Variation in Number and Vertebral Level of Origin of Renal Artery in North Indian Population

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ISSN 0970-4973 (Print) ISSN 2319-3077 (Online/Electronic)

J. Biol. Chem. Research Volume 31 (1) 2014 Pages No. 182-191

Journal of Biological and Chemical Research

(An International Journal of Life Sciences and Chemistry)

Published by Society for Advancement of Sciences®

J. Biol. Chem. Research. Vol. 31, No. 1: 182-191 (2014)

(An International Journal of Life Sciences and Chemistry)

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RESEARCH PAPER

Received: 25/12/2013 Revised: 02/01/2013 Accepted: 03/01/2014 Variation in Number and Vertebral Level of Origin of Renal Artery in North Indian Population Anshu Mishra P. K. Sharma Punita Manik

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ABSTRACT

Variations in number and vertebral level of origin of renal artery are frequent and this knowledge is valuable for various procedures involving renal arteries. The purpose of the study is to find out variations of the renal artery in North Indian population. The study was done by using 64-slice computed tomographic angiographic images of 53 subjects (106 renal arteries) from the Department of Radiodiagnosis, KGMU, Lucknow. The angiographic images were observed for the anatomy and variations of renal artery. It was found that more than one renal artery (accessory renal artery) on either side was present in 32.07% subjects. Out of 106 renal arteries, 83.65% of kidneys were irrigated by single renal artery, 15.09% by two renal arteries and 2.8% by three renal arteries. The vertebral level of origin of main renal arteries showed a wide range extending from the level of upper margin of L1 vertebra to the level of inter vertebral disc between L2-L3 vertebras. Only 24.53% of renal arteries on the right side and 20.75% on left side were seen to be originating at the level of inter vertebral disc between L1and L2 which is normally described. In 60.38% subjects, right main renal artery originated cranial to origin of left main renal artery and in 24.53% subjects, both right and left renal arteries originated at the same level. Renal artery showed a wide range of variation and the results should be kept in mind when a non-invasive diagnostic search is performed for renal artery stenosis, or when renal surgery related to renal arteries is performed.

Key Words: Renal Artery, Accessory Renal Artery, Computerized Tomography, and Vertebral Level of Origin.

INTRODUCTION

Variations of renal artery are common in general population and gained importance because of the wide spread development in renal transplantation surgery. A thorough knowledge of morphological variations of the renal arteries is important for renal transplant surgery as well as for other uroradiological procedures, management of renovascular hypertension, renal trauma and hydronephrosis (Cicekcibasi et al 2005, Mazzucchi et al 2005). Renal arteries are paired arteries arising laterally from the aorta just below the origin of superior mesenteric artery at the level of intervertebral disc between L1and L2vertebra. It has been previously reported that renal arteries show variation in their number and level of origin. The frequency of multiple renal arteries may range from 9% to 76%, but generally ranges between 28%-30% (Ozkan et al 2006, Khamanarong et al 2004, Satyapal et al 2001). The occurrence of accessory renal artery can be a problem for the surgeon because they do not anastomose intrarenally and each one nourishes only a segment of the kidney's parenchyma. According to Odman & Ranniger (1968), the renal arteries may emerge at the same level or at different levels, the right renal artery may be found cranial or caudal to the left.

The study was done with Multislice CT angiography, which has become a principal imaging investigation for assessment of renal vasculature, because it is a fast and non invasive imaging tool that provides highly accurate and detailed evaluation of normal renal vascular anatomy and its variants. According to Rubin et al (1995), CT angiography has 100% sensitivity in the identification of renal arteries. It is safe, cost effective, time saving and highly accurate (Rawat et al 2006).

Aim of the present study is to determine the variation of renal artery regarding their number and vertebral level of origin in North Indian population.

MATERIAL AND METHODS

The study was conducted in Department of Anatomy and 64-slice CT center of the Department of Radiodiagnosis, King George's Medical University, UP, Lucknow. The study group included 53 patients including 33 males and 20 females of age ranging between 13 yrs to 65yrs. The patients underwent computed tomographic aortic angiographic scan for various indications.

Computed tomographic angiographic images taken were reviewed for normal anatomy of renal arteries and their variants. Firstly, the kidneys were identified in axial as well as volume rendered images and then observed for the arteries entering and supplying them (Fig. 1). The number of renal arteries on either side was noted. In case of presence of more than one renal artery, the artery showing maximum diameter was considered to be the main renal artery and the rest of the arteries were considered as accessory renal arteries (ARA).

After identifying all the visible arteries entering the kidneys, the vertebral level of origin of renal arteries was observed in sagittal maximum intensity projection (MIP) images as well as in volume rendered images (Fig. 4).



Fig. 1. A) Volume rendered image showing two renal artery on left side. B) Axial maximum intensity projection (MIP) image showing accessory renal artery originating from aorta in front of main renal artery.

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В

RESULTS

Number of renal arteries

In present study 32% (N=17) cases showed presence of ARA. It was observed that the ARAs were present on the left side in 13.2% (N=7) cases and on the right side in 13.2% (N=7) cases. In two cases (3.7%), there was bilateral presence of ARA. Overall 83.65% (N=87) of kidneys were irrigated by single renal artery, 15.09% (N=16) by two renal arteries and 2.8% (N=3) by three renal arteries (Table 1, Fig.2).

Incidence of accessory renal artery was slightly higher on left side i.e. 18.86% (N=10) than on right side i.e. 16.98% (N=9). The incidence of ARA was found to be higher in females (35%, N=7) as compared to males (27.27%, N=9).

Number of renal arteries	Right side (N=53)		Left side (N=53)		Total (N=106)	
	No.	%	No.	%	No.	%
1	44	83.02%	43	81.13%	87	83.65%
2	8	15.09%	8	15.09%	16	15.09%
3	1	1.89%	2	3.77%	3	2.8%

Table 1. Prevalence of accessory renal artery on right and left side.



Fig. 2. Bar diagram showing distribution of renal arteries on right and left side. Vertebral level of origin.

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Variation inPopulation

It was found that in 96.22% (N=51) cases, the level of origin of main renal artery was between upper margin of L1 to lower margin of L2 on both right and left side. The most common level of origin on right side was at the level of intervertebral disc between L1-L2 in 24% (N=13) cases and on the left side it was at the level of lower margin of L1 in 28% (N=15) cases (Table 2, Fig. 3 & 4).

The findings were grouped depending upon the level of origin and shown in table 2 Table 2. Prevalence of various vertebral levels of origin of main renal artery on right and left

side.						
Vertebral level of origin	Right side (N=53)		Left side (N=53)			
	No.	%	No.	%		
L1- upper margin	5	9.43%	2	3.77%		
L1- middle	12	22.64%	6	11.32%		
L1-lower margin	10	18.87%	15	28.30%		
Disc between L1-L2	13	24.53%	11	20.75%		
L2- upper margin	7	13.21%	12	22.64%		
L2-middle	4	7.55%	4	7.55%		
L2- lower margin	0	0%	1	1.89%		
Disc between L2-L3	2	3.77%	2	3.77%		



Fig.3. Bar diagram showing distribution of renal artery at various vertebral levels on right and left side.



Fig. 4. Volume rendered 3D images showing: A) Origin of RRA opposite middle of L1 and origin of LRA opposite intervertebral disc between L1-L2, (B) Origin of LRA opposite intervertebral disc between L2-L3 (T= Thoracic vertebra, L= Lumbar vertebra)

All ARA originated between upper margins of L1 to the lower margin of L2. Out of these, 70% (N=7) of ARA on the right and 58% (N=7) of left side originated between lower margin of L1 to upper margin of L2. None of the ARA had shown origin above L1 vertebra and below L2. It was also found that in 60.38% (N=32) cases the origin of right renal artery was cranial to the origin of left renal artery (Fig 4B). The origin of both right and left renal artery was on the same level in 24.53% (N=13) cases. The origin of right renal artery was significantly higher than the origin of left renal artery.

DISCUSSION

A thorough knowledge of the variations of the renal artery is important with the increasing number of renal transplants. Accurate evaluation of donors in respect to their renal anatomy and its vasculature is an important part of donor screening which helps in planning surgery and avoiding surgery related complications (Zhang et al 2009). It is especially crucial for the laparoscopic harvest of kidney during which operative visibility and surgical exposure are limited, making details of vessel anatomy difficult to appreciate (Zhang et al 2009).

The accessory renal artery was seen in 32.07% of cases in present study. The results are similar to that of Patil et al (2001) who found presence of ARA in 31% and Harrison et al (1978) in 32% of cases. The incidence was slightly higher than that reported by Zhang et al (2010) and Kapoor et al (2004) who documented the presence of ARA in 27% and 26.68% of cases respectively.

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Our incidence was less than that reported by Ragiba Zagyapan et al (2009) who reported the presence of ARA in 42% cases.

In present study, it was found that one ARA was present in 26.4% cases and two in 5.66% cases. Similar findings were reported by Saldarriaga et al. (2008) who preformed a cadaveric study and found presence of one ARA in 22.3% cases and two ARA in 2.6% cases.

Some authors reported incidence of ARA higher on the right side (Baniel and Donohue 1995) while some others found higher incidence of ARA on the left side (Satyapal et al 2001).

In present study, the incidence of accessory renal artery was slightly higher on left side in 18.86% than on right side in 16.98% cases. This finding is similar to findings of Saldarriaga et al. (2008) and Ragiba Zagyapan et al (2009). The finding differ from findings of Tarzamni et al (2008) and Zhang et al (2010) who reported incidence of ARA higher on the right side.

A comparison of incidence of number of renal artery in different population group is shown in the Table 3.

Author (year)	Population	Type of study	Single	Double	Triple
			(%)	(%)	(%)
Saldarriaga et al (2008)	Colombian	Cadaveric	77.8	20.1	2.1
Ogeno et al (2010)	Kenyan	Cadaveric	71.8	24.8	2.6
Ozkan et al (2006)	Turkish	Conventional	76.0	13.5	0.9
		angiographic			
Khamanarong et a (2004)	Thai	CTA	82.0	17.0	1.0
Raman et al (2007)	American	64-slice CTA	81.0	15.9	3.6
Tarzmani et al (2008)	Iranian	64-slice CTA	74.4	22.6	2.1
Present study (2013)	Indian	64-sliceCTA	67.92	26.4%	5.66%

Table 3. A comparative incidence of number of renal artery in different population.

Table 4. Comparison (sidewise) of the vertebral level of origin of renal artery in different
studies.

Author (year)	Type of study	Origin at IVD L1 and L2		Origin between upper margin of L1and lower margin of L2	
		Right side	Left side	Right side	Left side
Prakash et al (2011)	Cadaveric	-	-	92%	92%
Ozgan et al (2006)	Conventional angiographic	23%	22%	98%	97%
Palmieri et al (2011)	CT angiography	38.8%	35.7%	94.8%	91.4%
Gumus et al (2012)	CT angiography	37.0%	38.9%	-	-
Present study (2013)	64-slice CT angiographic study	24.53%	20.75%	96.22%	96.22%

It was documented that the level of origin of 96.22% of renal arteries on both sides was between upper margin of L1 and lower margin of L2. Only 24.53% of renal arteries on the right side and 20.75% on left side were seen to originate at the level of inter vertebral disc between L1and L2.

The findings are similar to the findings of Ozkan et al 2006 who observed that 98% of the renal arteries on the right side and 97% on the left side originated between upper margins of L1and lower margin of L2. They also reported that 23% and 22% of renal arteries originated between the L1-L2 inter vertebral disc on the right and left sides respectively.

Similar studies on vertebral level of origin of renal artery were carried out by many authors and findings can be compared as shown in Table 4.

The ARAs showed a range of vertebral level of origin between the upper margin of L1 and lower margin of L2. None of the ARA had shown origin above L1 and below L2. This finding is different from that reported by Ozgan et al (2006) who noted that only 76% of ARAs was originating from the same vertebral range. This finding can be explained by a small sample size in present study.

The right renal artery has a cranial origin in relation to the left. In the present study, it was found that in 60.38% cases right main renal artery originated cranial to origin of left main renal artery. The finding was similar to that reported by Cicekcibasi et al (2005) who demonstrated cranial origin of right renal artery in 65% of cases.

CONCLUSION

Variation of vertebral level of origin of renal artery is important to consider while using angiographic, non-invasive methods for investigating renal artery stenosis, as well as during surgeries related to renal arteries. This is also relevant in angiographic studies to help in visualizing renal arteries and decreasing the chance to miss an accessory renal artery taking very high or low origin from aorta.

ACKNOWLEDGEMENTS

The author is indebted to Dr. A. K. Srivastava, Professor and Head, department of Anatomy KGMU for his constant support during the study and also to Dr. Archana Rani, Associate professor, Department of Anatomy, KGMU, for her guidance while writing the manuscript.

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