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ORIGINAL ARTICLE

STUDY OF RENAL APICAL SEGMENTAL ARTERY BY CORROSION CAST METHOD

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ABSTRACT: The advent of more conservative methods, practiced in modern urinary surgery, necessitated a perfect and precise knowledge of the renal arterial supply. The main objective of the study was to observe the pattern of renal apical segmental artery in human kidneys and its variations by corrosion cast method. Corrosion casting is a very useful method which allows three dimensional visualization of micro vessels. Sixty (thirty pairs) human kidneys were obtained from the cadavers in Anatomy Department of Subharti Medical College, Meerut after ethical clearance from ethical committee and corrosion casts were prepared by infusing red colored butyl butyrate solution in renal arteries through abdominal aorta. Variations in the apical arterial supply of human kidneys have been frequently observed. The present study is a modest venture to further elucidate the renal apical arterial supply by corrosion cast technique. Most frequent origin of apical artery observed was from posterior division of renal artery (43%). This study will be helpful to urologic surgeons in nephrectomy and renal transplants.

KEYWORDS: Renal artery, Anterior division, Posterior division, Renal apical artery, Upper segmental artery, Corrosion cast.

INTRODUCTION: Until the middle of the nineteenth century, renal surgery had invariably been limited to the drainage of renal abscesses. By the end of the century, major renal surgical procedures, like nephrectomies, did catch the surgeons fancies but did not appear to gain momentum and popularity due to their inevitable operative and post-operative hazards. Control of hemorrhage was one of the major technical difficulties of the nephrectomy.

Graves FT[1] came across two cases of nephrolithotomy which resulted in postoperative persistent haematuria which compelled him for total nephrectomy to save life of those patients. This loss of normal kidney inspired him to investigate the arterial distribution of the kidney. He described five segmental branches of renal artery. His observations opened up a new chapter in the anatomy of the kidney and tempted conservative urinary surgeons at modification of their surgical procedures for dealing with serious renal pathology e.g. cancer, tuberculosis and calculus.

Standarding S.[2] describes that paired renal arteries branch laterally from the aorta just below the origin of superior mesenteric artery at the level of L_1 vertebra. Right renal artery is longer and often higher. Near the renal hilum, each artery divides into anterior and posterior divisions. Posterior divisions continue as posterior segmental artery. The anterior division of the renal artery supplies the greater part of the kidney and it divides into branches outside the hilum as 1. Apical segmental artery, 2. Upper segmental artery, 3. Middle segmental artery, 4. Lower segmental artery.

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Renal arteries can be studied through dissection, angiographic and corrosion cast methods. Corrosion casting is a tissue preparation technique that involves the injection of plastic casting media into blood vessels or other hollow viscera and treating the tissue with a caustic substance. This results in a negative copy or a solid replica of the enclosed space of tissue.

Hinman[3] presented the basic principles of the corrosion casting method and pointed out that by lowering the viscosity of the injection mass, one can produce casts of very small vessels.

Lametschwandtner A, Lametschwandtner U, Weiger T.[4] states that the casting media must have following physiochemical properties for making adequate corrosion casts: low viscosity, rapid and even polymerization, minimal shrinkage during hardening and resistance to corrosion. Coloured solution of butyl butyrate fulfils these criterias.

Zworykin VK, Hiller J, Snyder RL[5] developed scanning electron microscope which opened doors for advanced study of corrosion casts. By scanning electron microscopy (SEM) of corrosion casts, normal and abnormal micro vessels, including capillaries, may be visualized with good resolution.

MATERIAL AND METHOD: Sixty (30 pairs) human kidneys were obtained from the cadavers in the Anatomy Department of Subharti Medical College, Meerut after ethical clearance from ethical committee. They were removed, en masse, with the associated segments of abdominal aorta, renal arteries and the ureters.

l8% (w/v) stock solutions of red granules of butyl butyrate, dissolved in acetone, were prepared and stored in air tight glass containers. The removed kidneys, were thoroughly washed in running tap water for about thirty minutes to one hr. Then they were flushed with water through a cannula inserted into the upper part of the abdominal aorta whose both the cut ends had been ligated. Then, the blood clots were removed by injecting warm normal saline through the ligated cannula till a clear fluid came out from the ureter.

Quantities ranging from 25 to 50 c.c. of the red coloured stock butyl butyrate solution were injected in the renal arteries slowly with pressure by a 10 c.c. syringe fitted with a cannula, which had been previously rinsed with acetone. Injection was continued until a resistance was felt. Both the cut ends of aorta are tightly ligated. Similarly, the ureter was infused with about 10 to 15 c.c. of the red coloured stock solution. The cut end of the ureter was also tightly ligated.

These infused specimens, needing proper fixation of the injected material were submerged for 48 to 72 hours in covered trays containing 10% formalin. The specimens were washed with water.

The macerating agent used was concentrated Hydrochloric acid. The decapsulated specimens were very carefully transferred manually and immersed into glass jars containing concentrated hydrochloric acid and allowed to stay undisturbed for a period of 4 to 7 days. The acid gradually corroded the surrounding renal tissue without affecting the solidified renal artery and ureter casts. Fine dissection was used to remove the debris of renal tissue.

Each individual cast, thus obtained was immersed in 50% glycerine for about half an hour. Patterns of apical segmental arteries were observed and results were analyzed.

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RESULTS: Renal artery divided into anterior and posterior divisions in 56 specimens (93%) in the present study. In rest of the 4 specimens (7%) no anterior & posterior divisions were observed, and all the segmental arteries, instead, originated directly from the renal artery in the hilum of kidney. While the posterior division of the renal artery, supplying the posterior segment of the kidney, showed a fairly constant system of branching patterns, the anterior division appeared to be rather more variable.

The presence of an apical artery was a constant feature of all specimens examined in the present study but its origin and distribution was very variable (Table 1).

In 26 specimens (43%), it was seen arising from the posterior division of the renal artery (Fig. 1-both kidneys and Fig. 2-Right kidney).

In 18 specimens (30%) anterior division of the renal artery was giving out the apical artery (Fig. 2 –Left kidney).

In another 9 specimens (15%), it was arising from upper segmental artery (Fig. 3- Right kidney) and in 7 specimens (12%) its origin was from the main trunk of the renal artery (Fig. 3- Left kidney)

DISCUSSION: The study of the renal vascular system and its relation to the renal pelvis and their calices had been a subject of controversy till the middle of the nineteenth century. Graves FT[1] studied the corrosion casts of the kidneys and demonstrated that the renal arteries, intrarenally, had a definite segmental distribution.

The origin of apical artery was observed to be variable as studied by Graves FT[1]; Kher GA, Bhargava I and Makhaniz JS;[6] Raghavendra VP, Manjappa T and Telkar A[7] and Patil GV and Kumar S.[8] Comparative study of apical artery is shown in table 2.

Graves FT[1] Observed Four Main Types of Apical Artery: Type-I (43.03%) apical artery arises from the anterior division of the renal artery; Type-II (23.03%) apical artery taking origin from upper segmental artery; Type-III (23.03%) the apical artery arises from the junction of anterior and posterior divisions; Type-IV (10%) the apical artery arising from the renal artery.

Depending upon origin of the apical artery, Kher GA, Bhargava I and Makhaniz JS[6] observed six types: Type I from anterior division (45.28%); Type II from upper segmental artery (15.05%); Type III from junction of anterior and posterior divisions (5.66%); Type IV from renal artery (1.86%); Type V from aorta (2.45%) and Type VI from posterior division (29.7%).

In the present study, the apical artery most frequently (43%) originated from the posterior division of renal artery (type VI). There was no contribution of posterior division in origin of apical artery in the study of Graves FT[1] but in the study of Kher GA, Bhargava I and Makhaniz JS[6], it was second in order of frequency (29.7%).So, the frequent origin of apical artery from the posterior division in the present study resembles Kher GA, Bhargava I and Makhaniz JS[6] and it is dissimilar to studies of Raghavendra VP, Manjappa T and Telkar A [7] and Patil GV and Kumar S.[8]

In the present study, next group in order of frequency was type I, in which apical artery arises from anterior division (30%). This is similar to 40% in the study of Patil GV and Kumar S.[8] The apical artery most frequently originated from anterior division (Type I) in the studies done by

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Graves FT;[1] Kher GA, Bhargava I and Makhaniz JS;[6] Raghavendra VP, Manjappa T and Telkar A[7] and Patil GV and Kumar S.[8] Raghavendra VP, Manjappa T and Telkar A[7] observed that apical artery took origin from anterior division in 51.66% cases. Chatterjee SK. and Dutta AK[9] observed frequent origin of apical artery from anterior division of renal artery (42.2%). The apical segmental artery, originating from the anterior division, is easily seen by surgeons in the renal hilum.

Type II, apical artery arising from upper segmental artery, includes 15% in the present study. This group stands second in order of frequency (36%) in the study by Patil GV and Kumar S.[8] Raghavendra VP, Manjappa T and Telkar A[7] observed that if apical artery arises from upper segmental artery, its origin is hidden under the lip of hilum or more rarely within the renal parenchyma.

Type IV, apical artery arising from renal artery includes 12% specimens in the present study which is similar to Graves FT[1;] Raghavendra VP, Manjappa T and Telkar A[7] and Patil GV and Kumar S.[8]

Origin of apical artery from aorta (type v) was not observed in the present study, similar to Graves FT[1].While,the origin of apical artery from the junction of anterior and posterior divisions of the renal artery (type III) was observed by Graves FT[1] in 23.03% cases but it was absent in the present study.

Rani N et al[10] observed that in 60% cases apical segmental artery had common origin with upper segmental artery, while in 40% cases it took origin directly from main renal artery.

All the specimens showed presence of apical artery in the present study. In some specimens multiple apical arteries were observed.

Knowledge and awareness of these possible variations of renal apical arteries are necessary for effective surgical management during renal transplantation, repair of abdominal aorta aneurysm, radical nephrectomy, renovascular hypertension and angiographic interventions. So, the recognition of variations of renal apical arteries is significant in anatomy as well as in surgical and radiological practice.

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Sl. No.	Origin from	Number of kidneys N=60	Percentage (%)
1.	Main trunk of renal artery	7	12%
2.	Posterior division	26	43%
3.	Anterior division	18	30%
4.	Upper segmental artery	9	15%

Table 1: Origin of apical arteries

Workers	Graves F.T(1954)[1]	Kher et al (1960)[6]	Ragha-vendra VP et al (2007)[7]	Patil GV and Kumar S. (2012)[8]	Present study (2014)
Number of kidneys studied	-	54	60	42	60
Type I-arises from the anterior division of the renal artery	43.03%	45.28%	51.66%	40%	30%
Type II-arises from the upper segmental artery	23.03%	15.05%	25%	36%	15%
Type III-arises from the junction of anterior and posterior division of renal artery	23.03%	5.66%	1.66%	-	-
Type IV- arises from renal artery	10%	1.86%	11.66%	12%	12%
Type V- arises from the aorta	-	2.45%	1.66%	4%	-
Type VI-arises from posterior divisions of renal artery	-	29.7%	8.33%	8%	43%

Table 2: Comparative study of apical segmental artery

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Fig. 1: Corrosion cast of renal arteries (anterior view) showing: Apical artery arising from posterior division on both sides (R-right kidney, L-left kidney, AD**-**anterior division, PD-posterior division, AP-apical artery, A –abdominal aorta, U-ureter).

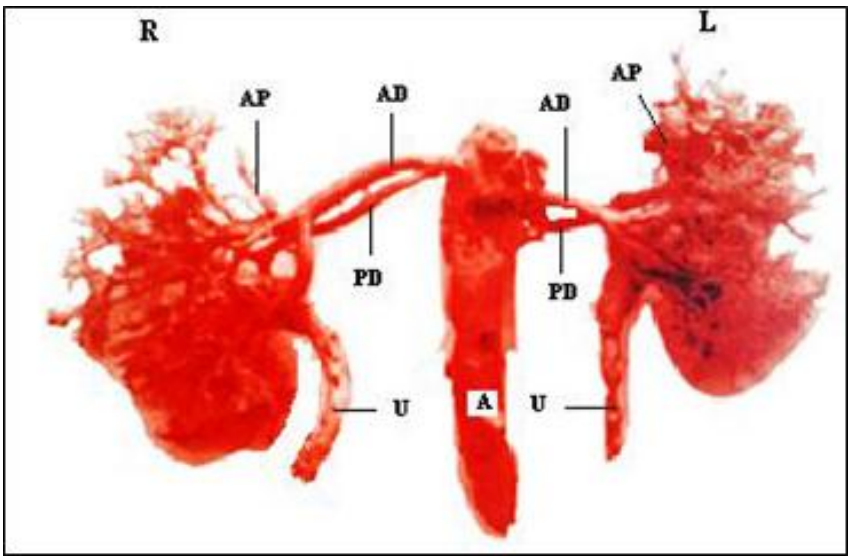

Fig. 1

Fig. 2: Corrosion cast of renal arteries (anterior view) showing: Apical artery arising from posterior division on right side and from anterior division on left side. **(**R-right kidney, L-left kidney, AD-anterior division, PD-posterior division, AP-apical artery, A-abdominal aorta, U-ureter)

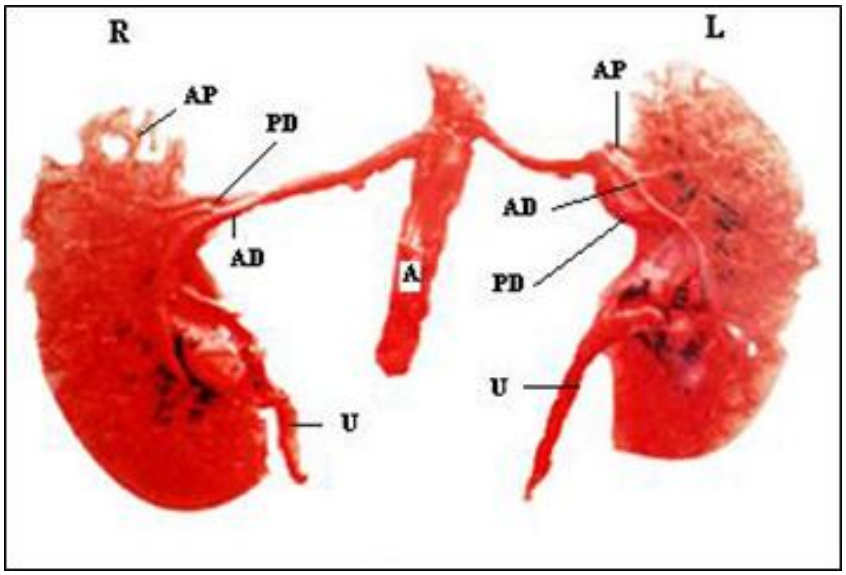

Fig. 2

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Fig. 3: corrosion cast of renal arteries (anterior view) showing:- Apical artery arising from upper segmental artery on right side and from renal artery on left side. (R-right kidney, L-left kidney, AD-anterior division, PD-posterior division, US-upper segmental artery, AP-apical artery, RA-renal artery, A-abdominal aorta, U-ureter).

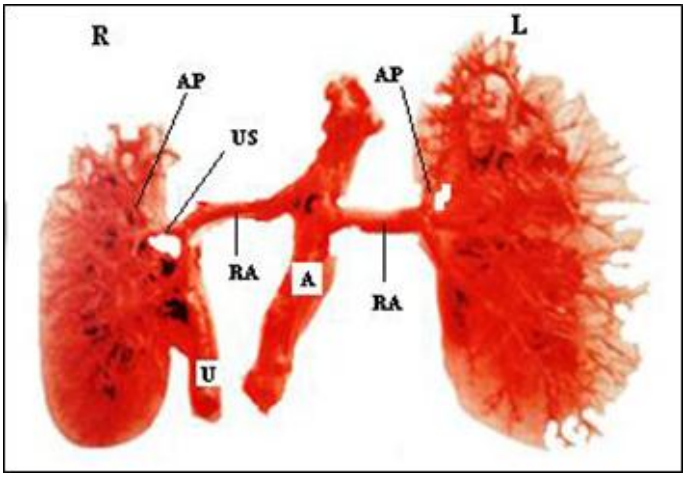

Fig. 3

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