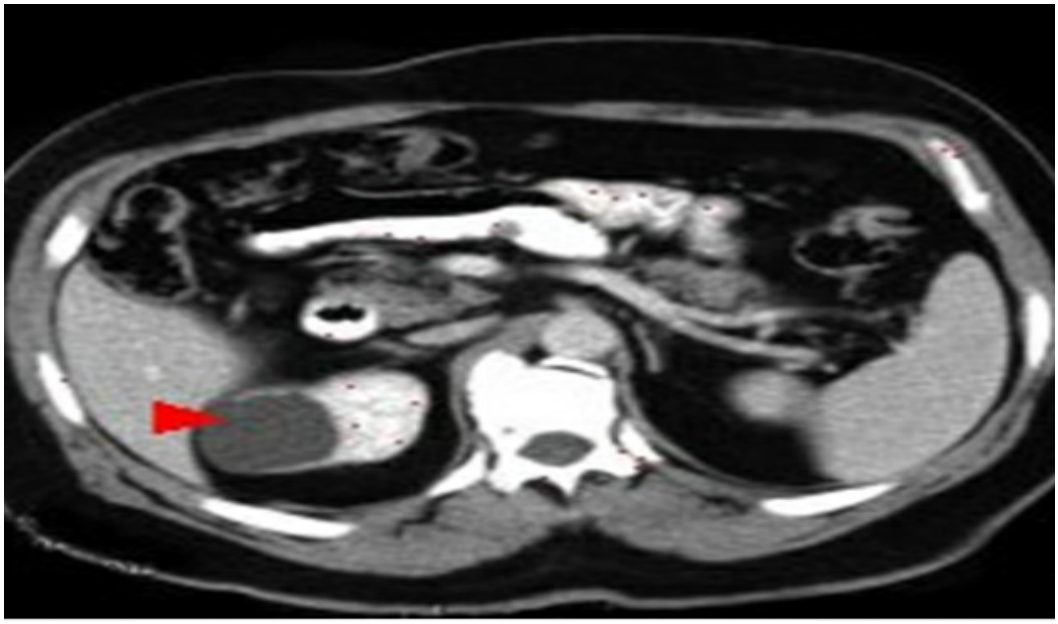

Figure 5: Renal cysts (www.googel .com/renal cyst by CT).

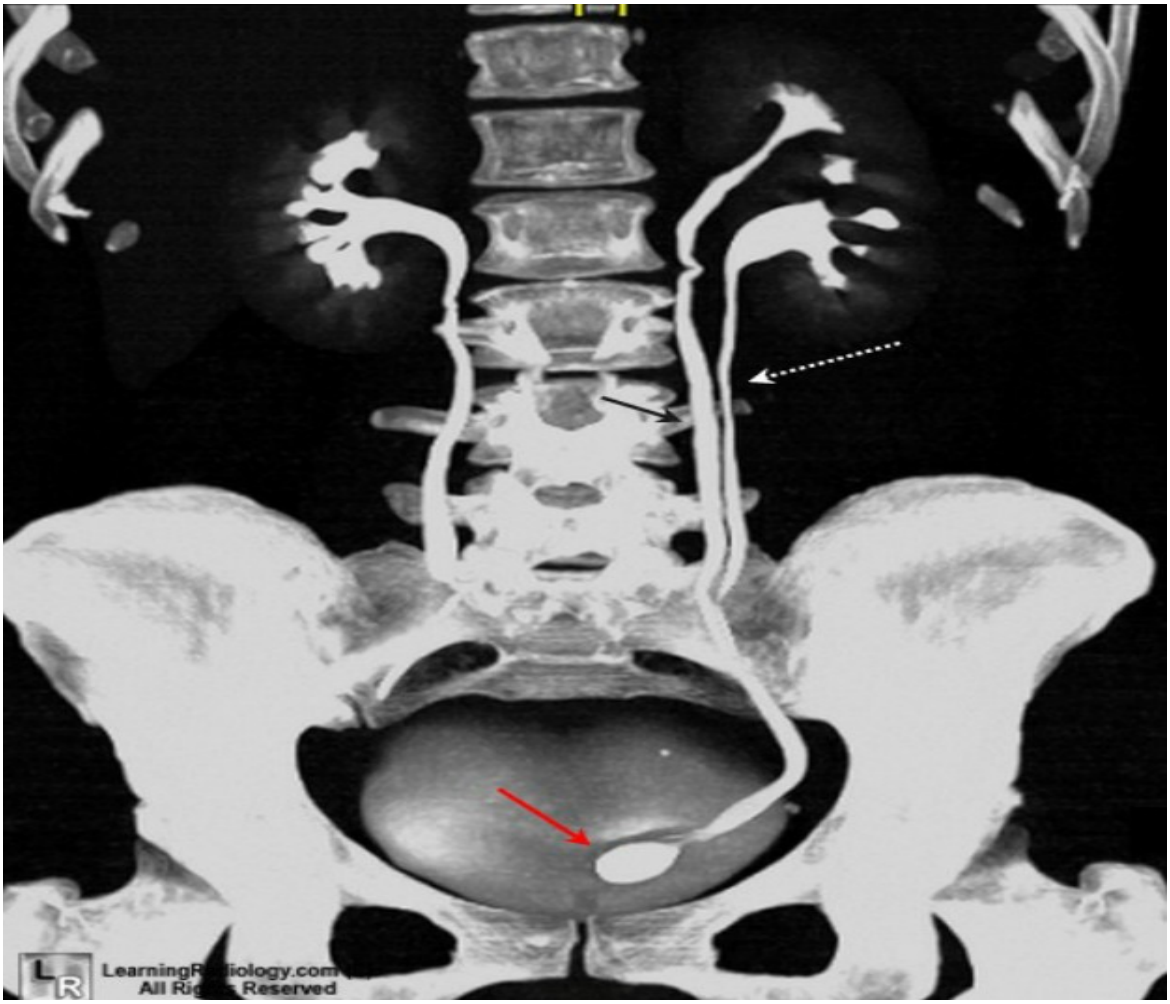

Figure 6: Duplex left collecting system (www.googel.com/ dupplexcollecting system)

2.1.9 Ureters

Partial or complete duplex ureter (associated with duplex kidney)

Ureterocele

Retrocaval ureter

Congenital ureteric strictures, pelvi-uretericjunction obstruction

Primary megaureter

Megacalycosis and polycalycosis. (Sutton D., 2002. Textbook of Radiology and imaging, Dahnert W., 2007).

2.1.10 Urinary bladder

Agenesis

Bladder extrophy

Urachal anomalies

Diverticulae.(Kabala J., 2002, Dahnert W., 2007)

Vascular anomalies

These can be further divided into arterial and venous;

Arterial vascular anomalies

Accessory renal artery

Pre-hilar branching

Aberrant renal arteries

Venous vascular anomalies

Accessory renal veins

Circumaortic renal vein

Retroaortic renal vein

Late venous confluence

Figure 7: Accessory renal artery(www.googel.com / accessory renal artery)

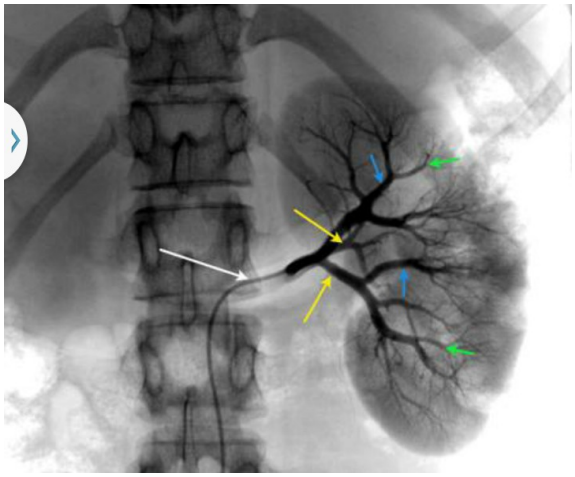

Figure 8: Pre-hilar branching of the renal artery (www.googel.com /branches of renal artery)

2.2 Renal transplantation

2-2-1Indicatios

The main indications are chronic renal failure and renal tumours

2-2-2 Renal failure

Denotes failure of the excretory function of the kidneys, leading to retention of nitrogenous waste products of metabolism. Various other aspects of renal function may fail at the same time, including the regulation of fluid and

Electrolyte status and endocrine function of the kidneys. A wide range of clinical manifestations may therefore occur. (Turner, A., et al., 2002)

2-2-3 Chronic renal failure

Chronic renal failure refers to an irreversible deterioration in renal function which classically develops over a period of years. Initially it manifests only as a biochemical abnormality. Eventually, loss of the excretory, metabolic and endocrine functions of the kidney leads to the development of symptoms and signs of uraemia. When death is likely

without renal replacement it is called end-stage renal failure (ESRF). (Turner, A., et al., 2002)

Causes of chronic renal failure and end-stage renal failure

These include diabetic kidney disease, hypertension, vascular disease, glomerular disease (primary or secondary), tubulointerstitial disease, urinary tract obstruction and unrecovered acute renal failure.

Management of chronic renal failure

Approach to chronic renal failure includes:

Delaying or halting progression of chronic kidney disease

Treating the pathologic manifestations of chronic kidney disease

Diet control

Timely planning for long-term renal replacement therapy. This includes dialysis and renal transplantation. (Arora P., et al. February 2013)

2-2-4 Renal tumors

This is another indication for renal transplantation although chronic renal failure remains the most common cause. The major types of renal tumors are renal

Cell carcinoma (which is the main type), transitional cell cancer of the renal pelvis and Wilm's tumour in children.

2-3 Investigations in renal transplantation

2-3-1 Pre-procedural evaluation

The pre-transplant evaluation must address potential contraindications, should include baseline immunologic studies, and should assess the patient's likelihood of success with transplantation.

2-3-2 Investigating patient (recipient) well-being by

Echocardiography and a stress test

Chest radiography

Pulmonary studies

Colonoscopy or barium enema (depending on patient age)

Mammography, pap smear, PSA (depending on patient age)

Non-invasive vascular studies

Abdominal and renal ultrasonography

Serologic test for HIV, hepatitis B and C infection

Studies of bladder capacity and function (as indicated)

2-3-3 Immunologic studies:

HLA typing and PRA (panel-reactive antibody) titre

2-3-4 Evaluation of potential living donors

The choice of studies for living donors is subject great variation between programmes, but generally includes:

Assessment of renal function

Evaluation of general health

Imaging of the renal vasculature

HLA typing and cross-matching

Imaging of the renal vasculature:

Nowadays, this is done by CT-renal angiography

2-4 CT-Renal Angiography

2-4 -1 Technique

Studies are usually done multi-detector CT scanners. The patient should be fasting 6-8 hours prior to the study.

Firstly, a conventional scout radiographic is obtained. Then, a plain CT scan (no oral or IV contrast administration) of the kidneys, ureters and bladder is done. The region of interest extends from above the kidneys to just below the common iliac arteries. (Kawamoo S., et al, 2004)

For administration of intravenous contrast material, a 20-gauge peripheral line is inserted in an antecubital vein and is manually tested for stability with a small high-pressure injection of sterile saline solution.(Cochran, S., et al., June 1991)

A mechanical injector is then used to administer a total volume of 120-150mL of non-ionic IV contrast (omnipaque 350) at a rate of 2.5-5.0mL/sec and at a pitch of 6. A K Vp of 120 and mAs of 150-180 is used. Section thickness of 1-2mm is used and a table increment of 6mm/rotation.

For the arterial phase, imaging is acquired after 20-30 secs of contrast administration and for the venous phase after 50-70 secs. This gives angiographic and parenchmal phase image respectively. A delayed (excretory urographic phse image is then obtained after 10-15 mins and shows the pelvi-calyceal system.

Studies have been done to determine the value of CT angiography in replacing conventional renal arteriogrpahy and as a means of assessing potential living renal transplant donors by Cochran et al and date back to 1996. Their results have indicated that CT arteriography is as accurate as conventional arteriography at revealing the number of vessels that perfuse and drain the kidneys and can replace conventional arteriography. Use of excretory urography plus CT angiography instead of excretory urography

plus conventional areteriography can result in a 35-50% reduction in cost of the imaging studies in potential renal donors.(Cochran, S., et al., June 1991 Moreover), the use of CT renal angiography alone with its different proposed protocols will result in even more reduction in the cost of imaging for potential renal donors.

In a study conducted by Apisarnthanarak et al. in Thailand in 2012, supernumerary renal arteries and early branching (per-hilar branching) were present in 18.5% and 12.8% respectively on the right kidneys and 27.7% and 22.4% respectively on the left kidneys. The prevalence of precaval right renal artery was 4.6% Supernumerary renal veins were present in 35.4% and 1.5% on the right and the left kidneys, repectively. Late confluences of left renal veins were identified in 1.5% of left kidneys. Other venous anomalies included 1.5% circumaortic left renal vein, 1.5% retroaortic left renal vein, 1.5% outsized left gonadal veins drained into the left renal vein, and 6.2% right gonadal vein drained into the right renal vein.(Apisarnthanarak, P., et al., July 2012). Another study conducted by Lorenz et al. in 2010 showed that the most common abnormalities were kidney stones (11%), focal scarring (3.6%), focal scarring (3.6%), fibromuscular dysplasia (2.8%, and other renal artery narrowing or atherosclerosis (5.3%). Fibromuscular dysplasia, focal scarring, parenchymal atrophy, and upper tract dilation were more common in women. Renal artery

narrowing, focal scarring and indeterminate masses increased with age. Overall, 25% of potential donors had at least one abnormality. However, these incidental radiographic abnormalities contributed to exclusion from donation in only 6.7% of potential donors.(Alam, A., et al., 2003).

In another study by Alam et al., it was determined that the renal angiogram could also exclude the presence of pathologies like polycystic kidney, horse-shoe kidney with a thick isthmus and occult renal cell carcinoma that would prevent the patient from being a donor. It also showed that the most common non-vascular anomalies were cysts which constituted 5% and renal calculi which constituted 1.67%.(Chu L., et al., November 2012)

In a study by Chu et al., the most common renal abnormalities were cysts (34%) and renal stones (4.4%). Renal artery disease was identified in 3.4% of potential donors, including renal artery stenosis, possible fibromuscular dysplasia, and renal artery aneurysm. Suspicious renal masses were incidentally found in 0.5% of potential donors.

2.5 Other Imaging used in kidney donors:

Conventional X-ray.

kidney, ureter and bladder(K.U.B) and also intra venous urogrphy(I.V.U)

The most common modalities and easier one to imaging renal tract to detect any abnormalities in the renal system.

Figure 9: shows the both radiograph of urinary tract on the right side show IVU image and on the left side the K.U.B image

(www.googel.com/ urinary tract)

Ultrasound:

Also more frequently and safe procedure because no radiation and easily prepare the patient just fasting 8 hours before the exam and full the bladder.

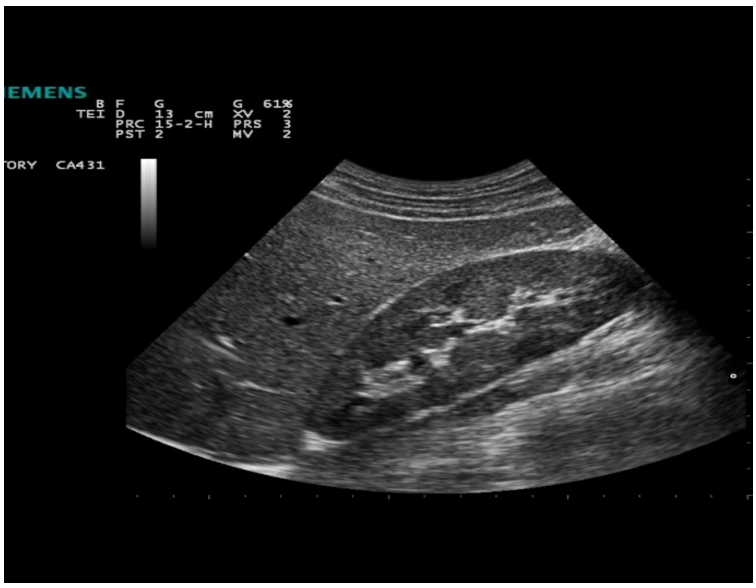

Figure 10 :show the right kidney (www.googel.com / renal tract by U/S)

Magnetic resonance image MRI:

In form of abdominal MRI to detect relation of renal tract.

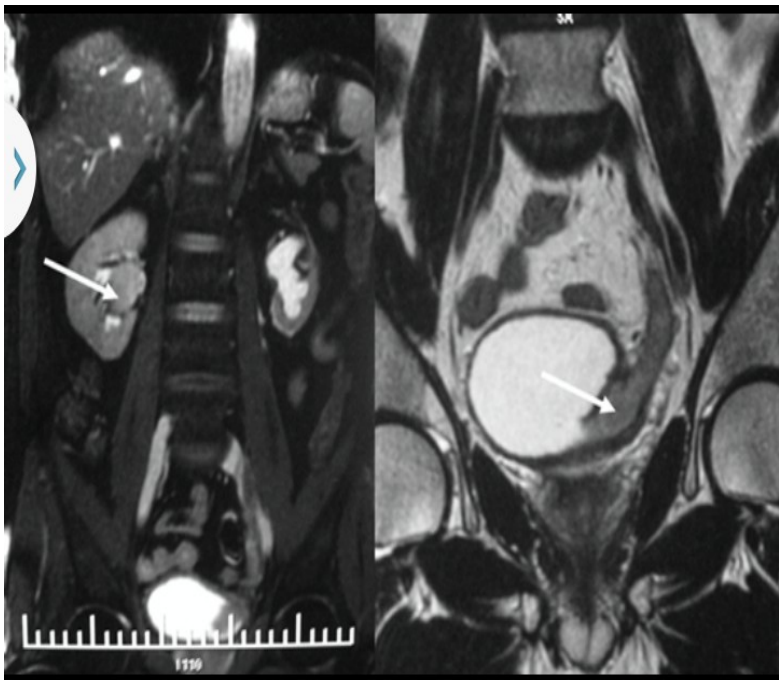

Figure 11: show MRI abdomen coronal scan(www.googel.com/ MRI abdomen)

Chapter three

Material and method

3-1 study design, area and duration

This descriptive study , about the assessment of pre-opartive of live potential renal transplant donors by CTA. The data were collected in radiology department of prince mohmmed bin Nasser specialized hospital, the study was carried out in the (north of Saudi Arabia –jizan) the study duration from (july-october 2015) .

3.2 Study type

Observational, case-finding, retrospective study.

3.3 Study population

Target population: All patients presenting to Prince Mohamed Bin Naser Specialized Hospital.

Study population: potential donor renal transplant patients who present to Prince Mohamed Bin Naser Specialized Hospital.

3.4 Sample size

50 patients

3.5 Data collection technique

Data collection sheet

3.6 Inclusion and exclusion criteria

Inclusion criteria

All patients presenting to the above mentioned radiology departments a potential renal donors.

Patients undergoing renal CT angiography in the above mentioned radiology departments as pre-transplant assessment study too.

Exclusion criteria

Patients present to radiology department above for renal CT angiography for reasons other than pre-transplant assessment.

3.7 Data processing and analysis

SPSS (Statistical Package for Social Sciences) and Microsoft Excel.

3.8 Ethical consideration

Permission from the radiology departments was obtained in the different hospitals from which data was collected. There was no need for consent from patients or their guardians as it was a retrospective study.

3-9 machine used:

The machine used in this the study is Toshiba medical system 64 slice.

3-10 accessories

Automatic injector (nemato), contrast material is iodinated contrast material injected directly through the cannula into the vein (omnipaque).

3-11 method

3-11-1 technique

Patients were requested to fast for 6-8 hours before the study.

Plain unenhanced CT scan of the kidneys, ureters and bladder were obtained.

Post-IV contrast scans were taken as follows:

Arterial phase (angiography) after 20-30 seconds.

Nephrogenic phase (parenchmal) after 50-70 seconds.

Excretory phase (urography phase) to show the pelvi-calyceal system and the ureters, preformed after 10-15 mins.

3-12 image interpretation

Accurate radiologic interpretation depends on the radiologists experience level, attention to detail, and commitment to careful image evaluation in this study all cases it reported by DR. AKhtar Whab .(radiology consultant in prince mohmmed bin Nasser specialized hospital.

Chapter four

4-1 Result

The CT renal angiography images and accompanying reports of the 50 selected patients were reviewed and the information retrieved was analyzed.

In the 50 cases reviewed the ages ranged from 16-50 years with a mean age of 29.44 years and a standard deviation of 5.865.30 patients were males and 20 were females.

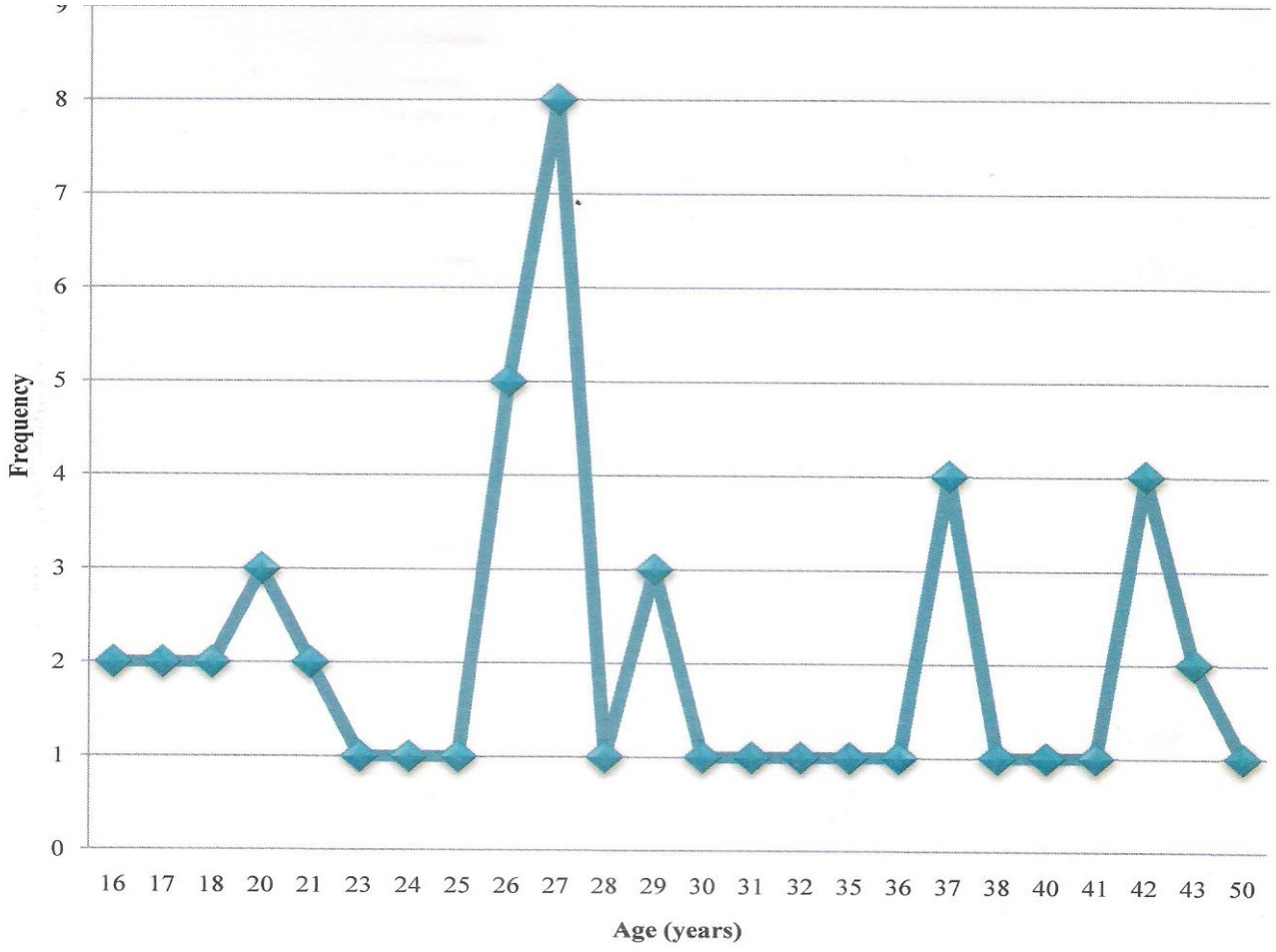

Figure 4-1 age distribution of study group.

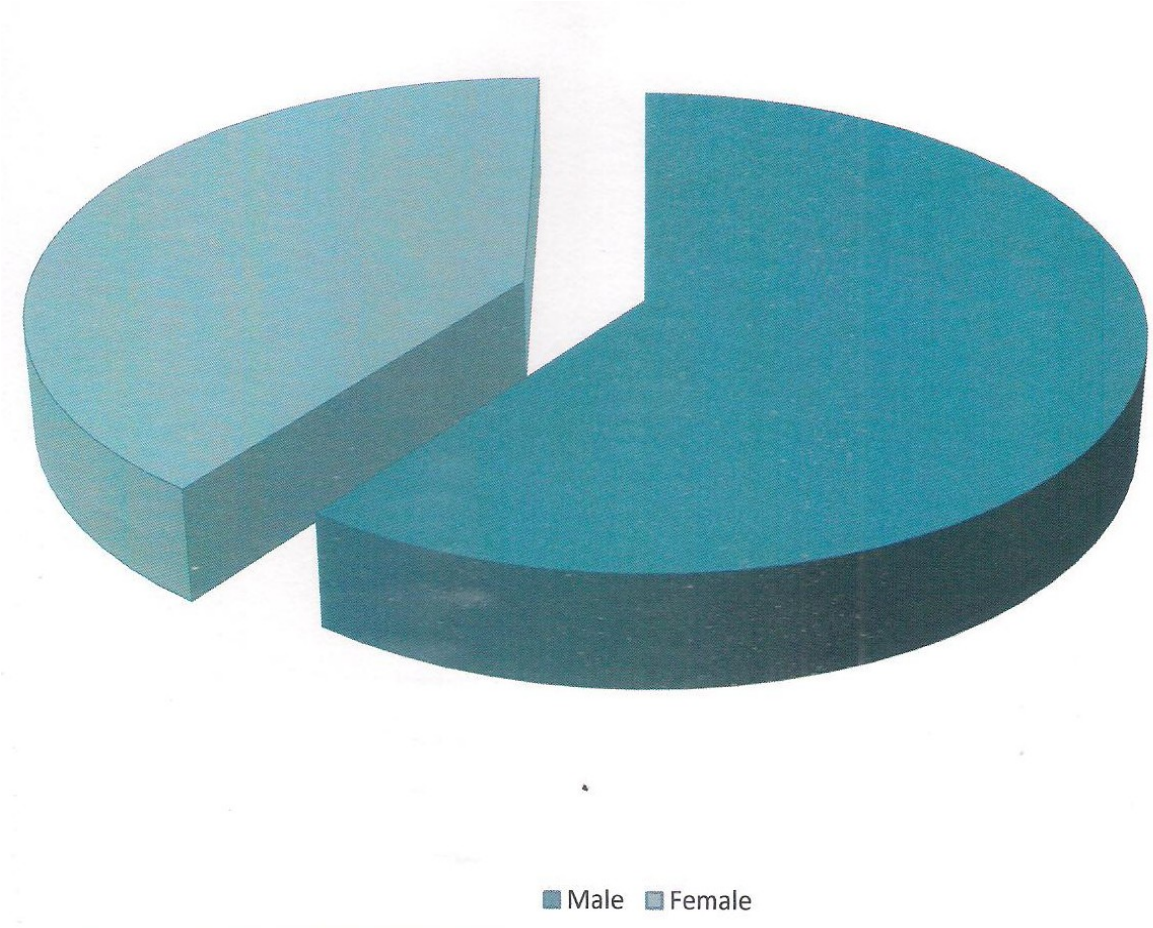

Figure 4-2: Gender distribution of study group

35 patients showed a completely normal CT renal angiogram (70%).

15 patients showed abnormal studies which constituted 30% of the study group.

Of the 15 abnormal patients, 1 patient showed abnormal renal shape in the form of persistent fetal 1 oblation (2%). 1 showed a unilateral renal cyst (2%), 1 patient showed bilateral duplex

collecting system, not extending to the ureters (2%), 1 patient showed a double anomaly consisting of extra-renal pelvis combined with pelvi-ureteric junction obstruction (2%).

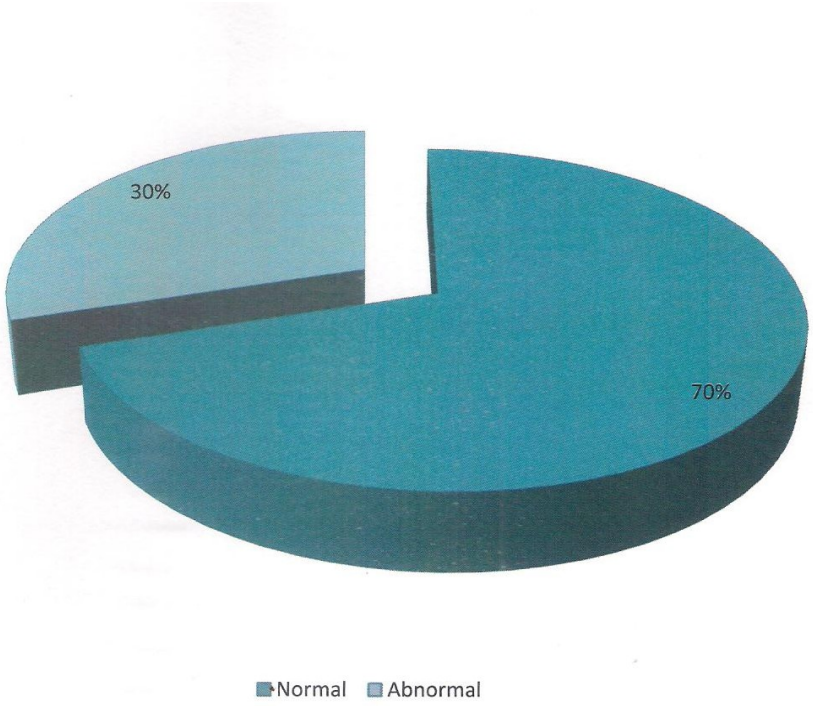

Figure 4-4: Percentage of normal to abnormal studies

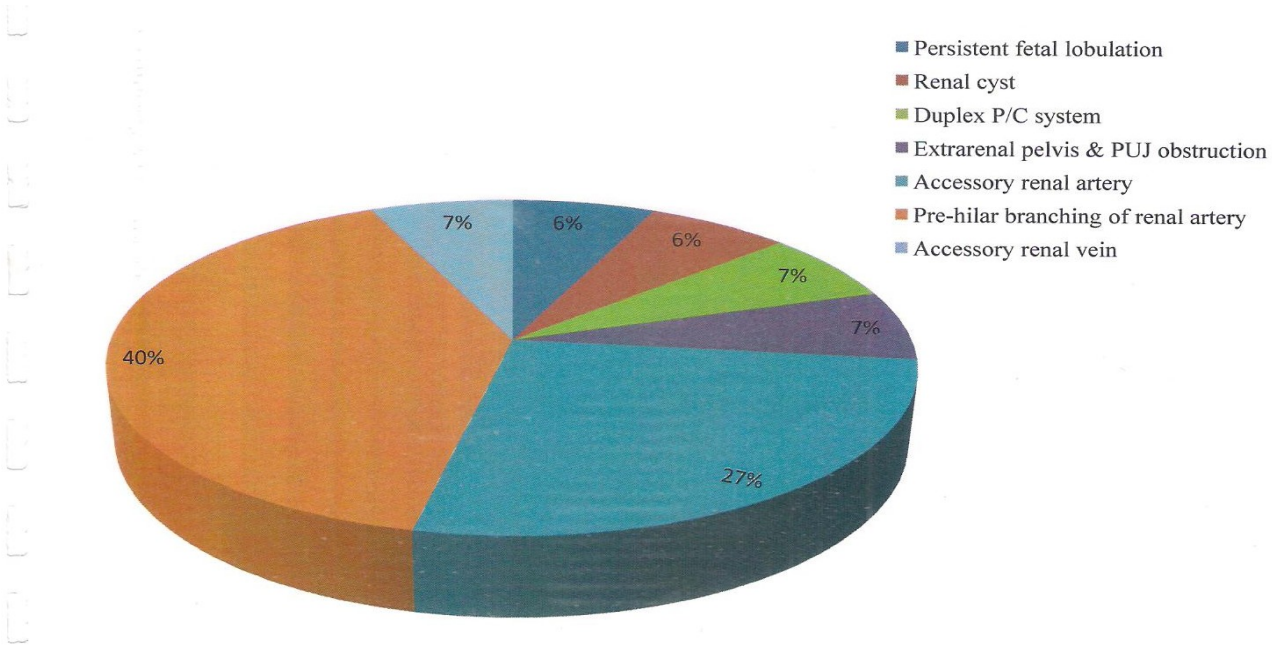

Figure 4-5 : distribution of renal anomalies

Vascular anomalies composed 10 out of the 15 cases with anomalies (67%) while non-vascular anomalies composed 5 out the 15 patients (33%).

Vascular anomalies comprised 10 out of the 15 cases with anomalies (67%) while non-vascular anomalies comprised 5 out of the 15 patients (33%)

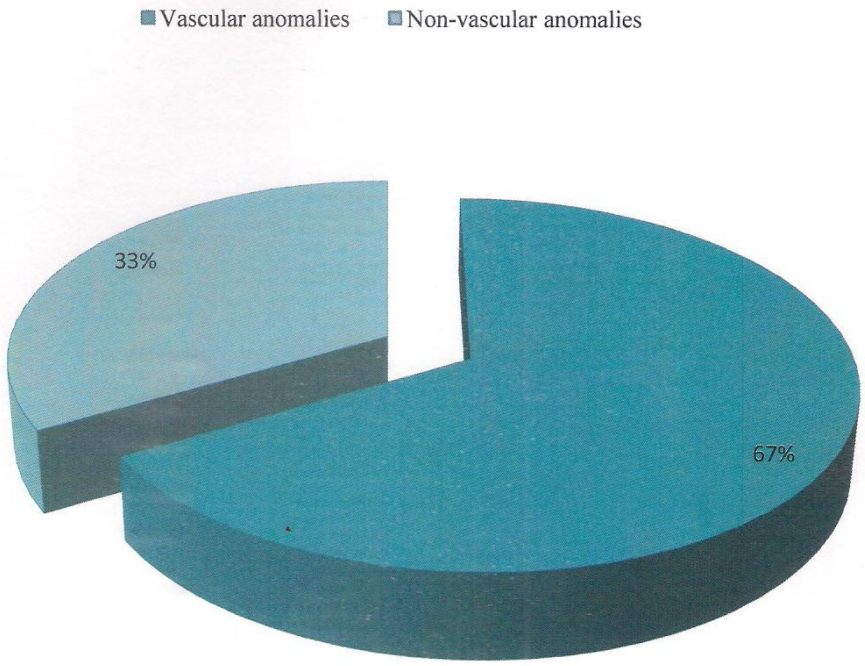

Figure 4-6: ratio vascular to non-vascular anomalies

Regarding the vascular anomalies, 6 patient showed pre-hilar branching, 4 of which were (8%) and 2 of which were unilateral (4%), 3 patient showed unilateral single accessory renal arteries (6%), and 1 patient showed bilateral single accessory renal (2%), and 1 patient showed 2 unilateral accessory renal veins (2%).

1 patient showed a double anomaly which comprised 2% of the study group.

Vascular anomalies encountered may be divided into pre-hilar branching (50%), accessory renal arteries (36%) and accessory renal veins (9%).

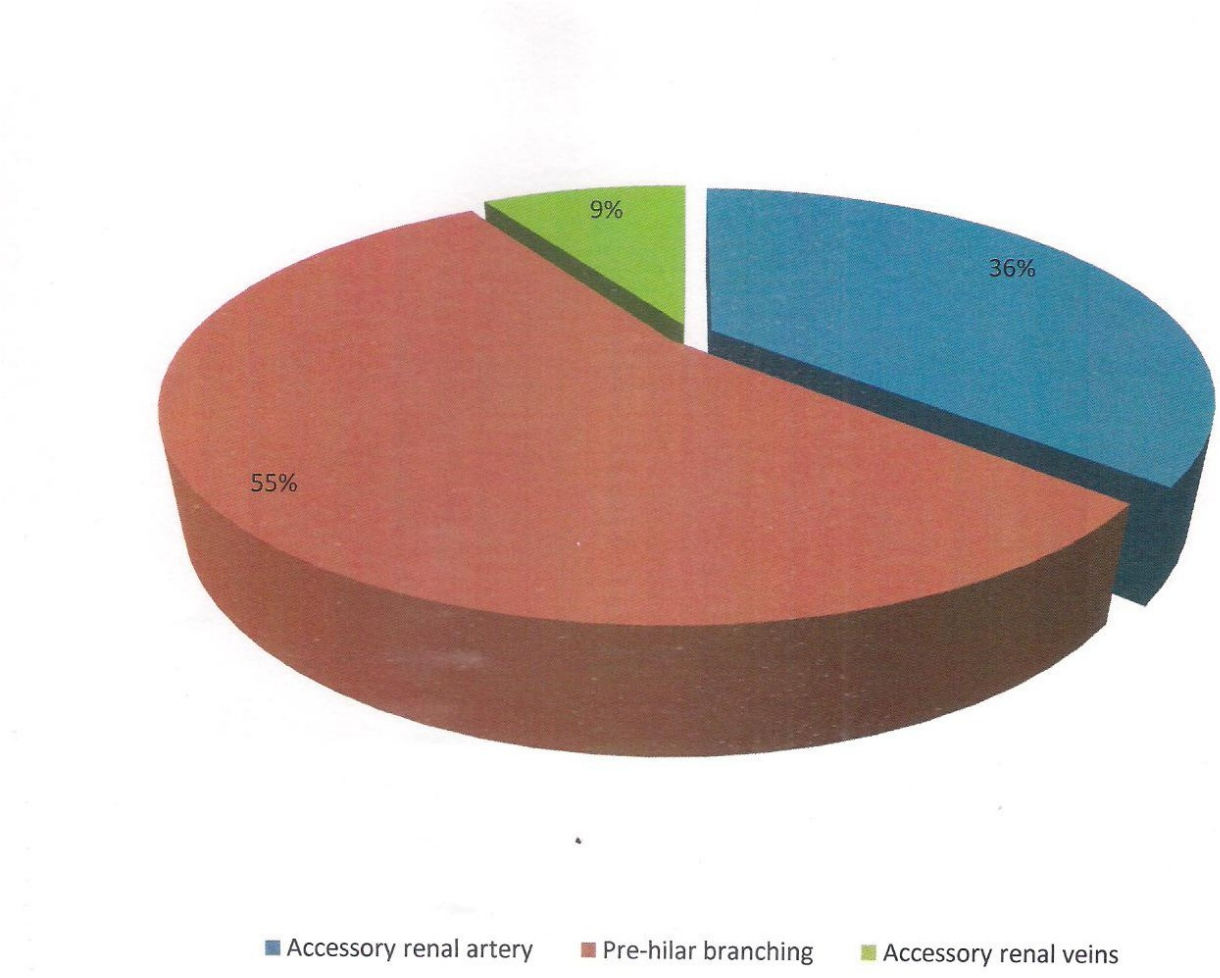

Figure 4-7: distribution of vascular anomalies

No anomaly was detected regarding the number of kidneys, no absent or accessory kidneys. Normal renal size was found in all

cases, normal renal position; no ectopic kidneys. No renal atones or masses were detected. No ureteric anomalies or stones found. Normal bladder was found in all patients.

Regarding the vasculature, which was the main object of interest, no aberrant renal arteries, circum-aortic or retro-aortic renal veins were found and no late venous confluence.

The commonest renal anomaly was pre-hilar branching which presented in 6 out of the 5 patients (12%) followed by single accessory renal arteries which was found in 4 out of the 50 patients(8%) of the group. Bilateral pre-hilar

Branching of the renal ateries was found to be more common than unilateral branching (8% and 4% respectively).

Arterial anomalies comprised 10 out of the 11 patients with vascular findings (91%) while only 1 patient had venous anomalies (9%).

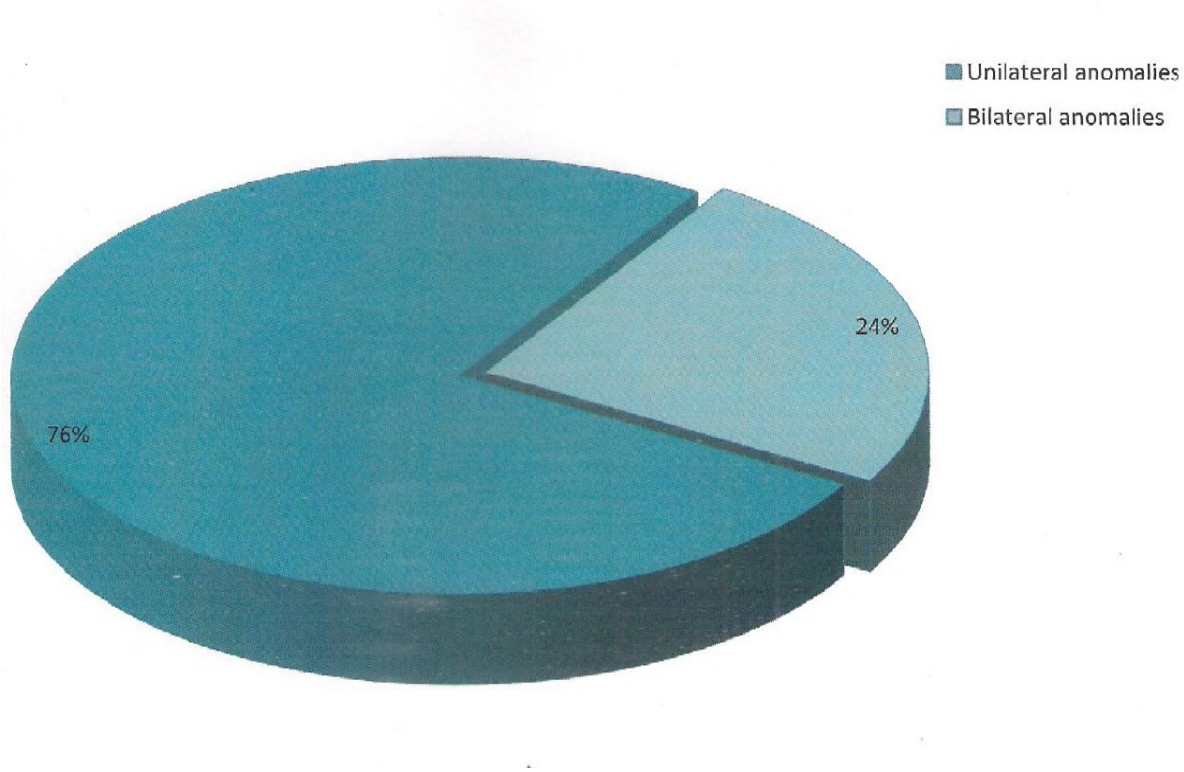

Figure 4-7: ratio of arterial to venous anomalies

Bilateral anomalies presented in 5 patients out of the cases in the study group (33%) while unilateral anomalies were found in 10 out of the 15 patients (67%).

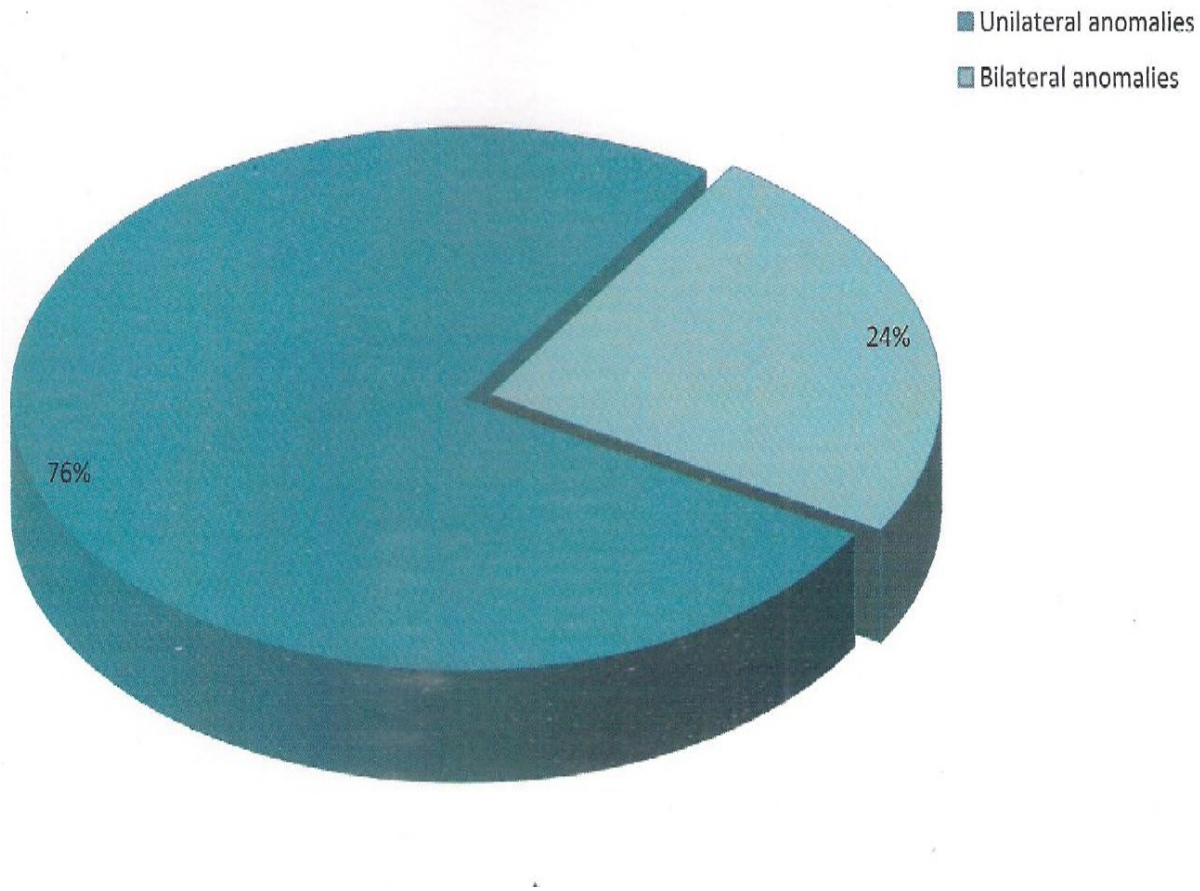

Figure 4-8: Ratio of unilateral to bilateral renal anomalies

Right sided abnormalities were found in 6 patients (12%). Left sided anomalies were found in 2 patients (4%) and 7 patients had bilateral anomalies (14%).

Ureteric anomalies were not recorded in the study and no urinary bladder anomalies were documented.

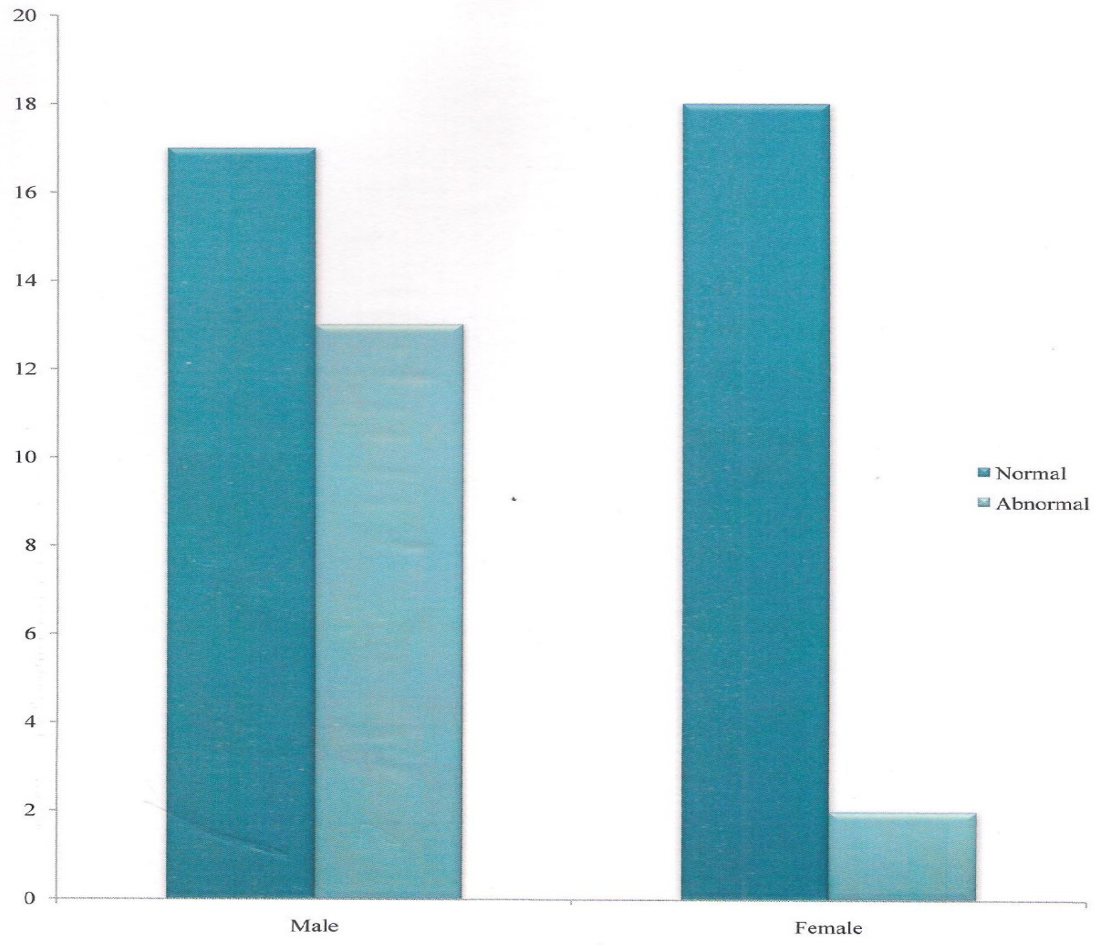

Figure 4-9: Distribution of anomalies according to gender

Chapter five

Discussion, conclusion and recommendation

5-1 discussion

The main objective of the study was to evaluate the potential donor renal anatomy for detection of any renal anomaly that precludes them from being a donor. More specifically, it aimed towards assessing the renal vascular anatomy to guide the surgeon accurately in the case of normal variants. It also intended to assess the pelvi-calyceal system and ureters at the same procedure. And finally, it aspired to determine the CT protocol that will fulfill the purpose of the renal transplantation.

The study by Pozniak et al. was conducted in the year 1998 and consisted of group of 205 patients. It revealed that 40% of potential donors had multiple renal arteries: 24.9% of whom had left sided anomalies and 20% had right sided anomalies. Multiple right renal veins were present in 13.2% while 8.3% had left sided circumaortic left renal veins and 2.9% had retroaortic left renal veins[1]

Another study, conducted by Alam et al, consisted of 30 potential donors, with ages ranging from 35-50 years; 22 males and 8

females. The findings were divided into vascular and non-vascular anomalies. The vascular anomalies were further sub-divided into arterial and venous anomalies. 80% of patients were found to have a single renal artery. Accessory arteries were found in 20% of patients while pre-hilar branching was found in 3.33% of patients. The venous studies reveal retroaotic renal veins in 1.67% of patients and accessory renal veins in 6.67% of donors. Non-vascular anomalies of renal calculi in 1.67% of cases and renal cysts in 5%.

The study by Chu et al in 2012 was carried out 417 patients, in the age range between 17-79 years of age. It revealed non-vascular causes of renal anomalies to be renal cysts (34%) and renal stones (4.4%). renal artery disease comprised 3.4% of patients and was due to renal artery stenosis, possible fibro muscular

dysplasia and renal artery aneurysm. Renal scarring was found in 1.8% of patients. Selection of right kidneys in 29 donors was due to presence of ipsilateral vascular or complex left anatomy

Apisarthanarak et al conducted a study in Thailand in year 2012 on 65 patients. Results showed arterial anomalies to consist of supernumerary renal arteries and early branching. On the side, these comprised 18.5% and 12.8% respectively and 27.7% and 22.4% respectively on the left side. Precaval renal artery was found

in 4.6% of cases. Supernumerary renal veins were found in 35.4% on the right side and 1.5% of cases. Supernumerary renal veins were found in 35.4% on the left. Circumaortic renal veins were found in 1.5% on the side left side and retroaortic renal veins were found in 1.5% on the same side.

The study conducted has shown non-vascular causes of anomalies in 4 patients (8%) of which 1 patiant (2%) had persistent fetal lobulation, 1 patient (2%) had a renal cyst, 1 patient (2%) had a duplex P/C system and 1 patient (2%) had adouble anomaly consisting of external renal pelvis and PUJ obstruction. This compared with the results reported by Chu et al: renal cysts constituted 34% being the commonest anomaly and renal stones which were found in 4.4% of cases. Alam et al found the frequently of renal calculi and renal cysts to be 1.6% and 5% respectively. The reason for the difference in frequency might be due to the fact that before proceeding to do a CT renal angiogram, the donor would quickly exlude the patient from being a potential donor would usually be requested to do an ultrasound scan of the renal system. This would quickly exclude the patient from being a potential donor and hence they would not proceed to doing a CT renal angiogram. Also, the study by

Chu et al included an older age group, renal cysts would be more common.

In this study, pre-hilar branching of the renal artery was found to be the commonest anomaly (in 12% of cases) this compared with 3.33% in the study

by Alam et al and 12.8% in the right side and 22.4% in the left side the study by Apisarnthanarak et al.

Supernumerary renal arteries were found in 8% of patients which compares to 40% in the study by Pozniak et al and 20% in the study by Alam et al. Apisarnthanarak et al found 18.5% of patients to have right sided accessory renal arteries and 27.7% to have left sided accessory arteries. These studies were conducted in India, USA and Thailand while the study was conducted in Africa. Different races might have different frequencies of the different anomalies. Further studies with langer samples are required to prove this suggestion.

The venous anomalies in the study were found to be accessory renal veins, which presented in 4% of patients. In comparison, this was found to be in 6.6% in the study by Alam et al, 13.2% in the study by Pozniak et al, and in 35.5% and 1.5% in the right and left renal veins (respectively) in the study by Apisarnthanarak et al. the justification for the difference in frequency could also be attributed to the difference in study group location. Pozniak et al also found circumaortic renal veins in 8.3% and retoaortic renal veins in

2,.9% Alam et al found retroaortic veins in 1.6% Apisarnthanarak et al found circumaortic renal veins in 1.5% and retroaortic renal veins in 1.5%. the study revealed none of the above abnormalities, which could be absent or in an even smaller minority of Sudanese patients. No ureteric anomalies were reported, this could be due to its low prevalence.

No bladder anomalies were documented. This most probably is due to the fact that usually bladder anomalies are discovered at younger age e.g. bladder extrophy, etc. and hence, patients with these anomalies will not be potential donors.

In addition, CT renal angiography with different proposed protocols has been found to be sufficient in answering all the question raised by the transplant surgeon with regards to the pre-operative assessment and it is proposed that there is no need for evaluation by ultrasound scan or excretory urography .

5-2 conclusion

The study of conclusion revealed that 35 patients (70%) were normal, while 15 (30%) were abnormal. Of the 15 patients that were abnormal, 1 patient (2%) had persistent fetal lobulation, 1 patient (2%) had a unilateral renal cyst, 1 patient (@%) had a combined anomaly of extrarenal pelvis and pelvi-ureteic junction obstruction, 4 patients (8%) had accessory renal arteries (of which 1 showed bilateral accessory renal artery), 6 patients (12%) had pre-hilar branching of the renal arteries (4 of which were bilateral) and 1 patient (2%) had 2 accessory renal veins.

There was a difference in the frequency of anomalies in the study group as compared to other studies. This could be a cause of exclusion or alteration of the renal transplant procedure (e.g. harvesting of the left kidney instead of the right kidney).

Assessment of the pelvi-calyceal system is also important and should be included in the study done for potential donors because anomalies were actually encountered and it would be wise to acknowledge them before undertaking the transplant procedure so as to accurately plan approach.

The CT protocol used in the study (and applied in the centres from which the data was collected) which includes assessment of the collecting system and ureters by unenhanced scan, arterial phase,

nephrogenic phase and excretory phase seems to be adequate as it has revealed all anomalies that searched for.

It is also proposed that the CT renal aniograohy for potential donors be given a separate name; CT renal angiography with donor protocol as it shows more than just the renal vasculature.

5-3 recommendation

A difference in the statstic between the study conducted and the studies that were used as a comparison have been elicited. This calls for further studies to be done with a larger study group so as to reveal further results that would be more accurate and more usefull.

No such study was conducted presviously in Sudan and the study could be used as base to verify and record statistics of normal variants and their differences.

Normal variants could pose a difficulty in the surgical procedure and a prior knowledge of them could make a difference by avoiding complications that could otherwise cause a lot of preventable harm to the donor patient.

Standardization of the CT renal angiography protocol and reporting system would be recommended between different centers

working in the pre-operative donor assessment for renal transplantation.

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