

Variations in the branching pattern of renal artery: a cadaveric study

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Abstract:Renal artery variations are very common and the commonest one is the presence of an additional vessel. Existence of the additional arteries is accountable in cases of renal pathologies and the knowledge of such variations is important while performing surgical and interventional procedures in and around the kidneys. The present study was done on 30 embalmed adult donated human cadavers of known sex obtained from Department of Anatomy, J.N. Institute of Medical Sciences (JNIMS), Imphal, Manipur. Therefore, the findings in this study should be representative of anatomic variations in the general population across the North-East India. We studied renal arterial pattern in 30 formalin fixed cadavers, on 60 kidneys during the period of 5 year. The purpose of this present study was to establish the incidence of accessory (aberrant) renal arteries in human cadavers. Out of the 60 kidneys, 3 kidneys showed accessory renal artery one cadaver had bilateral double renal arteries with altered left renal hilar architecture and in another cadaver, an additional renal artery arising from the anterolateral side of the abdominal aorta reaching the lower pole of the right kidney was observed. Right kidney showed 6.6% of ARA, left kidney 3.3%, bilateral ARA in 3.3%, unilateral in 3.3%, 4% were male and 20% were that of female. Therefore the present study would facilitate the understanding of renal vasculature variations. The anatomical knowledge of such variations is of importance for academic purpose, as well as for surgical and radiological interventional procedures.

Key words: [renal artery] [accessory renal artery] [aberrant renal artery]

I. Introduction

A single renal artery branching from the aorta supplies each kidney (70%). Each renal artery divides into an anterior and a posterior division near the renal hilum and these divide into segmental arteries, being themselves the end arteries. The apical, upper, middle and lower segmental arteries usually originate from the anterior division, whereas the posterior segmental artery from the posterior division. The anterior branches lie between the renal vein and renal pelvis, the vein being in front, the pelvis behind, but one or more posterior branches may be situated behind the renal pelvis. However, accessory renal arteries are common (30% of individuals), and usually arising from the abdominal aorta. They are regarded as persistent embryonic lateralsplanchnic arteries.¹ Knowledge and awareness of these possible variations and anomalies of the renal arteries are necessary for sufficient surgical management during renal transplantation, repair of abdominal aorta aneurysm, urological procedures, abdominal imaging studies and angiographic interventions.²⁻⁴

II. Materials and methods

The study material comprised of 30 embalmed adult donated human cadavers of known sex obtained from Department of Anatomy, J.N. Institute of Medical Sciences (JNIMS), Imphal, Manipur. Therefore, the findings in this study should be representative of anatomic variations in the general population across the North-East India. The human cadavers were serialized from 1-30 with suffix M for male & F for female. The abdominal cavity was opened by a cruciform incision passing through the whole thickness of anterior abdominal wall. Flaps were reflected and abdominal viscera were systemically removed according to Cunningham Manual of Practical Anatomy.¹⁶ The dissection was carried out to expose the kidneys & their arterial supply and observations were made.

III. Results/ observation

A total of 60 kidneys obtained from 30 cadavers were dissected and accessory renal arteries were looked for; 30% of the specimens showed the presence of accessory renal arteries. In 20% of specimens, double renal arteries were observed on both sides with altered left renal hilar architecture (Fig.1).

Right kidney shows 6.6% of ARA, left kidney 3.3%, bilateral ARA in 3.3%, unilateral in 3.3%, percentage in male were 4% and in female were 20%.

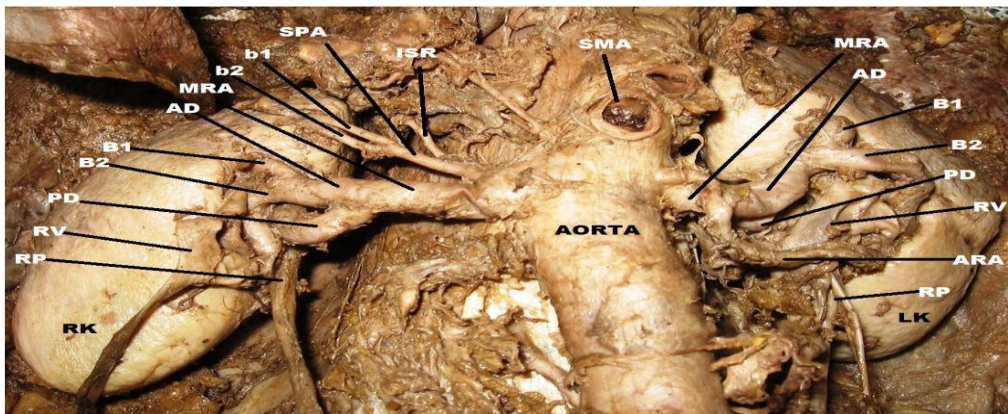


FIG-1 Showing double renal arteries were observed on both sides with altered left renal hilar architecture

On both sides, the main renal artery (MRA), originated from the lateral aspect of the abdominal aorta below the superior mesenteric artery (SMA). Before reaching the hilum, each divided into anterior (AD) and posterior divisions (PD), the anterior division further divided into upper and lower branches (B1 & B2), all the three then enter the kidney through the hilum. On the right side, another artery, superior polar artery (SPA) was present, also originating from the abdominal aorta from its lateral aspect just above the main renal artery (MRA). It gave off a branch to the right suprarenal gland; the inferior suprarenal artery (ISR) instead of arising from the main renal artery, it arose directly from the abdominal aorta (AA) and divided into two branches (b1 & b2) that entered the kidney through the anterior aspect of its superior pole and not through its hilum. On the left side, an accessory renal artery (ARA) was present which also originated from the abdominal aorta from the same level but anterior to the main renal artery (MRA) and entered the kidney through the hilum below the lower branch of the anterior division (AD) of the main renal artery (MRA). Moreover, the renal hilar architecture was altered on the left side. The left renal vein was found in between the anterior and posterior divisions of the main renal artery and behind the accessory renal artery while the renal pelvis was posterior most. The hilar architecture was normal on the right side with vein, artery and pelvis from before backwards. There was no other associated anomaly.

In 10%, one accessory renal artery was found as shown in Fig 2, an anatomical variation of the origin of the accessory right renal artery (ARRA) was observed in one female cadaver. We observed an additional renal artery arising from the anterolateral side of the abdominal aorta (AA), reaching the lower pole of the right kidney (RK). This accessory right renal artery (ARRA) was seen passing towards the inferior pole of right kidney without passing through the hilum. This artery is end artery. In the present study, the artery passed superficial to the ureter on the right side and hence can lead to partial obstruction of ureter leading to hydronephrosis.



FIG-2- Showing right ARRA passing towards the lower pole of right kidney superficial to the right ureter

IV. Discussion

Knowledge of the existence of aberrant renal arteries is important because they may be inadvertently damaged during renal surgery or interventional radiological procedures. Presence of an extra renal artery is one of the most frequent variations in the kidneys (30%)¹ and it may be associated with other underlying renal pathological conditions.⁵ Single, double, multiple renal arteries are reported as 17.6%, 3.3% and 1% respectively.⁶ The presence of additional renal arteries is very probable when the main renal artery has a

diameter of less than 4.15 mm, but unlikely if it is greater than 5.5 mm. So, the renal artery diameter is a factor which should be considered as predicting the presence of additional renal arteries.⁷ Extra renal arteries are divided into two groups: hilar or accessory and polar or aberrant arteries.⁸ An accessory renal artery is the one that is accessory to the main artery accompanying the same towards the hilum and entering the kidney through the hilum to supply it, while the aberrant artery supplies the kidney without entering its hilum.¹ An aberrant renal artery present in the poles is called as polar artery. Aberrant arteries could arise as high as inferior phrenic artery or as low as internal iliac arteries. The unusual vessels may originate from the aorta, as well as gonadal, common iliac, middle sacral, external or internal iliac or superior or inferior mesenteric arteries. Superior polar renal arteries are usually single. They arise as separate branches from the aorta or as branches of the renal artery, inferior suprarenal, inferior phrenic or superior mesenteric artery.⁹ In the present study, one male cadaver showed both the left accessory renal artery and the right superior polar artery originated from the aorta and the latter provided the inferior suprarenal artery as shown in fig-1. And present of aberrant or polar artery on the right kidney passing from the anterolateral part of the abdominal aorta just superficial to the right ureter as shown in fig-2 in another female cadaver.

The nomenclature of renal arterial variations is still unclear. Nevertheless, it is a misnomer to call such vessels accessory, aberrant or even supernumerary because they are not extra but essential, tissue-sustaining arteries without anastomoses between them, which correspond to the segmental branches of a single renal artery.^{10,11} Therefore, in such cases, the risk of haemorrhage during urological procedures or renal transplantation, segmental ischemia and postoperative hypertension due to loss of parenchyma increases.¹¹ The presence of multiple renal arteries must be considered in evaluating a donor kidney for possible renal transplantation. The transplantation of the kidney with the single renal artery is technically easier compared to the kidney with multiple arteries. The kidney grafts with multiple arteries resulted in post-transplant morbidity and graft loss following the ligation of the polar arteries.⁸ However, with the increasing demand for kidney transplantation, living donor grafts has become the major source for maintaining the donor pool, and successful allografts with multiple arteries has become a necessity.¹² In order to precisely plan the surgical procedure and avoid any vascular complication, arteriography should be performed before every nephrectomy.¹¹ Presence of right superior polar artery in the present study, therefore, carries the risk of aforementioned complications, however presence of double renal arteries on the left side with altered renal hilar architecture in the present study becomes more significant, since the left kidney is preferred for renal transplantation.¹³

Knowledge of the embryology of the renal vasculature and development of the kidney is essential in order to understand the possibilities of the multiple anomalies and variations of the renal arteries.¹⁴ The metanephric kidney begins development at sacral level and subsequently migrates cranially. The definitive renal arteries develop as a capillary network "rete arteriosumurogenitale" branching off from the aorta as segmental lateral splanchnic arteries. Persistence, enlargement and differentiation of some of these capillaries that usually regress give rise to variations of renal arterial supply such as ARA.¹⁵ Thus, the presence of extrarenal arteries in the present case may be because of the persistent lateral splanchnic arteries that failed to regress. Therefore, considering the high incidence of multiple renal arteries, the anatomical knowledge of such variations is of importance for academic purpose, as well as for surgical and radiological interventional procedures and the present case would facilitate the understanding of such variations.

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