Original Article

Anatomical Variations of Renal Artery Pedicle

Normal Anatomical Variations of Renal Artery Pedicle: A Review of 100 Renal Angiograms of Healthy Proposed Renal Donors

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ABSTRACT

Objectives: To present variations in renal arterial anatomy. To document renal artery number, source, course and patterns.

Study Design: Observational / descriptive study.

Place and Duration of Study: This study was **conducted at the** Angiography suite, Radiology Department, Sindh Institute of Urology and Transplantation from May 2011 to Oct 2011.

Materials and Methods: A total of 100 healthy adultswho underwent renal angiography for renal donor assessment in living related transplant programwere included. Both male and female with age group between 20-50 years having normal clotting profile, renal function and normal morphology on IVP were fully evaluated by predesigned performa including number, source, course and pattern of renal artery.

Results: Out of 100 cases of healthy renal donors, 66 were male and 34 were female. Fifty four percent were in 20 – 30 years of age group while 30% between 31 – 40 years and 16% in between 41 – 50 years. In 56% right renal artery found to be higher than left, where as 40% had both the arteries at same level. Right renal artery longer in 52% and left in 46%. Only 2% had same length of both renal arteries. Regarding the number, 66% had bilateral single, 24% unilateral double, 6% bilateral double and only 4 % unilateral triple.

Out of 100 renal donors with 200 renal pedicles (each donor having 2kidneys), single hilar artery seen in 75% in single hilum with inferior polar aortic branch in 14% and single hilar with suspicious polar aortic branch seen in only 4%. Double hilar arteries seen in 1% and hilar with extrahilar branch in 4% . Triple vessels found in 4% cases.

Conclusion: The study shows that normal variation of vascular anatomy of renal pedicle is clinically very important to perform urological interventional procedures and transplantation. This study providesinformation concerning renal artery anatomy not only for interventional radiologists but also to urologic surgeon.

Key Words: Angiography, Renal artery, Renal donors

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INTRODUCTION

The knowledge of variations of renal arterial anatomy has importance not only in exploration and treatment of renal trauma[1] but also in renovascular hypertension, renal artery embolization, angioplasty or vascular reconstruction for congenital and acquiredlesions.

Evaluation of living potential renal donors routinely involves preoperative imaging of the kidneys and their vascular anatomy[2]. The conventional angiograms enable identification of the number, length and location of renal arteries. Intrinsic disease of arteries may be identified. The kidney best suited for removal is selected on the basis of angiographic findings[3].

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Evaluations of conditions affecting the renal vasculature constitute a major focus of Digital subtraction angiography, which has documented utility for demonstrating both arterial and venous disease. DSA accurately displays the normal and variant renal vascular anatomy, that is crucial todetermine before partial or laparoscopic nephrectomy.

Renal artery variations including their number, source and course are very common (35%). The most common is the presence of an additional vessel (28%)[4].

Variations of renal artery have their origin in embryonic development[5]. Initially, the kidneys are in the pelvis, but they gradually come to lie in the abdomen. During development urogenital tissue is supplied by a wide network of small aortic branches called the reteartеriosumurogenitale. As the kidneys move out of pelvis, they are supplied by successively higher vessels[6,7]. While the lower vessels normally degenerate. Therefore, arterial variations result from persistence of embryonic arteries that normally disappears.

Each kidney is supplied by a single renal artery arising from abdominal aorta[8]. The renal arteries arise opposite

each other from the lateral or anterolateral aspect of the aorta at the L1-L2 level[9] about 2 cm below the superior mesenteric artery. This single artery divides into anterior and posterior trunks anywhere along arterycourse to kidney hilum. The right renal artery course posterior to the inferior venacava[10].

Multiple renal arteries occur in about 20% of cases, more often on left[11]. Most frequently they arise from the aorta below the main artery, although their origin may be above the main renal artery or even aberrantly fromnearest pointthe iliac arteries. They usually enter the kidney parenchyma accompanying the main artery into the hilum (so called accessory branches).

Current terminology of renal arteries include hilar artery which traverse the renal hilum and pierce renal substance from within the sinus but may sometime enter the kidney medially directly either above or below called polar arteries. The extra hilar artery is a renal artery branch that has extra hilar penetration (superior pole) in the kidney where as precocious bifurcation is the one in which renal truck has < 1 cm length before branching off[12].

Accessory renal arteries may enter the kidneys at any point and vary in size and are generally derived from aorta (26 – 30%) in all reported kidneys studied.

In different studies renal arteries were reported to be located between lower third of first lumber vertebra and cranialthird of second lumbar vertebra. The right and left renal arteries can be at same level but usually right is higher than the left in most of the cases. A single renal artery on one side and multiple 2-4 renal arteries on the other is not unusual.

The right renal artery usually courses behind the inferior vena cava andis longer than the left. When multiple, the more caudal arteries often takes a precaval course. The right renal artery may measures up to 0.5 to 8 cm from its aortic origin to the point of division, while left may vary from 0.5 to 6 cm. In most cases, the division of single renal artery into anterior and posterior trunks may be anywhere along course of the artery reaching the kidney hilum. Precocious[13] (near to its origin) division may be interpreted mistakenly, as dual or even multiple renal arteries. The number of renal arteries may vary from two to four, although there may be, rarely five or six, branches arrange either unilaterally or bilaterally.

Accessory renal arteries can arise from aorta as high as (superiorly) as the diaphragm or as low (inferior) as the internal iliac artery. But a superior accessory artery is a segmental apical artery and an inferior accessory artery is a separate lower segmental artery.

Double renal arteries may be side by side, one in front of the other, or spaced so that they enter the kidney at opposite ends of hilum. In cases of double renal arteries, there may be primary aortic hilar renal and renal polar artery. Rarely three hilar renal arteries are derived from the aorta, twohilar (of aortic origin) and a superior or a lower renal polar branch are typical triple renal artery pattern.

Quadruple renal may exist as two hilar and two polar, three hilar and one polar or one hilar and three polar renal arteries usually only one of these is large and other are smaller and distributed to the superior or inferior extremities of the kidney. Therefore detailed knowledge about renal artery variation is very important in order not be misinterpret normal variations as renal pathology.

MATERIALS AND METHODS

A descriptive study including100 healthy adults who underwent renal angiography for renal donor assessment in living related transplant programdone from May 2011 to Oct 2011. , at Angiography suite of .Radiology Department ,Sindh Institute of Urology and Transplantation.

Both male and female with age group between 20-50 years having normal clotting profile, renal function and normal morphology on IVP were fully evaluated by predesigned performa including number, source, course and pattern of renal artery.Angiograms withInadequate visualization of accessory vessels were excluded.

We analyzed the renal arterial pattern in 100 adults with 200 renal pedicles.

Renal angiography of the patient was performed by Digital Fluorography system Toshiba DFP-2000A with computerized advantage of the subtraction of precontrast film from a radiographic film after contrast medium injection in the arteries. The subtraction is made in real time while the contrast injection is being recorded.

DSA angiography of the patients were performed in order to analyze the normal variations of renal arterial pattern. No inferential test was applicable for this descriptive study.

RESULTS

Out of 100 renal donors, 66 were male and 34 were female in which 54% were in age group between 20 – 30 years, 30 % were between 31 – 40 years. 16 % were in between 41 – 50 years.

In our study most of the right and left renal arteries found to be at same level in 40 % of cases while right was higher in 56 % and left was higher in 4 % of cases. This indicates gradual ascend of kidneys from pelvis to abdomen during embryologic development and results in different level of origin of both renal arteries. Renal arteries were found to be located between first lumbar vertebra and second lumbar vertebra in 91% cases.

The longer right renal artery courses its way behind the inferior vena cava. 52 % cases presented with right renal artery longer (from aortic origin to its division) and 46 % with left longer. 2 % cases found with same length of both renal arteries.

The number of renal arteries i.e. single on one side and multiple renal arteries on the other is not unusual. 66 % presented with bilateral single renal arteries, 6 % with bilateral double (hilar with polar aortic branch), 24 % with unilateral double and 4 % with unilateral triple (figure 1).

Regarding pattern of renal arteries (figure. 2), out of 100 donors with 200 renal pedicles (each donor having 2 kidneys), single hilar artery found in 75 %. 4 % presented with single hilar with extra hilar branch and 1 % with double hilar arteries. Extra hilar branch is ramification of main trunk of renal artery and has surgical importance similar to polar aortic branch, since this vessel can be injured during mobilization or other procedures on superior pole. 4% of renal pedicles found to have single hilar with superior polar aortic branch and 14% with single hilar inferior polar aortic branch and 2% showed single hilar with superior and inferior polar aortic branch.

Precocious bifurcation of renal artery seen in 6 % of renal pedicles and considered to be equivalent of multiple blood supply in surgical terms because to ligate safely and perform anastomosis in living donors, main renal artery should be at least 1 cm in length.

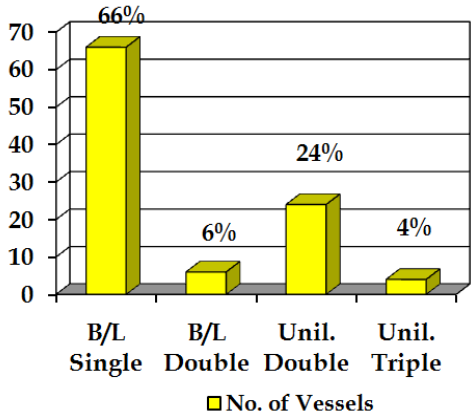


Figure No.1: Number of Renal Arteries (n=200)

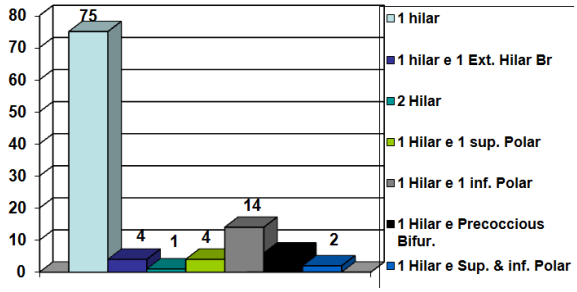
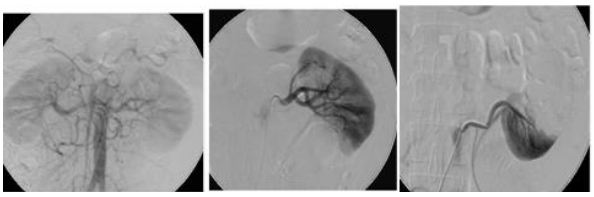
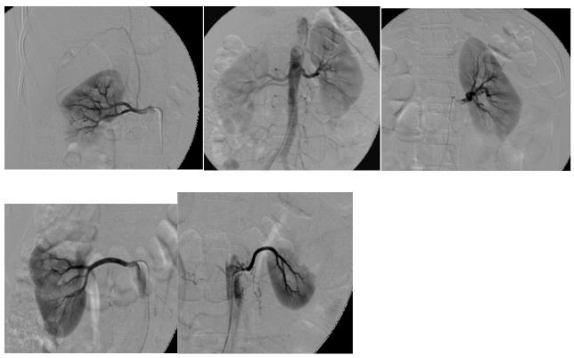


Figure No.2: Patterns of Renal Arterial Anatomy

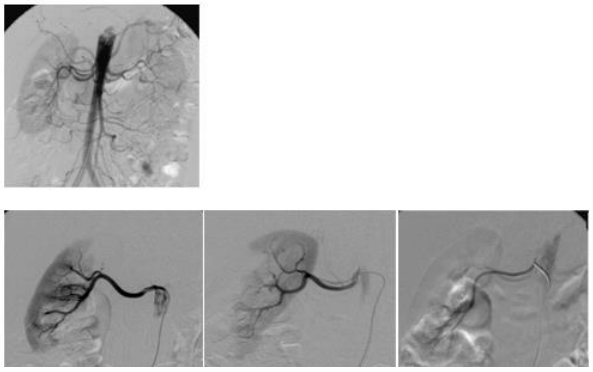
Bilateral Single Renal Arteries (Aortogram with Selective Images)



Double Renal Artery (Single Hilar with Inferior Polar Aortic Branch)



Bilateral Double Renal Arteries



Triple Renal Arteries

DISCUSSION

End stage renal disease is a devastating, physical, economical and social problem for patients and their family. The prevalence of it has increased over last few decades which has led to tremendous rise in number of renal transplant surgery. Therefore, meticulous screening and selection of renal donors is of primary importance.[14]

Kidney transplant from living donors have become increasingly common. A major reason for this increase in living donor transplant is better outcome obtained with living donors as opposed to cadaveric kidneys.[15]

Anatomic assessment of the donor kidney is performed prior to transplantation to help select the kidney to be used and plan the surgical approach. The preoperative diagnosis becomes even more pertinent due to increasing use of laparoscopic donor nephrectomy as the details of arterial and venous anatomy may be more demanding to appreciate during laparoscopic surgery[16].

Angiography occupies a unique place in medicine. It is invaluable aid in diagnosis of diseases of viscera and definitive method of showing vascular anatomy.

Nowadays the imaging techniques have been supplanted largely by computed tomography[17,18] (CT) or magnetic resonance (MR) angiography but still Digital subtraction angiography (DSA) is the idealand most accurate technique for visualization of renal vascular system not only to identify the number, position and patency of the renal arteries but also to identify proximal branches of main renal artery presence.[19] By means of DSA unit the image of bones and soft tissues is blotted out and a subtractive picture of contrasted vessels alone emerges[20]. Small renal arteries can be missed on multi-slice CT usually due to interpretation errors and rarely from non visualization of the artery as compared to DSA.

Differences between the renal pedicles, depending on the side, are accounted for chiefly by adult asymmetry in the renal venous drainage. it is regularly stated that the right renal artery is longer than the left; and the left renal vein longer than the right.[21]

The study of normal variations of renal arterial anatomy is very important because for renal transplants as surgeons usually avoid the kidney with more complex anatomy. Therefore, failure to distinguish between normal variants of renal artery can result not only in renal transplant failure but also in treatment of renal trauma, embolization, angioplasty and reconstruction for congenital and acquired lesion and conservative or radial renal surgery.

Our results suggest that multiple renal arteries supply approximately one third of all kidneys. The length right renal artery from aortic origin to its division point measured between 0.2 – 7.4 cm. with right renal artery higher in 56% as compared to left. Single hilar arteries seen in majority (66%). 24% had unilateral double and only 4% had unilateral triple vessels having pattern of single hilar with superior and inferior polar aortic branch. The most common presentation of normal variation is single hilar with inferior polar aortic branch in 48 %.

CONCLUSION

The study highlights the normal variations of renal artery in order to provide thorough understanding of such anatomy so that the urologic surgery and uroradiologic interventional procedures can be performed safely and efficiently.

Accessory renal arteries are the most common and clinically important renal vascular variantionseen in upto one third of patients , so it is just as important today as it was few years ago to have detailed knowledge about renal angiogram in order not to misinterpret the many normal variations as renal pathology. This normal and variant vascular anatomy can be viewed easily and accurately by surgeons on CD, similar to that seen in surgery. Digital subtraction angiography identifies the vascular anatomy of kidney donorsaccurately. It is the preferred imaging study for preoperative evaluation of kidney donors.

As it provides accurate assessment of renal vasculature in efficient manner, it is more beneficial to recipient for long term survival and viability of renal graft. The vascular map provided by DSA facilities the technical performance of live donor nephrectomy

Conflict of Interest: The study has no conflict of interest to declare by any author.

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