

## Kidney malrotation with aberrant renal arteries and extra-renal calyces - case report

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### ABSTRACT

Variations in the ureteral patterning, venous, and arterial of the kidneys are common; however, concomitant involvement with two systems is rare. The current case was discovered during routine dissection course that took place in the Human Anatomy laboratory of the University of Rwanda. While dissecting the retroperitoneal space of one specimen, it was realized that the right kidney was mal-rotated with a ureter connected to the anterior side. That right kidney also had two aberrant arteries in addition to the main renal artery, those two aberrant arteries emerged from the inferior pole of the kidney.

Renal arterial variants may be grouped as supernumerary, multiple, and aberrant, in the current case it is aberrant. It is expected that the kidney rotates from anterior to medial around the longitudinal axis during development, and the renal hilum turns toward the medial direction. However, in the current case, the hilum faced anteriorly.

**Keywords:** Kidney Malrotation, Aberrant Renal Artery, Ureter, Case Report

### INTRODUCTION

The kidney is a bean-shaped organ, about the size of a fist located just below the rib cage. Healthy kidneys filter blood by removing wastes and extra water to make urine [1]. Kidney formation starts from the sacral region and ascends to the lumbar region at the end of the 7th week [2]. At the sacral region, the kidney receives its blood supply from the median sacral artery and the hilum is placed anteriorly. When the kidney ascends, it rotates 90 degrees medially along the longitudinal axis and the renal hilum turns toward the medial direction. However, this rotation may be incomplete or may not occur [1, 2]. Kidneys may have a variety of morphology in terms of rotation, shape, number,

size, position, and vascularization [4]. When it comes to malrotation, it is believed to be caused by inequality in the branching of the ureteral tree in successive order, with excessive dorsal versus ventral branching [4].

Normally each kidney has only one renal artery penetrating the hila of the kidney [5]. The right renal artery is longer and passes posterior to the inferior vena cava (IVC) to gain access to the renal hilum of the right kidney [6]. The renal arteries variation is divided into two groups, one is extra renal arteries (ERA), and the other is early division. The ERA is further divided into two groups as well, one is polar or aberrant and hilar accessory arteries. The polar arteries enter into kidneys directly from outside the hilum whereas hilar arteries enter into

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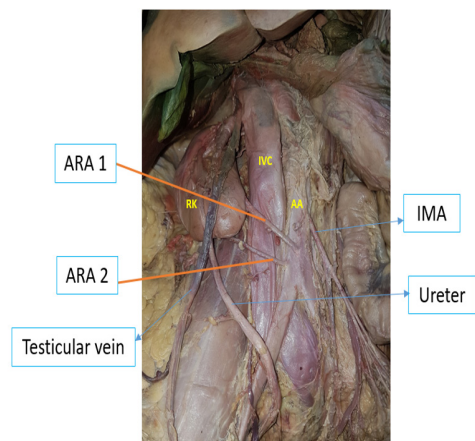
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kidneys from the hilum with the main renal artery [7]. The category of early division variation is when the main renal arteries have segmental branches extra proximally than the renal hilum level at the early division [8].

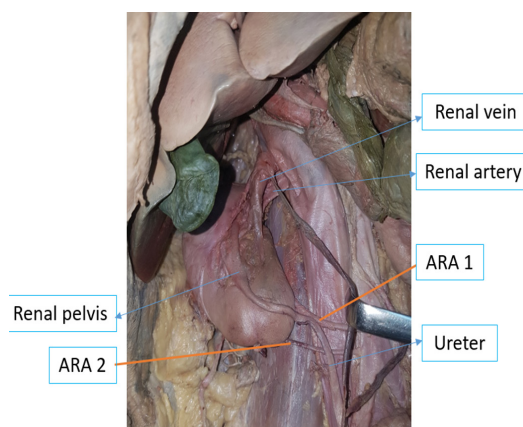
## CASE PRESENTATION

This case was seen during the dissection of the abdomen of a thirty-nine-year-old adult male cadaver. The dissection was performed in the anatomy laboratory of the University of Rwanda. The abdomen was dissected following the steps outlined in the grant dissector handbook of Sauerland [12]. While dissecting the retroperitoneal space, it was observed that the hilum of the right kidney was anteriorly positioned as shown in figure one, instead of being medial at its normal position. The ureter was connected to it at the anterior side. This change in renal hilum position is named kidney malrotation [8]. Even though the ureter was anteriorly positioned, the main renal artery and renal vein were medially positioned at the superior renal pole (Figure 1).

At the inferior pole of the kidney, it was observed that there were two more extra arteries inferior to the origin of the inferior mesenteric artery (IMA) (Figures 1 and 2). The first aberrant renal artery (ARA1), originated from the anterior surface of the abdominal aorta (AA), three centimeters superior to the bifurcation of AA in common iliac arteries. The ARA1 then connects to the kidney at the medial side of the inferior pole.

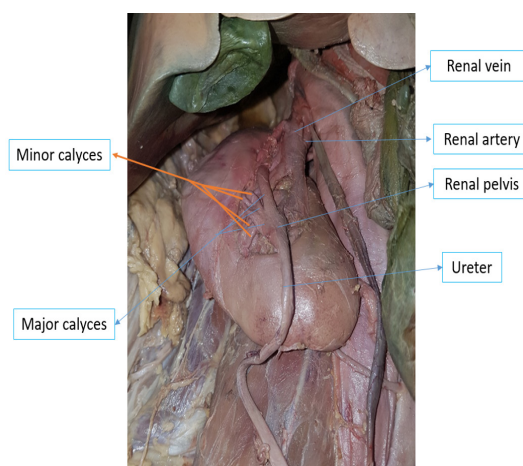


**Figure 1: Abdominal Aorta (AA), Inferior Vena Cava (IVC), Inferior Mesenteric Artery (IMA), the first aberrant renal artery (ARA1), second aberrant renal artery (ARA 2), Right Kidney (RK)**



**Figure 2: Main renal artery, the renal vein, the first aberrant renal artery (ARA1), second aberrant renal artery (ARA2), and renal pelvis**

The second aberrant renal artery (ARA2) originated from the right side of the abdominal aorta (AA), one point eight centimeters (1.8 cm) superior to the bifurcation of AA in common iliac arteries, the ARA2 then enters the kidney at the apex of the inferior pole (Figures 1&2). The anteriorly placed renal hilum had no renal sinuses. Additionally, the calyces, the whole 3 major calyces, and some minor calyces were extra-renal (Figure 3).



**Figure 3: Anteriorly-positioned renal pelvis and extra-renal calyces**

## DISCUSSION

At first, the metanephric kidney lies in the pelvic cavity and receives blood supply from the median sacral artery. In the subsequent development of the embryo, differential growth of the abdominal

wall causes the kidney to ascend upward to the iliac fossa and receive the blood supply from common and internal iliac arteries. Finally, the ascent of the kidney is arrested by the diaphragm where it gets permanent arterial supply from the lowest supra renal artery and persists as a definitive renal artery [9]. This happens due to the degeneration of developing metanephric arteries leaving only one mesonephric artery, failure in the degeneration of other mesonephric arteries results in an aberrant renal artery [10].

There are different kinds of renal arterial supply variations, some others divide the renal arterial variants into 2 groups: early division and extra renal artery, but others use supernumerary, multiple, and aberrant. The current case falls into the extrarenal artery or aberrant group as the kidney has two additional arteries to the main renal artery, similar to what was reported by Monam & Najjar [10] that one kidney had three renal arteries (two aberrant renal arteries and one main renal artery), this was identified in 2.7 % of kidneys that they studied. This case may make a partial nephrectomy procedure of either the superior pole or the inferior pole more challenging due to the branching patterns of the renal artery and vein.

According to Wróbel et al [11], the frequency of multiple renal arteries is determined by the features of the population. For instance, in Caucasian and African populations a high incidence of multiple renal arteries is observed (30–40%), compared to the Indian population (13.5%). The frequency also varies depending on ethnicity as well, 4% (Malaysians) and 61.5% (Indians), 32% (Nigerians) have unilateral or bilateral accessory renal arteries [3, 4, 11].

During embryological development, the kidneys rotate ninety degrees along the longitudinal axis as they ascend from the pelvis to their final position [13], as the above embryological position changes fail to happen, it results in malrotation. Kidney malrotation may be classified as a reversed rotation: laterally faced hilum, excessive rotation or hyper-rotation: posteriorly faced hilum, and incomplete rotation: anteriorly faced hilum [14]. The current case is classified as an incomplete rotation as the renal hilum is anteriorly positioned. In the case reported by Wrobel et al [15], the left renal artery was crossing anteriorly in the transverse direction to the kidney forming a loop to reach the hilum, and the hilum of the left kidney

was observed along the lateral border of the organ. The extra-renal calyx is a rare congenital defect and its development mechanism is still unclear [16]. For this renal hilum feature, it can be suggested that the two primordial of the metanephric (definitive) kidney, the mesonephric diverticulum or uretic bud which forms the collecting system of the kidney and the metanephric blastema that develops in the excretory renal tissue had an uncoordinated growth. The extra-renal calyces' anomaly has been associated with renal pelvis obstruction that led to hydronephrosis [17].

## CONCLUSION

In conclusion, this case has shown a ureter connected to the kidney anteriorly rather than the commonly known medial side, with additional renal arteries. Such cases as this may present challenges during a partial nephrectomy. Thus, it will be of interest to perform a pre-operative renal angiogram as a surgery planning investigation to avoid unnecessary complications. This rare extra-renal calyce anomaly is an informative case for medical practitioners.

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