The variation of renal artery anatomy in the Iraqi population: An angiographic study of 358 middle Euphrates Iraqi patients attending the catheterization laboratory in Hilla province

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Abstract

Objective: the aim of this study is to determine the prevalence and the rate of renal artery variations in the middle Euphrates Iraqi population.
Materials and methods : Three hundred fifty eight (358) patients were referred to Shaheed Al Mihrab Cardiac Centre in Hilla province for a variety of indications for catheterization including ischemic heart disease , lower limb peripheral arterial disease , valvular heart disease , etc , detailed information about the angiographic procedure was given, an informed consent was obtained ,all patients renal arteries were visualized by either selective engagement using Judkins RT catheter or non selectively using a pig tail catheter .
Results : Anatomically the origin of the main renal artery was at the level of the first lumbar vertebra (L1) in 62% , L1-L2 disk in 13% ,L2(22%) of the cases , the remaining 3% was distributed over the T12 ,T12-L1 ,L2-L3 ,L3, L4 vertebral levels . The renal artery bifurcates at the hilum into the segmental arteries in 56.7% of the cases , in the remaining 43.3% ,the renal artery bifurcates in to segmental arteries before it reaches the hilum and at variable distance from it aortic origin .Each kidney was supplied by a single renal artery on both side in the same patients in 79.8% of the cases while in the remaining 20.2% there was more than one renal artery in the following ratios :unilateral dual blood supply on the LT kidney (10%), RT kidney (6.5%) ,bilateral dual blood supply on both sides (2.5%) and in 1% of the cases there was more than two arteries on either side .we recorded one case four renal arteries on the left kidney , and there was triple renal arteries bilaterally in another one case .
Conclusion: Renal artery anatomical variation is common in the general population and this study confirms a nearly comparable frequency of variations in the Iraqi population with some diversion from the comparable studies that might be explained on racial bases.

Introduction

The embryological development of the urogenital system is highly complicated and hence the congenital anomalies and variations of that system are relatively higher than other organs, the variation in the renal arteries might be either asymptomatic, or may cause problems in the urinary flow or interfere with the blood supply to the kidneys [(1)].

The kidney and ureter are mesodermal in origin, the metanephric duct develops into the ureter, pelvis, calyces and collecting Tubules, the metanephros develops into the glomeruli and the proximal part of the renal duct system. The kidney first develops in the pelvis and then migrates upwards and as the kidneys ascend from the pelvis during the development they receive their blood

supply from the vascular structures close to them. Initially renal arteries are the branches of common iliac arteries. Later, while the kidneys ascend they receive new branches from the aorta, and the inferior branches disappear. In the ninth week of the intrauterine life the kidneys come in to contact with the suprarenal glands and the ascent stops. The kidneys receive their most cranial branches from the aorta and these are the permanent renal arteries. This continuously changing blood supply of the kidneys as they ascend explains the high incidence of the variations in the blood supply to the kidneys [2,3].

Therefore it is common for one or more distally placed arteries to persist (*aberrant renal arteries*) and one may even run to the kidney from the common iliac artery. Occasionally the kidney will fail to migrate cranially, resulting in a persistent *pelvic kidney*. The mesonephric duct may gives off a double metanephric bud so that two ureters may develop on one or both sides. These ureters may fuse into a single duct anywhere along their course or open separately into the bladder [3]

Anatomically each renal artery emerges as a single vessel from the aorta on each side of the vertebral column between the first and the second lumbar vertebra, about 1-2 cm below the origin of the superior mesenteric artery; it divides in to anterior and posterior braches just after giving off the inferior suprarenal artery.

although this is not definitive, the aortic origin of the left renal artery is higher than that of the right renal artery .the right renal artery take off from the abdominal aorta tend to be anterolaterally with an average angle about 30-35 degrees, while the left renal artery take off tends to be posterolaterally with an average angle of about 10-15 degrees [4]

Each renal artery divides into five segmental arteries that enter the kidney from the hilum, they distribute in to different segments of the kidney, each segmental artery give multiple lobar arteries with one lobar artery for each pyramid, each lobar artery gives multiple interlobar arteries before it enters the renal parenchyma, the interlobar arteries gives the arcuate arteries that in turn gives the interlobular arteries and then the afferent glomerular arterioles [5].

The aortic branch that penetrate the kidney in the hilar region is called the hilar artery, while the artery that penetrate the kidney in the extra hilar region is called the extra hilar artery (e.g. the superior polar artery), the superior polar artery usually originate from the aorta, while the inferior polar artery can be either from the aorta or from the iliac artery and it penetrates the renal parenchyma from its inferior pole.

Renal artery variations are divided into 2 groups: early division (precocious bifurcation) and extra renal arteries (ERA). Early division is a Branching of the main renal arteries into segmental branches more proximally than the renal hilum level [6], (also can be defined as a renal artery bifurcates at a distance shorter than 1 cm from its aortic origin) ([4]. ERA is divided into 2 groups: hilar (accessory) and polar (aberrant) arteries. Hilar arteries enter kidneys from the hilus with the main renal artery, whereas polar arteries enter kidneys directly from the capsule outside the hilus[6].

Renal artery variations are common in the general population and the frequency of variations shows social, ethnic, and racial differences [7,8] It is more common in Africans (37%) and Caucasians (35%), and is less common

in Hindus (17%) and the populations except Caucasians (18%). The frequency of extra renal arteries (ERA) shows variability from 9% to 76% and is generally between 28%–30% in anatomic and cadaver studies [7, 8,9] . Renal artery variations are becoming more important due to the gradual increase in interventional radiological procedures, urological and vascular operations, and renal transplantation.

Up to our knowledge there is no study conducted in Iraq addressing the prevalence of variation of the renal arterial supply in the Iraqi population, and the aim of this study is to determine the prevalence and the rate of renal artery variation in the middle Euphrates Iraqi population.

Materials and methods

Three hundred fifty eight (358) patients were included in this study for the period from Feb 2010 – Feb 2011 ,they were referred to Shaheed Al Mihrab Cardiac Centre in Hilla province for a variety of indications for catheterization including ischemic heart disease , lower limb peripheral arterial disease , valvular heart disease , renal artery stenosis , mesenteric vascular disease , etc , detailed information about the angiographic procedure was given and an informed consent was obtained.

Conventional angiography was performed using ALLURA 9 catheterization machine, Philips manufacture . Arterial puncture was performed through the right or the left femoral approach for most of the cases, trans brachial approach was performed in those with difficult femoral access mostly a 6 F sheath was used with few exceptions where either 5F ,7F ,or 8F sheaths were used when an on table interventions was decided. selective renal angiography was performed using Judkins right (JR)catheter for those whom an left ventriculography not performed during coronary angiography , while for those in whom left ventriculography , Aortography , lower limb angiography was performed a pig tail non selective injection was done to visualize the renal arteries. The contrast agent used was IOHEXOL 300, and IOHEXOL 350, with an average volume injected around 15-20 mil. When there is a definite pathology in the renal arteries or when the non selective image not clearly shows the renal arterial anatomy, selective canulation with JR was done. all angiographies were evaluated by two interventional cardiologist, precocious bifurcation was considered when the artery bifurcates either before the hilum or with in less than 1 cm from its aortic origin, when an additional renal artery penetrate the kidney at the hilum, a lable of accessory renal artery was given, while an additional renal artery that penetrate the kidney out side its hilum, a label of aberrant was given. Descriptive statistics of the studies sample were done using the SPSS statistical package version 15.

Results

A total number of three hundred fifty eight patients were enrolled in this study , the mean age was 55.4 ± 10.4 years standard deviation ,range 14-91 years two hundred sixty seven (267) of them were male , the remaining ninety one (91) were females .

Anatomically the origin of the main renal artery was at the level of the first lumbar vertebra (L1) in 62% , L1-L2 disk in 13% ,L2(22%) of the cases , the remaining 3% was distributed over the T12 ,T12-L1 ,L2-L3 ,L3, L4 vertebral levels .table 1

Table 1. The Anatomical Distribution of the Renal Artery Origin According to the Vertebral Level

Vertebral level	L1	L1-2disk	L-2	Others*
Percentage	62%	13%	22%	3%

***others: involves the following anatomical levels (T 12, T12-L1 , L2-3 ,L3 ,L4)**

The origin of the right and left renal arteries was at the same anatomical level in 65.4% of the cases, the right main artery was at higher level in 22.1%, while the left main artery was at a higher level in the remaining 12.5% of the cases.

The renal artery bifurcates at the hilum into the segmental arteries in 56.7% of the cases , in the remaining 43.3% ,the renal artery bifurcates in to segmental arteries before it reaches the hilum and at variable distance from its aortic origin .

Each kidney was supplied by a single renal artery on both side in the same patients in 79.8% of the cases while in the remaining 20.2% there was more than one renal artery in the following ratios :unilateral dual blood supply on the LT kidney (10%) , RT kidney (6.5%) ,bilateral dual blood supply on both sides (2.5%) and in 1% of the cases there was more than two arteries on either side .we recorded one case four renal arteries on the left kidney , and there was triple renal arteries bilaterally in another one case .table 2

Table 2. The distribution of the renal arteries according to their number on the RT and LT sides .

Bilateral single	79.8%
two arteries on the LT side	10%
Two arteries on the RT side	6.5%
Bilateral dual arteries	2.5%
More than two arteries on either side	1%

The extra renal artery was labeled to be accessory in 53.8 % of the cases , and it was an aberrant artery in 46.2% of the cases .the extra renal artery was more prevalent on the LT kidney compared with RT one ,57.7% ,42.3% respectively . The aberrant renal artery was an inferior polar artery in 63.6% and a superior polar in 36.4 %.the aortic origin of the extra renal artery located at the level of L1, L1-2, L2 in most of the cases and exclusively at that level for the accessory arteries, while in few occasions which was exclusively in the aberrant artery cases the aortic origin was either above or below that vertebral level .

The prevalence of multiple renal arteries on either side was more prevalent the female compared with the male patient (26.4%, 19.8% respectively).

Discussion

The variations in the renal arteries are common, this is explained by the development of the mesonephric arteries that degenerate leaving only one mesonephric artery. deficiency in the development of mesonephric arteries results in more than one renal artery ,up to our knowledge there is no study conducted in IRAQ directed towards the renal artery variation, this study is the first one addressing this issue in the Iraqi population covering the middle Euphrates region .this study showed a prevalence of extra renal artery (ERA) of 20.2% compared

with 28-30% in anatomic and cadaver study (2), 42% in another angiogram based study ,this difference can be explained by the wide range of the prevalence of ERA as showed by Satyapal et al (9-76%, average 28%) [3], and a frequency of 20% and 27% by other studies [6], racial difference can also explain the lower frequency in this study.

The origin of the renal arteries from the abdominal aorta located between the level of the upper margin of the first lumbar to the lower border of the second lumbar vertebra in 97% of the cases in our study matching with 98% reported by Ugur et al .however we reported a higher percentage at the level of L1 (62%) compared with 25% reported by others (ref no 14 book clinical anatomy). This study showed a nearly similar anatomical planes of origin in more than two thirds of the cases, the rest of the sample showed a tendency for the RT renal artery origin to be higher than the left renal artery in agreement with others, however the cadaver based studies reported a higher level of the LT renal artery than the RT [4].

In the 20.2% of patients whom shown by this study to have extra renal arteries , a unilateral dual blood supply on the LT kidney was shown (10%), RT kidney (6.5%) ,bilateral dual blood supply on both sides (2.5%) and in 1% of the cases there was more than two arteries on either side .we recorded one case four renal arteries on the left kidney , and there was triple renal arteries bilaterally in another one case, others study reported slightly different RT to LT ration but with a higher incidence on the RT (16%) than the LT (13%) and around 5% seen bilaterally [1,6].

The extra renal artery was labeled to be accessory in 53.8 % of the cases, and it was an aberrant artery in 46.2% of the cases (ratio 1.15/1) compared with a 1/1 ratio by others study [6]. The aberrant renal artery was an inferior polar artery in 63.6% and a superior polar in 36.4 %.the aortic origin of the extra renal artery located at the level of L1, L1-2, L2 in most of the cases and exclusively at that level for the accessory arteries, while in few occasions which was exclusively in the aberrant artery cases the aortic origin was either above or below that vertebral level.

Our study showed a higher prevalence of early bifurcation (43.3%) compared with kadir's study and others study who reported 15% and 5% respectively [6,7].

The prevalence of multiple renal arteries on either side was more prevalent the female compared with the male patient (26.4%, 19.8% respectively) in agreement with Satyapal ks et al who reported a Significant differences in the incidence of first additional arteries between sex and race.[10]

Conclusion and recommendation

Renal artery anatomical variation are common in the general population and this study confirms a nearly comparable frequency of variations in the Iraqi population with some diversion from the comparable studies that might be explained on racial bases .We think that orientation to the high prevalence of these variations in our population is important for the increased frequency of renal transplant operations , and for the observation that a number of these ERA arteries are stenotic and might potentially be the cause of renovascular hypertension in those patients for which we recommend evaluation by further study .

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