Study of Renal Posterior Segmental Artery by Corrosion Cast Method

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ABSTRACT

BACKGROUND

Variations in origin, course and distribution of renal blood vessels are frequent observations. The aim of this study was to observe the pattern of posterior segmental renal artery by corrosion cast method.

METHODS

Thirty pairs of kidneys were collected from cadavers in anatomy department of Subharti Medical College, Meerut. Corrosion casts of renal arteries were prepared by infusing cellulose acetate butyrate solution through abdominal aorta. They were macerated in conc. hydrochloric acid. Origin, course and distribution of the posterior segmental artery were studied.

RESULTS

Renal posterior segmental artery most frequently originated as a continuation of the posterior division (93 %). It has no anastomosis with nearby segmental arteries.

CONCLUSIONS

Posterior segmental artery supplies posterior segment of kidney and may also frequently give origin to apical segmental artery. This study of origin, course, distribution and variations of renal posterior segmental artery will be useful for surgical and radiological practice.

KEYWORDS

Kidneys, Renal Artery, Anterior Division, Posterior Division, Posterior Segmental Artery, Abdominal Aorta, Corrosion Casts

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BACKGROUND

The kidneys, developing from metanephros, ascend from the pelvis. They receive their blood supply from the vessels that are close to them. Initially, the renal arteries are branches of the common iliac arteries. As they ascend further, the kidneys receive their blood supply from the distal end of the aorta. When they reach at a higher level, they receive new branches from the aorta. Normally, the caudal branches undergo involution and disappear. When the kidneys come into contact with the suprarenal glands in the ninth week, their ascent stops. The kidneys receive their most cranial branches from the abdominal aorta. These branches become the permanent renal arteries. The paired renal arteries branch laterally from the aorta just below the origin of superior mesenteric artery at the level of first lumbar vertebra. Right renal artery is longer and often higher, passing posterior to inferior vena cava. The left renal artery is a little lower and passes behind the left renal vein. Near the renal hilum, each renal artery divides into anterior and posterior divisions and these divide into segmental arteries supplying vascular segments of the kidneys. The anterior division of the renal artery supplies the greater part of the kidney. It divides into branches outside the hilum as apical, upper, middle and lower segmental arteries. The posterior division continues as posterior segmental artery and supplies the posterior segment of the kidneys.

Renal surgeries had invariably been limited to the drainage of abscesses of the kidneys until the middle of the nineteenth century. Control of haemorrhage during surgery was one of the major technical difficulties of the nephrectomy before the middle of nineteenth century. The segmental nephrectomy could be possible only after detailed studies of the patterns of the blood supply of the kidneys by dissections, renal angiography and corrosion cast methods. Additional renal arteries are not uncommon; they appear in about twenty five percent of the general population and represent persistence of the embryonic pattern. Additional renal arteries may be equally or differently distributed between the two kidneys. The presence of excessive numbers of renal arteries results in technical limitations in kidney transplantations. The existence of supernumerary renal arteries is a challenge for the surgeons performing the kidney transplantations, since each renal artery is a terminal blood vessel and its injury causes segmental ischemia. The aberrant vessels are more common in ectopic kidneys.

Variations in the origin, course and distribution of renal blood vessels have been quite frequent observations of the anatomists. Brodel M (1901) defined the renal arteries as end arteries with the anterior segments never crossing over to the posterior side, or vice versa.[1]

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 (1954) laid down the concept of the segmental blood supply to the kidneys. He was the first to recognize the five renal vascular segments by making corrosion liquid polyester resin casts of the kidneys obtained from post-mortem specimens and also by angiography of post-mortem kidneys. He identified five renal segments as apical, upper, middle, lower and posterior. The location of posterior segment was defined on the posterior aspect between apical segment and lower segment. The apical, upper, middle and lower segments were supplied by anterior division of renal artery and the posterior segment is supplied by posterior division as posterior segmental renal artery.[2] His study is a marvellous contribution in field of renal surgery as realization of the segmental nature of the distribution of renal arteries led to attempts at preservation of significant healthy renal tissue. His description of concept of segmental pattern of the distribution of renal arteries was confirmed by Kher et al (1960), Verma et al (1961), Sykes D (1963), Fine H and Keen EN (1966).[3,4,5,6]

Corrosion casting is a technique in which a plastic material is injected into the blood vessels or hollow viscera and the tissue is immersed in some caustic substance. This leads to a solid copy of the enclosed space of that tissue. Corrosion casting is a very significant method as it provides three dimensional views of blood vessels. Cellulose acetate butyrate used in this study has low viscosity and less shrinkage. It is resistant to corrosion by acid. So, it is a good medium for corrosion cast preparation.

The interest in the anatomy of hollow space systems (blood vessels, chambers of heart, respiratory system, ventricular system of brain and bile duct system) is as old as anatomy. Air blown into blood vessels, instillation of non-colored and colored fluids (water, milk etc.), the injection of solidifying wax, low melting point metal alloy for bronchial tree and natural occurring resins characterize the pre-corrosion casting era. The modern corrosion casting methods evolved after successful cast formation by dissolving surrounding tissues after wax injection into the arteries, veins and the ducts. Gradually, the anatomists tried to improve the casting media, the method of injection and the method of removing the surrounding tissues in order to produce more accurate replica of the biological structures. The use of celluloid, the first synthetic plastic material, dissolved in organic solvents for formation of corrosion casts provided new hopes for the study of the blood supply of the kidneys. A great advance was made when new synthesized resin products were used to make corrosion casts.

Development of the scanning electron microscope opened doors for the advanced study of corrosion casts. The use of semi polymerized resin methyl methacrylate as casting medium in scanning electron microscope studies of the microvascular beds was a great advancement. Infusion of small blood vessels including capillaries became possible due to its low viscosity.

It is important to remember that branches of renal arteries are end arteries, that do not anastomose inside the kidneys and each one feeds only a segment of the parenchyma of the kidneys. Because of that the obstruction of the blood flow in one of them may cause segmental ischemia with subsequent hypertension. On the contrary, the veins do anastomose and that is why they may be tied easily. The knowledge of variations of the various segmental arteries arising from renal arteries provides significant clinical data, especially for surgery and radiology.

The aim of this study was to observe pattern of posterior

segmental renal artery by corrosion cast method. This study will be beneficial in surgical and radiological renal procedures.

METHODS

Thirty pairs (60) of cadaveric human kidneys were collected from the Department of Anatomy, Subharti Medical College, Meerut. In all cases they were removed with the associated segments of abdominal aorta, inferior vena cava, renal vessels and ureter. The gross study of all specimens was done. Stock solutions of red cellulose acetate butyrate were prepared by dissolving them in acetone. They were stored in air tight glass jars for twelve hours for these stock solutions to develop uniform consistency. The kidneys were thoroughly washed in running tap water for about one hour. Then they were flushed with water through a cannula inserted into the upper part of the abdominal aorta and inferior vena cava whose cut ends had been ligated. Then, the blood clots were removed by injecting warm normal saline through the cannula.

Quantities ranging from 25 to 50 c.c. of the red cellulose acetate butyrate solution were injected slowly with pressure into the upper end of abdominal aorta by a 10-c.c. syringe fitted with a wide bore cannula, which had been previously rinsed with acetone. Both the cut ends of aorta were tightly tagged. These infused specimens, needing proper fixation of the injected material, were submerged for three days in flat covered trays containing sufficient bulk of 10 % formalin. The formalin was decanted off and kidneys were decapsulated. The decapsulated specimens were very carefully immersed into glass jars containing conc. hydrochloric acid and allowed to stay undisturbed for a period of about one week. This macerated the renal tissue without least affecting the solidified renal vessels. Each individual cast, thus obtained was immersed in 50 % glycerin for about half an hour. Relevant observations were made. Patterns of posterior renal segmental artery in thirty pairs were studied and data analyzed.

RESULTS

The origin and course of the posterior segmental renal artery was found to be practically constant (Table 1). In 56 specimens (93 %), it was the continuation of the posterior division of the renal artery (Figure 1 - Right kidney). In 4 specimens (7 %) it arose from renal artery directly as they have no anterior and posterior divisions (Figure 2 - Left kidney). The posterior segmental artery turned downwards with an outward convexity and divided into multiple branches to supply posterior segment in all specimens.

In 2 specimens (3 %) an accessory posterior segmental artery, the continuation of the anterior division of the renal artery was noted. Posterior segmental artery gave rise to apical artery in 43 % specimens and upper segmental artery in 3 % specimens (Table 2).

Sl. No.	Origin From	No. of Specimens 60	Percentage %
1	Posterior Division	56	93
2	Renal Artery	04	7

Table 1. Origin of Posterior Segmental Artery

Sl. No	Origin of Other Renal Segmental Arteries from Posterior Segmental Artery	No. of Specimens 60	%
1	Apical Artery	26	43
2	Upper segmental artery	02	3

Table 2. Origin of Other Renal Segmental Arteries from Posterior Segmental Artery

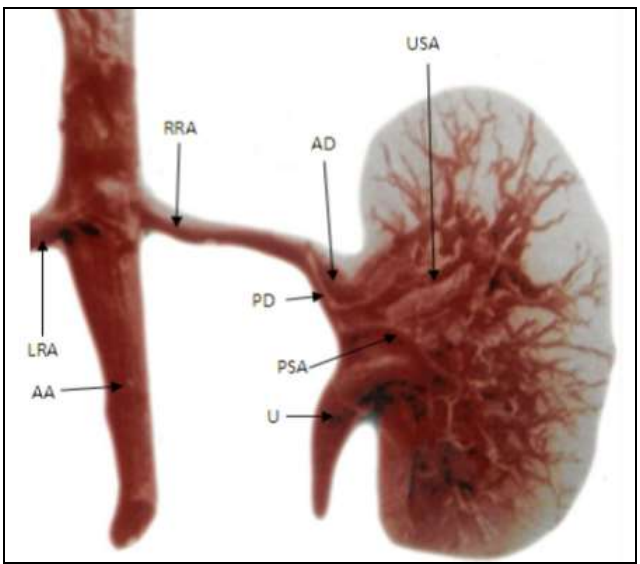

Figure 1. Corrosion Cast of Right Kidney (Posterior View) Showing: Posterior Segmental Artery Arising from Posterior Division and Dividing into Multiple Branches. Upper Segmental Artery Arising From Posterior Segmental Artery. [AA-Abdominal Aorta, LRA-Left Renal Artery, RRA-Right Renal Artery, AD-Anterior Division, PD-Posterior Division, PSA-Posterior Segmental Artery, USA-Upper Segmental Artery, U-Ureter]

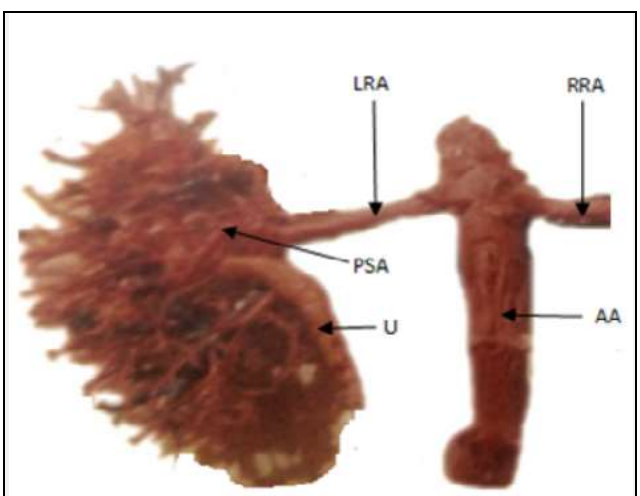

Figure 2. Corrosion Cast of Left Kidney (Posterior View) Showing Posterior Segmental Artery Arising from Renal Artery. [AA-Abdominal Aorta, LRA-Left Renal Artery, RRA-Right Renal Artery, U-Ureter]

DISCUSSION

Graves FT (1954) found that the posterior division continued as the artery to the posterior segment and was constant in

its origin and course.[2] Its origin from posterior division is described by Kher et al (1960), Verma et al (1961), Fine H and Keen EN (1966), Longia GS et al (1984) and Raghavendra V et al (2012).[3,4,6,7,8] The posterior segmental artery exhibited a fairly constant pattern in this study as continuation of posterior division of renal artery in majority of specimens (93 %). Posterior segmental artery originated from renal artery in 7 % specimens. Fine H and keen EN (1966) reported double posterior segmental arteries in 2.14 % cases.[6] Ajmani ML and Ajmani K (1983) observed that very rarely (1 %) the posterior division is absent.[9] Thampi S and Krishnapillai R (2017) reported that posterior segmental artery is absent in six kidneys out of forty-eight kidneys studied.[10] In this study in two specimens (3 %), the posterior segment was observed to be supplied by both, anterior and posterior divisions of the renal artery. Anterior division continued as the accessory posterior segmental artery for the upper part of the posterior segment, while, the regular posterior division supplied middle and the lower panrt of the posterior segment. Ajmani ML and Ajmani K (1983) and Longia GS et al (1984) observed three ramification patterns of posterior segmental artery.[9,7] Graves F.T. (1954) observed that the posterior division of the renal artery continues as the posterior segmental artery which runs posterior to the ureteric pelvis, enters the upper part of the renal hilum, curves downwards with a lateral convexity giving off ramifying collateral branches. From the convexity, usually three unnamed groups of arteries run laterally to supply the posterior segment. He classified the branches arising from convexity of posterior segmental artery into three groups, an upper group of one or two in number supplying the posterior part of the upper calyx; middle group which was usually small and interdigitated with arteries of the middle segment, and a terminal group, branches of which supplied the upper part of the posterior surface of the lower calyx.[2]

The above pattern was reported by Kher et al (1960) in 27 %, Verma et al (1961) in 62 %, Fine H. and Keen (1966) in 50 %, Raghavendra V. et al (2012) in 28.33 % cases.[3,4,6,8] Similarly, in this study also, the posterior segmental artery turned downwards behind the ureteric pelvis with a lateral convexity and gave rise to three or four branches to supply the posterior segment in all specimens studied.

Another pattern of course of posterior segmental artery described is that it bifurcates or trifurcates and then supplied posterior segment. This pattern is reported by Verma et al (1961) in 29 %, Fine H and Keen EN (1966) in 30 %, Longia et al (1984) in 36 %) and Raghavendra V et al (2012) in 51.66 % cases.[4,6,7,8] In this study this pattern is not seen.

Studies of posterior segmental renal arteries reveal that it may give rise to other segmental arteries which usually arises from the anterior division. This branching pattern is reported by Verma et al (1961) in 9 %, Fine H and Keen EN (1966) in 10 %, and Longia et al (1984) in 17 % and Raghavendra V et al (2012) in 16.66 % cases.[4,6,7,8] Study of Raghavendra V et al (2012) reports that apical artery arose from the posterior segmental artery in 8.33 % cases.[8] In this study posterior segmental artery gave rise to apical artery in 43 % specimens and upper segmental artery in 3 % specimens.

CONCLUSIONS

Renal posterior segmental artery most frequently (93 %) arose as a continuation of posterior division of the renal artery. It turned downwards with an outward convexity and divided into multiple branches to supply posterior segment in all specimens. In this study posterior segmental artery gave origin to apical artery in 43 % specimens. Origin, course and ramification patterns of posterior segmental artery in this study may prove helpful in renal surgery, renal transplants and radiological investigations.

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REFERENCES

[1] Brodel M. The intrinsic blood vessels of the kidney and their significance in nephrotomy. Johns Hopkins Hosp Bull 1901;12:10-13.
[2] Graves FT. The anatomy of the intrarenal arteries and its application to segmental resection of the kidney. Br J Surg 1954;42(172):132-139.
[3] Kher GA, Bhargava I, Makhani IS. Intra-renal branching of renal arteries. Int J Surg 1960;12(2):63-69.
[4] Verma M, Chaturvedi RP, Pathak RK. Anatomy of renal vascular segments. J Anat Soc of India 1961;10(2):12-18.
[5] Sykes D. The arterial supply of the human kidney with special reference to accessory renal arteries. Br J Surg 1963;50:368-374.
[6] Fine H, Keen EN. The arteries of human kidneys. J of Anat 1966;100(Pt 4):881-894.
[7] Longia GS, Kumar V, Gupta CD. Intra-renal arterial pattern of human kidneys- corrosion cast study. Anat Anz 1984;155(1-5):183-194.
[8] Raghavendra V, Manjappa P, Telkar A. Renal apical segmental artery variations and its surgical importance. J Clin and Diag Research 2012;6(4):561-563.
[9] Ajmani ML, Ajmani K. To study the intra-renal vascular segments of human Kidney by corrosion cast technique. Anat Anz 1983;154(4):293-303.
[10] Thampi S, Krishnapillai R. A cadaveric study of variations in origin and branching of renal arteries. J Evolution Med Dent Sci 2017;6(52):3943-3946.