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Case Report
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Bilateral Accessory Renal Arteries: A Cadaveric Case Study

Peters J, Swanke T, Angulo C and Sant D*

Noorda College of Osteopathic Medicine, USA

Abstract

Introduction: The kidneys are bilateral filtration organs that are perfused by the right and left renal artery. The presence of Multiple Renal Arteries (MRA), an anatomical variation, with varying health implications and outcomes. There have been multiple case reports and literature review studies that describe these findings. The current literature uses various classification methods, and this report utilizes the Cases et al. classification system.

Materials and Methods: A cadaveric dissection at Noorda College of Osteopathic Medicine presented with abnormal renal vasculature findings. A standard ruler was used to measure the length and width of each renal artery *in situ*. All measurements were recorded in centimeters by two observers. A camera was utilized to document findings. The data was classified by the Cases system.

Results: Upon dissection, a 75-year-old male donor presented with five renal arteries. The right and left renal arteries originated from the abdominal aorta at the L2 level, and inserted at the renal hilum. Each Renal Accessory Artery (RAA), two on the right, and one on the left, originated at the abdominal aorta bifurcation. Both right RAA's were inserted at the inferior pole of the right kidney, and classified as Type D, Level III pattern. The left RAA was inserted at the inferior pole of the left kidney, and classified as Type D, Level II pattern.

Conclusion: Multiple RAAs were discovered in a cadaver during a dissection lab at Noorda College of Osteopathic Medicine. Further research is needed on multiple RAA's to correlate the clinical implications of these findings.

Introduction

The kidneys filter waste and excess fluid from the body. They are located retroperitoneally on the posterior abdominal wall. Each renal artery supplies its respective kidney. The renal dimensions are typically 10 cm to 12 cm in length, 5 cm to 7 cm wide, and 3 cm to 5 cm thick [1]. In 70% of cases, paired renal arteries stem directly from the abdominal aorta between L1-L2, and connect to the renal hilum. In the remaining 30% of cases, variations of the number of renal arteries have been documented.

Anatomical variations may arise during embryological processes. In the 4th week of development, the intermediate mesoderm differentiates into the metanephros. This is a segmented structure that necessitates nine pairs of lateral mesonephric arterial branches arising from the dorsal aorta [2]. During the 9th week, the kidneys ascend from the sacral to the lumbar region. Arterial branches from the abdominal aorta connect to the kidney, and the earlier arteries typically degenerate [3]. It has been hypothesized that the persistence of the first arterial branches in the sacral region may lead to renal variations. Possible factors include morphological aspects, such as the renal ascent to the lumbar region, fetal curvature, and growth of the lumbar and sacral regions [4].

There is an ongoing debate on classifying renal artery variation findings for international continuity [5]. Many case studies and radiological studies have used different methods to describe such variations. This includes origin and insertion points, unilateral *vs.* bilateral, branching patterns, the total arterial number *vs.* distinction between the main and accessory arteries, and the anatomical terminology [2]. The recent increase in the study of renal arterial variations have revealed demographic correlations with race, ethnicity, and gender [6].

There is a unifying element throughout the literature to further investigate and understand the distinction of these variations. This knowledge may benefit surgeons, nephrologists, radiologists, and urologists during diagnostic or therapeutic intervention. It would assist specialists by mitigating

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***Correspondence:**
Talia Swanke, Noorda College of Osteopathic Medicine, 2162 S 180 E, Provo, UT 84606, USA, Tel: 801-710-1996;

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as much potential for error as possible, as well as decrease associated healthcare complications and costs [7].

This study aims to add to the growing body of documented cases regarding renal arterial variations. The researchers use the terminology of Multiple Renal Arteries (MRA) and Renal Accessory Artery (RAA) to describe the anatomical variations. The data was organized from an adaptation of Cases, et al. [8] literature review and classification proposal.

Case Presentation

At Noorda College of Osteopathic Medicine, a cadaver dissection revealed a 75-year-old male donor with five total renal arteries. The donor died from atrial fibrillation, secondary to chronic hypertension and type II diabetes.

During a routine dissection, it was noted that on the right kidney, two Renal Accessory Arteries (RAA) were present, and on the left kidney, one RAA was present. The length and diameter of said renal arteries were measured. All measurements were recorded in centimeters by two observers. A camera was utilized to document findings.

The Cases [8] classification system was utilized because it intersects two aspects of renal arterial variations. The first category is defined by the number of renal arteries entering each kidney, defined as "Patterns". Patterns are represented by numerical frequency from one to five. The second category distinguishes each arterial origin and insertion point, defined as "Types". Types are represented by an alphabetical order from a-e [8].

The artery in the type "a" group represents traditional anatomical placement by arising from the abdominal aorta and inserting at the hilum of the kidney. The acronym "ha" is used to label the hilar artery. The type "b" group specifies an accessory artery arising from the hilar renal artery and inserting at the upper pole of the kidney. The acronym "hup" is used to label a hilar upper polar artery. The type "c" group recognizes a second artery arising from the aorta and inserting at the upper renal pole. The acronym "aup" is used to label an aortic upper polar artery. The type d group describes a second artery arising from the aorta and inserting at the lower renal pole. The acronym "alp" is used to label an aortic lower pole renal artery. The type e group specifies a second artery arising from the hilar artery and inserting at the lower renal pole. The acronym "hlp" is used to label hilar lower polar renal artery [8] (Figure 1).

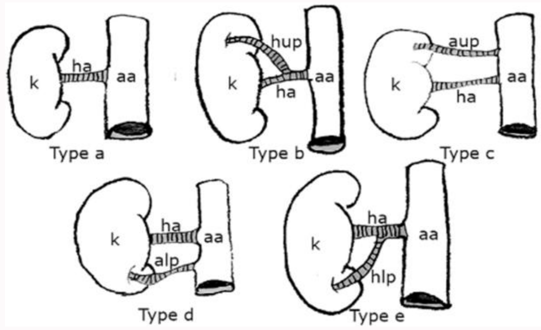

Figure 1: Adapted from cases, et al. [8] proposed classification system.

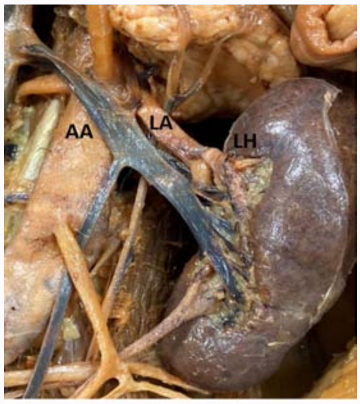

Figure 2: Image showing the Left Renal Artery (LA) originating at the Abdominal Aorta (AA), inserting to the Hilum (LH) of the left kidney.

Figure 3: Image showing the left RAA (LRA) originating at the Aortic Bifurcation (AB), inserting to the Inferior Pole (LIP) of the left kidney.

Results and Discussion

Left kidney

The cadaver's left kidney was connected to the abdominal aorta by two arteries. The main artery was classified as type "a", pattern II artery. The RAA was classified as type "d", pattern II artery. It originated at the aortic bifurcation and inserted at the left inferior renal pole. Both were within the normal range for length (4-6 cm) and width (0.5-0.6 cm) (Figure 2, 3 and Table 1).

Right kidney

The cadaver's right kidney was joined to the aorta by three renal arteries. The main artery was assigned a type a, pattern III classification. The two right RAA, like the left RAA, both originated from the aortic bifurcation. Both right RAA were classified as type "d", pattern III. All were within the normal range for length (4-6 cm) and width (0.5-0.6 cm) (Figures 4-6 and Table 2).

Renal arterial variations have been cited in previous literature to exist in up to 20% to 30% of the general population. This significant faction has been further researched to assess the frequency of MRA among different races, to show demographic correlation from multiple sources. The main findings listed the most frequent as black people, with 37% of the population estimated to possess MRA. White people were listed second with 35% among the population. Finally, 17% of the Indian population was listed to have MRA [2]. In this case study, the cadaver was a white male, making up part of the 35% population with MRA.

The number, size, and course of RAA are frequently compared to dominant renal arteries, as well as other RAA, when multiple present.

Table 1: Anatomical details of the left renal arterial variations.

Left Kidney	Arterial Type/Pattern	Origin	Insertion	Length (cm)	Width (cm)
Renal Artery	Type A/II	Abdominal Aorta	Hilum	7.2	0.5
RAA	Type D/II	Aortic Bifurcation	Inferior Pole	8.2	0.5

Figure 4: Image showing the right Renal Artery (RA) originating at the Abdominal Aortic (AA), inserting to the Hilum (RH) of the right kidney.

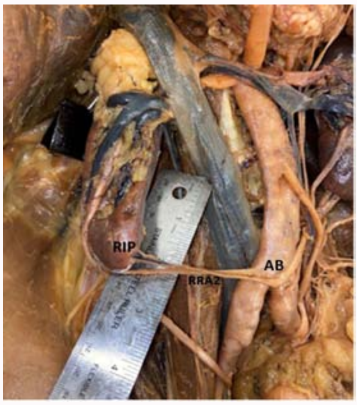

Figure 6: Image showing the 2nd right RAA (RAA2) originating at the aortic bifurcation (AB), inserting to the Inferior Pole (RIP) of the right kidney.

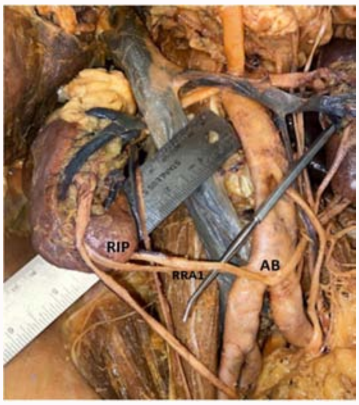

Figure 5: Image showing the 1st Right RAA (RAA1) originating at the aortic bifurcation (AB), inserting to the Inferior Pole (RIP) of the right kidney.

It has been reported that RAA inserting into the renal hilum are typically the same size overall as normal renal arteries, but larger than polar RAA [6]. The cadaver in this case study had RAA with similar width, but an average of 1.45 cm longer compared to the dominant arteries. In extremely rare cases, MRA are present on both right and left kidneys, and contribute to approximately 1% of variations in branching patterns of the renal arteries [9].

A new classification system has been proposed in the article "Anatomical variations of the renal arteries: Cadaveric and radiologic study, review of the literature, and proposal of a new classification of clinical interest" [8]. The authors recommend a dual system based on arterial types and patterns. The arterial types are separated based on RAA origin and insertion. The arterial pattern will note the total number of arteries supplying each kidney.

MRA could result in ureter obstruction, which may lead to hydronephrosis [3]. There are a small number of case reports correlating renin dependent hypertension and RAA [10]. The RAA length and narrowed diameter may lead to a hypoperfused kidney [11].

General recommendations narrow screening for secondary hypertension to be performed only in patients with high clinical suspicion. However, this cadaver had chronic hypertension and type II diabetes, common comorbidities, likely raising no clinical suspicion. If a secondary cause of hypertension is identified and treated, blood pressure rarely returns to normal. This suggests vascular remodeling is involved, which relates to the cadaver's chronic hypertension [12]. This case should not prompt indiscriminate interventions in hypertensive patients with accessory renal arteries. However, it should alert physicians to the possibility of the occasional causal role of accessory renal arteries in patients with severe and difficult to manage hypertension.

Conclusion

This cadaver has an anatomical variation with a ~1% prevalence of occurring: the left ki dney has type "d", pattern II RAA. The right kidney has type "d", pattern III RAA. Case studies on renal arteries can further the advancement of healthcare in medical and surgical scenarios.

In utilizing the Cases classification system, it lacks description of insertion points on the anterior and posterior surfaces, as well as the lateral and medial borders. An alternative classification system with these inclusion criteria may benefit towards an international

Table 2: Anatomical details of the right renal arterial variations.

Right Kidney	Arterial Type/Pattern	Origin	Insertion	Length (cm)	Width (cm)
Renal Artery	Type A/III	Abdominal Aorta	Hilum	6.8	0.5
1st RAA	Type D/III	Aortic Bifurcation	Inferior Pole	8.7	0.4
2nd RAA	Type D/III	Aortic Bifurcation	Inferior Pole	8.7	0.4

consensus on the classification of renal arterial variations.

Acknowledgement

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